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COCONUT VARIETIES AND HYBRIDS

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LIST OF ABBREVIATIONS

COD	Chowghat Orange Dwarf
WCT	West Coast Tall
LCT	Laccadive Ordinary Tall
MYD	Malayan Yellow Dwarf
CGD	Chowghat Green Dwarf
TPT	Tiptur Tall
GBGD	Gangabondam Green Dwarf
ADOT	Andaman Ordinary Tall
SSAT	Straits Settlement Apricot Tall
MGD	Malayan Green Dwarf
ECT	East Coast Tall
MOD	Malayan Orange Dwarf
FJT	Fiji Tall
PHOT	Philippines Ordinary Tall
KGD	Kulasekharam Green Dwarf
LCGD	Laccadive Green Dwarf
LCOD	Laccadive Orange Dwarf
WAT	West African Tall
EAT32	Kenya Tall
RWD	Root (wilt) disease
NCD	Naturally Crossed Dwarf
NGOs	Non Governmental Organisations
CPCRI	Central Plantation Crops Research Institute
NBPGR	National Bureau of Plant Genetic Resources
SAUs	State Agricultural Universities
AICRPP	All India Coordinated Research Project on Palms
CARI	Central Agricultural Research Institute
ANGRAU	Acharya N. G. Ranga Agricultural University
KAU	Kerala Agricultural University
BCKV	Bidhan Chandra Krishi Viswavidyalaya
Dr. BSKKV	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth
AAU	Assam Agricultural University
TNAU	Tamil Nadu Agricultural University
IGAU	Indira Gandhi Agricultural University
Dr. YSRHU	Dr. YSR Horticultural University
UHS	University of Horticultural Sciences

1. Introduction

The coconut palm, *Cocos nucifera* L., is a multi-purpose palm grown widely in the humid tropics and in India is referred to as 'Kalpavriksha' 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 domestic and industrial use. About 10 million families depend on coconut for their livelihood and as an important oil crop in the country, it contributes about 6 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 being promoted for consumption.

Global production of coconut is widely dispersed in most of the tropical regions, with 12.47 million hectares of global area under this crop. However, close to nine million hectares (about 75 percent of the total area) is contributed by only three countries, namely Indonesia, Philippines and India. In India, coconut is grown in an area of 2.07 million hectares with an annual production of 23351 million nuts and a per hectare productivity of 11277 nuts/ha (Coconut Development Board, 2011-12). Globally, India stands third in area, first in production and first in productivity of coconut. Kerala, Karnataka, Tamil Nadu and Andhra Pradesh, are the four major coconut cultivating states in the country and the state of Tamil Nadu with an annual production of 4.94 million metric tons of copra is the leading coconut producer, followed by Kerala, Karnataka and Andhra Pradesh, with annual production of 3.97, 3.79 and 1.27 million metric tons, respectively.

The average national productivity of coconut in India is around 63 nuts per palm per year. In contrast, 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 focussed on development of high yielding coconut varieties.

2. Coconut genetic resources

In coconut, the palms are commonly categorized into two broad categories – talls and dwarfs, based on the plant habit. The Tall palms are the most commonly cultivated for commercial production in all coconut growing regions of the world. Dwarf palms have gained importance in recent times due to tender nut water qualities and resistance to certain diseases. The general features of talls and dwarfs are listed below.

General characteristics of Tall and Dwarf coconut varieties

Trait	Tall	Dwarf
Stem circumference	Sturdy with bole at base	Thin without bole at base
Initiation of flowering	Late (5 - 7 years)	Early (3 - 4 years)
Mode of pollination	Predominantly cross pollinated	Predominantly self pollinated
Colour of fruits and petioles	Generally mixtures of greens and browns	Either pure green, yellow, red (orange) or brown
Arrangement of leaf scars on the trunk	Widely spaced	Closely spaced
Fruit size	Very small to very big	Small to medium
Phenotypic variation Within cultivar Between cultivars	 High High	 Low High
Leaf and bunch attachment	Very strong	Fragile
Root distribution	Generally more dense and plentiful	Less dense and few
Productive life span	About 60 years	About 40 years

Locating, maintaining and using genetic diversity is essential for crop improvement. Central Plantation Crops Research Institute (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 433 coconut accessions, including 132 exotic and 301 indigenous collections. In addition, CPCRI also hosts the International Coconut Gene Bank for South Asia at CPCRI Research Centre, Kidu in Karnataka.

The germplasm base is utilized in the coconut improvement programme for development of improved varieties suitable for different coconut growing regions of the country, through selection and hybridization. So far, 15 coconut hybrid varieties and 27 selections have been developed and released for commercial cultivation in different agro-climatic zones and states of the country.

3. Varieties developed through selection

The large collection of coconut germplasm maintained at CPCRI is being characterized and evaluated for agronomic characters and yield performance at the institute. Promising accessions are then evaluated for their performance and

regional adaptability at the centres under the All India Coordinated Research Project on Palms, namely, Aliyarnagar and Veppankulam in Tamil Nadu, Ambajipeta in Andhra Pradesh, Arsikere in Karnataka, Bhubaneshwar in Orissa, Jagadalpur in Chattisgarh, Kahikuchi in Assam, Mondouri in West Bengal, Ratnagiri in Maharashtra, Pilicode in Kerala, Sabour in Bihar and Navsari in Gujarat.

Selection and evaluation of promising accessions conserved both at the institute, the coordinating centres under the All India Coordinated Research Project on Palms and the State Agricultural Universities have resulted in the development and release of 27 high yielding varieties of coconut, suitable for different agroclimatic zones, through application of mass selection. 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 of coconut. Chowghat Orange Dwarf (COD) is recommended as the best tender nut variety. The improved varieties are capable of producing 1.63 to 4.8 tons of copra/ha/year. The table below indicates the varieties suitable for cultivation in the different states of the country.

Improved coconut varieties developed through selection

Variety	Important traits	Nut yield (nuts ha^{-1} $year^{-1}$)@	Copra yield (t ha^{-1} $year^{-1}$)@	Recommended states/regions	Agency responsible for release
Tall					
Chandra Kalpa	Drought tolerant, high copra oil content, suitable for neera tapping	17700	3.12	Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra	CPCRI
Kerachandra	High yield, dual purpose variety for copra and tender nut, suitable for soap industry	19470	3.86	Kerala, Karnataka, Konkan region, Andhra Pradesh, West Bengal	CPCRI

Kalpa Pratibha	High nut, oil yield, dual purpose variety for copra and tender nut	16107	4.12	Kerala, Andhra Pradesh, Tamil Nadu, Maharashtra	CPCRI
Kalpa Mitra	High nut, oil yield, drought tolerant	15222	3.68	Kerala, West Bengal	CPCRI
Kalpa Dhenu	High nut, oil yield, drought tolerant	14160	3.41	Kerala, Tamil Nadu, Andaman & Nicobar Islands	CPCRI
Kalpa Haritha	Dual purpose variety for copra and tender nut, less eriophyid mite damage	20886	3.70	Kerala, Karnataka	CPCRI
Kalpatharu	Drought tolerant, ball copra, high yield, coir fibre amenable for dyeing	20709	3.64	Kerala, Karnataka, Tamil Nadu	University of Horticultural Sciences (UHS), Karnataka
Pratap	High yield	26727	4.01	Maharashtra	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (Dr.BSKKV), Maharashtra
Kamrupa	High yield	17877	2.90	Assam	Assam Agricultural University (AAU), Assam
ALR (CN) 1	High yield	22302	3.50	Tamil Nadu	Tamil Nadu Agricultural University (TNAU), Tamil Nadu
Kera Bastar	High yield	19470	3.18	Chhattisgarh, Maharashtra, Tamil Nadu, Andhra Pradesh	Indira Gandhi Agricultural University (IGAU), Chhatisgarh

Kalyani Coconut 1	High yield	14160	3.84	West Bengal	Bidhan Chandra Krishi Viswavidyalaya (BCKV), West Bengal
Kera Keralam	High yield, drought tolerant, suitable for neera tapping	26019	3.53	Tamil Nadu, West Bengal, Kerala	TNAU
ALR (CN) 2	High yield	21240	2.89	Tamil Nadu	TNAU
VPM-3	High yield, drought tolerant	14868	3.41	Tamil Nadu	TNAU
Kera Sagara	High yield	17523	3.64	Kerala	Kerala Agricultural University (KAU), Kerala
Dwarf/Semi Tall					
Chowghat Orange Dwarf	Tender nut purpose, orange colour fruit, coarse fibre	19824	2.78	All coconut growing regions for tender nut	CPCRI
Kalparaksha	Semi-tall, green colour fruit,high nut and oil yield in RWD prevalent areas, tender nut purpose	13260 (17748)#	2.85 (3.34)#	Kerala, Root (wilt) disease prevalent tracts	CPCRI
Gouthami Ganga	Tender nut purpose, green colour fruit	11505	1.80	Andhra Pradesh	Acharya N. G. Ranga Agricultural University (ANGRAU), Andhra Pradesh

Kalpasree	Early flowering, green colour fruit; superior oil- rich in linoleic acid recommended for root (wilt) diseased areas	15930	1.54	Root (wilt) disease prevalent tracts	CPCRI
Kalpa Jyothi	Tender nut purpose, yellow colour fruit	20178	2.86	Kerala, Karnataka, Assam	CPCRI
Kalpa Surya	Tender nut purpose, orange colour fruit	21771	4.07	Kerala, Karnataka, Tamil Nadu	CPCRI
Kera Madhura	Semi-tall, dual purpose variety for copra and tender nut	24480	4.80	Kerala	KAU
CARI-C1 (Annapurna)	High copra content, tender nut purpose, green colour fruit	9133	2.20	Andaman & Nicobar Islands	Central Agricultural Research Institute (CARI), Andamans
CARI - C2 (Surya)	Ornamental purpose, orange colour fruit	20231	1.41	Andaman & Nicobar Islands	CARI
CARI - C3 (Omkar)	Ornamental purpose, yellow colour fruit	24072	1.77	Andaman & Nicobar Islands	CARI
CARI - C4 (Chandan)	Ornamental purpose, orange colour fruit	16373	1.67	Andaman & Nicobar Islands	CARI

[@ - Yield estimated, at 7. 5 m x 7.5 m spacing, population of 177 palms ha^{-1}; # - Figures in parenthesis indicate yield in root (wilt) disease free tracts]

4. Varieties developed through hybridization

In India, heterosis breeding has been employed for development of hybrid coconut varieties by crossing indigenous and exotic selections of Talls and Dwarfs. The first coconut hybrid in the country was produced at the erstwhile Central Coconut Research Station, Kasaragod 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 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, 19 hybrids, including eight superior Dwarf x Tall hybrid varieties and 11 Tall x Dwarf hybrid varieties have been developed in India for commercial cultivation in different regions across the country. These hybrids are capable of producing 2.79 to 6.28 tons of copra/ha/year.

Coconut hybrids released for commercial cultivation in India

Hybrid Variety	Source population of parents	Important traits	Nut yield@ (nuts ha^{-1} $year^{-1}$)	Copra yield@ (t ha^{-1} $year^{-1}$)	Area recommended	Agency responsible for release
Chandra Sankara	COD x WCT	High yield	20532	4.27	Kerala, Karnataka, Tamil Nadu	CPCRI
Kera Sankara	WCT x COD	High yield, drought tolerant	19116	3.78	Kerala, Karnataka, Maharashtra, Andhra Pradesh	CPCRI
Chandra Laksha	LCT x COD	High yield, drought tolerant	19293	3.76	Kerala, Karnataka	CPCRI

Kalpa Samrudhi	MYD x WCT	Dual purpose variety, drought tolerant, higher nutrient use efficiency	20744	4.35	Kerala, Assam	CPCRI
Kalpa Sankara	CGD x WCT	Tolerant to root (wilt) disease, high yield	14868	3.20	Root (wilt) disease prevalent tracts	CPCRI
Kalpa Sreshta	MYD x TPT	Dual purpose variety, High yield	29227	6.28	Kerala, Karnataka	CPCRI
Laksha Ganga	LCT x GBGD	High yield	19116	3.73	Kerala	KAU
Ananda Ganga	ADOT x GBGD	High yield	16815	3.63	Kerala	KAU
Kera Ganga	WCT x GBGD	High yield	17700	3.56	Kerala	KAU
Kera Sree	WCT x MYD	High yield	23364	5.05	Kerala	KAU
Kera Sowbhagya	WCT x SSAT	High yield	23010	4.49	Kerala	KAU
VHC-1	ECT x MGD	High yield	21240	2.87	Tamil Nadu	TNAU
VHC-2	ECT x MYD	High yield	25134	3.74	Tamil Nadu	TNAU
VHC-3	ECT x MOD	High yield	27612	4.47	Tamil Nadu	TNAU
Godavari Ganga	ECT x GBGD	High yield	18585	2.79	Andhra Pradesh	ANGRAU
Konkan Bhatye coconut hybrid 1	GBGD x ECT	High yield	20532	3.47	Maharashtra	Dr. BSKKV

Kalpa Ganga	GBGD x FJT	High yield, suitable for ball copra production	21417	3.38	Karnataka	UHS
Vasista Ganga	GBGD x PHOT	High yield	22125	3.88	Andhra Pradesh, Karnataka	Dr YSR Horticultural University (Dr.YSRHU), Andhra Pradesh
Ananta Ganga	GBGD x LCT	High yield	22656	3.84	Andhra Pradesh, Karnataka	Dr.YSRHU

@ - Yield estimated, at 7. 5 m x 7.5 m spacing, population of 177 palms ha^{-1}

5. Coconut varieties from 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, a brief account of the characteristic features of the varieties developed by the institute and recommended for commercial cultivation are described in the following paragraphs.

Among the 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 resistant varieties. Kalpa Pratibha, Kerachandra and Kalpa Haritha are recommended as 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, Kera Keralam and Kalpatharu are also relatively tolerant to drought.

5.1 Dwarf/Semi Tall varieties

5.1.1 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. Under average management, the average annual nut yield is only 63 nuts/palm.

The fruits are small with an average weight of 634 g and average copra content of 128 g/nut and 66% oil. Chowghat Orange Dwarf was found to have the higher total sugar content in the tender nut water on comparative evaluation of tender nut water quality in 44 accessions at CPCRI, Kasaragod and hence was developed by CPCRI as a tender nut variety. The tender nut water of 7 month old fruit is sweet with total sugar - 7 g/100 ml and sodium and potassium of 20 ppm and 2000 ppm, respectively and organoleptically graded as 'very good'. 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.

Chowghat Orange Dwarf – a popular tender nut variety

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.

5.1.2 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 kernel 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 - 2150 ppm, sodium - 22.40 ppm. The data on fatty acid profile of the coconut oil from this variety, reveals that Kalpasree is rich in 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.

Kalpasree - a root (wilt) disease resistant variety

The recommendation as a root (wilt) disease resistant variety 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.

5.1.3 Kalpa Jyothi

Kalpa Jyothi variety is derived from the CPCRI accession IND 058, Malayan Yellow Dwarf an introduction from Malaysia, acquired in 1961. The population was developed at CPCRI through selection of superior high yielding palms and *inter se* mating the selected palms. This variety was evaluated and found to perform well with comparatively higher yield over the Chowghat Orange Dwarf variety at CPCRI, Kasaragod. The variety was also found to perform well at CPCRI Research Centre Kidu and also at

the AICRP on Palm centres in Karnataka and Assam. Kalpa Jyothi gives an average yield of 114 nuts per palm per year, higher than 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 dwarf in habit with a compact spherical canopy and drooping frond tip. The fruits are medium, oval in shape and yellow in colour. The quantity of tender nut water is around 380 ml and good in taste with TSS of 5.9^0 Brix. The nutritive value of tender nut water: total sugars – 6.2 g/100 ml, free amino acids -1.7 mg/100 ml, 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 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 have been observed under field conditions. However, the palms of this variety are moderately susceptible to bud rot. No major pest attacks have been 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 eriophyid mite. Dwarf varieties in general are

Kalpa Jyothi - fruit bunch

Kalpa Jyothi - a dwarf tender nut variety

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.

Considering the superiority of this dwarf variety for nut yield, coupled with tender nut water quality, the XXI Group Meeting of the All India Coordinated Research Project on Palms during the year 2012 recommended the variety 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 the pedestrians.

5.1.4 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 and drooping frond tip. The fruits are medium, oval in shape and orange in colour. Under irrigated conditions, the palm

Early sprouting - Kalpa Surya seed nut

Kalpa Surya - a dwarf tender nut variety

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 organoleptic evaluation; the tender nut water is classified as "very good" in taste. The quantity of tender nut water is around 400 ml with TSS of 6.2^0 Brix. The nutritive value of tender nut water: total sugars - 6.7 g/100 ml, free amino acids - 1.8 mg/100 ml, 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 and disease outbreaks have been observed under field conditions. However, palms of this variety are moderately affected by eriophyid mite, as well as rhinoceros beetle and red palm weevil. The palms of this variety are moderately susceptible to bud rot and fruit rot.

Kalpa Surya is recommended for cultivation in the coconut growing tracts of Kerala, Karnataka, Tamil Nadu states as a dwarf tender nut variety in the XXI Group Meeting 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, Coconut Research Station, Aliyarnagar, Tamil Nadu and Arsikere, Karnataka under AICRP on Palms. 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.

5.1.5 Kalparaksha

Kalparaksha is a 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 and is superior to WCT in all important yield attributes in the root (wilt) disease tracts of Kerala. No major pest attacks have been observed in this variety in field conditions. However, under large-scale planting, precaution is advised against red palm weevil incidence.

Kalparaksha - a root (wilt) disease resistant variety

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.

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 - 2100 ppm, sodium - 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 and released by the 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.

5.2 Tall varieties

5.2.1 Chandra Kalpa

Chandra Kalpa was developed by CPCRI, Kasaragod during the year 1985. It is a selection from IND008, Lakshadweep Ordinary Tall (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 is 17 kg/palm/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 ton 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 organoleptically graded as "good" in taste. The tender nut water has total sugar - 4.2 g/100 ml, sodium - 50 ppm and potassium - 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 centres under AICRP on Palms.

Chandra Kalpa - a high yielding ball copra variety

5.2.2 Kerachandra

Kerachandra 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 at the age of 25 years, 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, 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.

Kerachandra - a high yielding dual purpose variety

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

Kerachandra shows superior performance at CPCRI Kasaragod in coastal Kerala and also in the AICRP on Palms centres in Maharashtra, West Bengal and Andhra Pradesh. Because of its high yield potential, Kerachandra 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.

5.2.3 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 1332 g and from one fruit, on an average, 256.37 g 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.

Kalpa Pratibha- a high yielding dual purpose variety

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 per ha per year, with an estimated yield of 5.97 tons of copra having 4.01 tons of oil.

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 centres of AICRP on Palms at 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.

5.2.4 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. 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. 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 per ha which can give, 5.56 tons of copra having 3.64 tons of oil.

The average weight of the fruit is around 1381.26 g and 243.93 g 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 290 ml. Based on the organoleptic evaluation, the tender nut water is classified as "average" in taste. The nutritive value of tender nut water is as follows: total sugars - 4.92 g/100 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. The 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 Dhenu- a high yielding variety

5.2.5 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 t copra/ha; 2.24 t oil/ha; 13973 nuts/ha (under rainfed condition). The variety is found superior over local control (WCT) with an estimated 16.01% and 13.45% higher copra and oil yield, 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 per ha which can give, 5.41 tons of copra having 3.60 tons of oil.

The average weight of the fruit is 1001.19 g and, on an average, 241.14 g 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 495 ml. Based on organoleptic evaluation, the tender nut water is classified as "average" in taste. The nutritive value of tender nut water is: total sugars - 5.7 g/100 ml; free amino acids - 1.3 mg/100 ml; potassium - 2150 ppm; sodium - 23.5 ppm.

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.

Kalpa Mitra - a high yielding drought tolerant variety

5.2.6 Kalpatharu

Kalpatharu is a high yielding variety, developed by selection of high yielding palms from Tiptur tall coconut population, a popular cultivar 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 fruits being round in shape. This variety gives an average nut yield of 117 nuts/annum/palm 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 weight 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 tons 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 g/100 ml; free amino acids - 2.9 mg/100 ml; 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

Kalpatharu - a high yielding ball copra variety

in Tamil Nadu. This variety has wider adaptability and would help in enhancing the productivity in the states of Karnataka, Tamil Nadu and Kerala.

5.2.7 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. 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, Veppankulam, and Mondouri, the XVIII Biennial Workshop of the All India Coordinated Research Project on Palms during the year 2007 recommended Kera Keralam for large scale commercial

Kera Keralam - a drought tolerant variety

cultivation in the states of Tamil Nadu, Kerala and West Bengal. CPCRI is a participating institute in developing this variety which was released by AICRP on Palms. The variety was subsequently released by the Central Sub-committee on Crop Standards, Notification and Release for cultivation in the states of Tamil Nadu, Kerala and West Bengal 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.

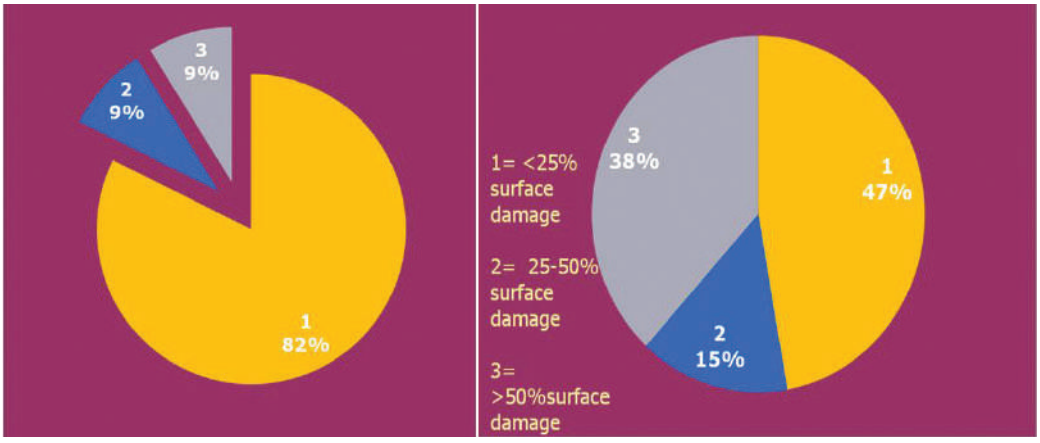
5.2.8 Kalpa Haritha

Kalpa Haritha variety is a tall selection derived from the CPCRI coconut accession IND045, Kulasekharam Green Dwarf (KGD), 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, 3.72 t/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 husked 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 of 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 are observed under field conditions. The palms of 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.

Kalpa Haritha - a dual purpose variety

Distribution pattern of eriophyid mite infested nuts in Kalpa Haritha



The average quantity of tender nut water is about 440 ml. Based on the organoleptic evaluation, the tender nut water is classified as "very good" in taste with a TSS of 5.85^0 Brix. The tender nut water has sodium - 17.5 ppm and potassium - 2100 ppm. The average fruit weight of Kalpa Haritha variety is 914 g, with copra content of 216 g/nut and 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. 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 Group Meeting of the All India Coordinated Research Project on Palms during the year 2012 recommended 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 per year which can provide 6.56 tons copra per ha, yielding up to 4.3 tons oil per ha.

5.3 Hybrid Varieties

Among the six hybrids developed and released for commercial cultivation by the institute, Kalpa Samrudhi and Kalpa Sreshta are recommended as dual purpose varieties for copra and tender nut purpose. Kalpa Samrudhi is relatively tolerant to drought and also has high nutrient use efficiency. Kalpa Sankara is tolerant to coconut root (wilt) disease and recommended for cultivation in the root (wilt) affected tracts of the country. Besides, two hybrids, LCGD x LCT, LCOD x LCT were identified as superior hybrids

suitable for cultivation in Lakshadweep Islands and three hybrids, namely, COD x WAT, COD x LCT and MYD x EAT32 were identified as superior hybrids suitable for cultivation in Kerala and these hybrids have been recommended by Institute Research Committee of CPCRI for further exploitation.

5.3.1 Chandra Sankara

Chandra Sankara was the first hybrid developed at the institute to be recommended for commercial cultivation in the year 1985 and is the most popular Dwarf x Tall (D x T) hybrid in the country. This hybrid was produced by crossing Chowghat Orange Dwarf palms (female parent) with pollen from elite West Coast Tall palms (male parent). The palms come to bearing early when compared to the tall WCT parent. The palms of this variety are semi tall in habit, with circular canopy. The average time taken for flowering is about 3 - 4 years, under favourable growth conditions. The fruits are round in shape and brown in colour. It is a heavy yielder and produces, on an average, 110-123 nuts/palm/year, with an estimated copra yield of 25-28 kg copra/palm/year or 4.40-4.82 t copra/ha yielding 2.99 t oil/ha. The hybrid progenies can easily be identified in the nursery, since the hybrid seedlings exhibit vigorous growth coupled with bronze-coloured petioles.

Chandra Sankara - a high yielding D x T hybrid variety

The fruits are medium-sized and the mean copra content is around 208-225 g and the oil content in copra is 64-68 per cent. Chandra Sankara is susceptible to drought and hence irrigation is required during the summer months. The hybrid performs better under good management conditions and is not recommended for cultivation in rainfed plantations. Chandra Sankara developed by CPCRI was also found superior to the local check, WCT in the AICRP on Palms centres and hence the VII Biennial Workshop of the All India Coordinated Research Project on Palms, in the year 1985, recommended this hybrid variety, Chandra Sankara, for large scale commercial cultivation in the states of Kerala, Karnataka and Tamil Nadu.

5.3.2 Chandra Laksha

This is the first Tall x Dwarf hybrid recommended for commercial cultivation by CPCRI and is a cross between Lakshadweep Ordinary Tall as female

parent and Chowghat Orange Dwarf as male parent. The palms of this variety are tall in habit, with circular canopy. The hybrid comes to flowering four years after of planting, under good management. The mean annual yield is 109 nuts per palm with an estimated copra yield of 21.3 kg copra/palm/year. Under irrigated conditions and good management, the hybrid variety Chandra Laksha produces higher average yield of 175 nuts per palm per year with estimated yield of 30.10 kg copra/palm/year and can yield 3.37 t oil/ha/year.

The fruits are oval in shape and medium-sized with a copra content of 195 g per nut and copra oil content of 69 per cent. This hybrid performs better than Chandra Sankara and Kera Sankara under moisture stress situation. This hybrid has been released by CPCRI in the VII Biennial Workshop of the All India Coordinated Research Project on Palms, in the year 1985, for cultivation in Kerala, Karnataka and Tamil Nadu, based on the superior performance of this hybrid under evaluation at CPCRI Kasaragod and coordinating research centres at Arsikere in Karnataka and Veppankulam in Tamil Nadu.

5.3.3 Kera Sankara

This is a popular Tall x Dwarf hybrid between West Coast Tall as female parent and Chowghat Orange Dwarf as male parent. The hybrid palms are precocious and exhibit higher productivity than the parents. The palms of this variety are tall in habit, with circular canopy. The palm comes to flowering by the fourth year of planting, under good management. The mean per palm annual yield of nuts is 108 with an estimated copra yield of 20.2 kg copra/palm/year.

The fruits are oval in shape, medium-sized and the average copra content

Chandra Laksha - a high yielding drought tolerant hybrid variety

Kera Sankara - a precocious T x D hybrid variety

is 187 g/nut with 68 per cent oil in the copra. This hybrid gives higher yields under good management and irrigation. However, Kera Sankara, unlike Chandra Sankara, can also perform well under rainfed conditions. This hybrid proposed by CPCRI was recommended by the X Biennial Workshop of the All India Coordinated Research Project on Palms, in the year 1991, for large scale commercial cultivation in Kerala, coastal Andhra Pradesh and coastal Maharashtra based on the superior performance at CPCRI and the AICRP on Palm centres.

5.3.4 Kalpa Samrudhi

Kalpa Samrudhi is a high yielding D x T hybrid involving MYD as the female parent and WCT as the male/pollen parent. It is a dual-purpose variety, suitable for copra and tender nut purpose. The palms of this variety are semi-tall with compact spherical canopy. The palms are regular bearers and commence flowering 5 years after planting, under rainfed conditions. However, under irrigated conditions, the palms commence flowering about 3 to 4 years after planting. The colour of the leaf petiole and fruits are green. The fruits are oval in shape, while the husked fruits are round in shape. The average nut yield of this variety is 117 nuts/palm/annum, under rain fedconditions, with an estimated annual copra yield of 4.5 tons/ha and oil yield of 3.04 tons/ha. The variety is superior to Chandra Sankara, the earlier released D x T hybrid, and the annual average nut, copra and oil yield per hectare is 30.27%, 66.05% and 73.71% higher than Chandra Sankara, respectively. The seed nuts germinate early and produce vigorous seedlings.

The average weight of the fruits of this variety is 1032.33 g with average copra content of 219.46 g and copra oil content of 67.5%. The oil extracted from the copra of this hybrid has 45.4% lauric acid. The quantity of tender nut water is around 346 ml/nut with good tender nut quality (TSS - 6^0 Brix). The nutritive value of tender nut water is as follows: total sugars - 4.17 g/100 ml; free amino acids - 2.08 mg/100 ml; potassium - 2370 ppm; sodium - 35.1 ppm.

Kalpa Samrudhi is also relatively drought tolerant when compared to Chandra Sankara, based on physiological parameters. Further, the seedlings of

Kalpa Samrudhi - a high yielding dual purpose D x T hybrid variety

this variety recorded higher nitrogen use efficiency when compared to Chandra Sankara. Considering the superior performance of the variety at CPCRI, Kasaragod in Coastal Kerala and AICRPP Centre, Kahikuchi, Assam, Kalpa Samrudhi was recommended for cultivation in the states of Kerala and Assam by XIX Biennial Workshop of the All India Coordinated Research Project on Palms in 2009. The variety has been approved for release by the Central Sub-committee on Crop Standards, Notification and Release in 2012, for cultivation in the states of Assam and Kerala and notification of Ministry Agriculture (Department of Agriculture and Co-operation) is awaited.

5.3.4 Kalpa Sankara

Kalpa Sankara is a D x T coconut hybrid developed in 'hotspots' of root (wilt) disease by crossing root (wilt) disease-free Chowghat Green Dwarf female parents with pollen of root (wilt) disease-free West Coast Tall male parents. Kalpa Sankara is found to be a high yielding root (wilt) disease tolerant variety suitable for cultivation in the root (wilt) affected tracts in the country. The palms of this variety are semi-tall in nature with precocious bearing habit. The palms attain a height of around 4.98 m at 18 years of age and come to flowering 3-4 years after planting. The quantity of tender nut water

Kalpa Sankara - a root (wilt) disease tolerant hybrid variety

is 373 ml and sweet in taste.

Kalpa Sankara requires adequate plant protection measures against major pests particularly red palm weevil when large scale plantings are adopted. Drought tolerance studies using different coconut hybrids reveals that tolerance to moisture stress was significant in Kalpa Sankara. The hybrid gives better yield under rainfed conditions in farmer's plots in the root (wilt) disease prevalent tract. Considering the superior performance of the hybrid coconut variety Kalpa Sankara at CPCRI Regional Station, Kayamkulam, located in the root (wilt) diseased tract, the variety was proposed for release by CPCRI and recommended by XIX Biennial Workshop of the All India Coordinated Research Project on Palms in the year 2009 for release for cultivation in the root (wilt) affected tracts in the country. Kalpa Sankara was 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.

5.3.5 Kalpa Sreshta

Kalpa Sreshta is a high yielding, D x T hybrid involving selections from MYD as the female parent and selections from Tiptur Tall (TPT) as the male/pollen parent. The female parent palms are dwarf, takes 38 months for flowering, bears bright yellow fruits and has yellow petiole colour. The male parent palms are tall, bearing green fruits and takes about 87 months for flowering. Kalpa Sreshta is a dual-purpose variety, suitable for cultivation as copra and tender nut variety. The palms of this variety are tall in plant habit and attain an average height of 10.05 m, 23 years after planting. The palms are without prominent bole. The colour of the petiole is green. Kalpa Sreshta is characterized by vigorous growth habit, higher rate of spathe production, high nut yield; green coloured fruits; more female flowers/inflorescence and tender nuts having more water with good taste. The fruits of this variety are oval shaped, with the husked fruits being round in shape. The palms of Kalpa Sreshta are regular bearers and commence flowering in 6-7 years after planting. However, under irrigated conditions, the palms are expected to commence flowering within 4 years after planting. The average nut yield of this variety is 167 nuts/palm/annum, under irrigated conditions, with an estimated annual copra out turn of 35.9 kg/palm/year (6.28 t/ha copra). Kalpa Sreshta is superior to Chandra Sankara, the earlier released D x T hybrid (COD x WCT), and gives 35.75% more

Kalpa Sreshta - a high yielding dual purpose D x T hybrid variety

Kalpa Sreshta - Fruit bunch

nut yield and 30.29% more copra yield over Chandra Sankara.

No major pest attacks and disease out breaks have been observed under field conditions at Kasaragod, Kerala and Arsikere, Karnataka. However, the Kalpa Sreshta variety, with a disease score of about 11% is categorized as moderately susceptible to grey leaf blight caused by *Lasiodiplodia theobromae* and stem bleeding caused by *Thielaviopsis paradoxa*.

The average quantity of tender nut water in Kalpa Sreshta is 368 ml. Based on the organoleptic evaluation, the tender nut water is classified as "good" in taste with a TSS of 5.89^0 Brix, with total sugars - 5.81 g/100 ml and amino acid - 1.34 mg/100 ml, sodium - 33.3 ppm and potassium - 2081 ppm. The average weight of the fruits of this variety is 940.09 g with weight of husked fruit being 610 g. The average copra content is around 215 g and copra oil content is about 64.1%.

The hybrid Kalpa Sreshta is found to be high yielding under irrigated conditions both at CPCRI Kasaragod and at AICRPP Centre, Arsikere and hence is recommended for cultivation in the coconut growing tracts of Kerala and Karnataka by the XXIII Workshop of the All India Coordinated Research Project on Palms during July 2014. Kalpa Sreshta will help in enhancing the coconut productivity as this hybrid gives an average yield of 29227 nuts per ha which will provide 6.28 tons copra per ha.

6. Other promising coconut cultivars

6.1 Kappadam Tall

Kappadam Tall, an ecotype from the WCT coconut population of the southwest coast of India, is also known as 'Chappadan' in some parts of Kerala. Compared to the other Indian varieties from west coast populations, this cultivar produces larger fruits with thinner husk. The fruits of this selection are predominantly green, oblong to round in shape. The palms of this selection are tall statured with clear bole on the stem. The leaves are longer with broader and longer leaflets. The palms are strictly cross pollinating as there is no overlapping of male and female phases within and between inflorescences. The palm starts flowering

Kappadam Tall - high copra content

6 to 7 years after planting and produces large inflorescences. The average fruit weight is around 1200 g, with husked fruit weight of about 800 g. The kernel weight ranges from 400-550 g with 215-280 g of copra per nut.

6.2 Laccadive Micro Tall

This is a popular cultivar of the Lakshadweep Islands, and is sporadically found in coconut gardens of mainland India, especially in the state of Kerala. The Laccadive Micro Tall is a selection from the tall coconut populations of Lakshadweep Islands. The cultivar is unique for its heavy bunches with large number of micro nuts and has recorded highest copra oil content (75%) among the coconut accessions studied. The accession is also found suitable for ball copra production as the fruits of this cultivar have a very slow rate of germination, small nuts with less nut water aiding in very low spoilage during storage for making ball copra.

Laccadive Micro Tall - high nut and oil yield

The palms of this cultivar are tall statured with clear bole on the stem. The palms start flowering after 6 to 7 years of age but profuse fruit production is generally observed after 9 to 10 years of planting. The mean annual bunch production is 11 bunches per palm, with a range of 8 to 12. The average yield varies from 100 to 320 fruits per palm per annum. However, a few of the micro palms in the population produce a still higher nut yield within few years of planting. The palms are mostly alternate bearers, and bear small nuts with greater kernel thickness and average copra content of about 90 g. The inflorescences are longer with strong peduncle with partial overlapping of male and female phases in alternate years during successive inflorescence production making the palms self pollinated to some extent. The fruits are green or greenish brown, oval to round shaped. The husked fruits are also oval or round shaped with a pointed tip. Laccadive Micro Tall is specially suited for producing premium grade ball copra.

6.3 Cameroon Red Dwarf

Cameroon Red Dwarf is a dwarf coconut population of the Republic of Cameroon, a country in the West Central Africa region, introduced to India from Cote d'Ivoire, bearing medium-sized orangered coloured fruits. It is conserved

Cameroon Red Dwarf - high nut yield

in many genebanks across the world, including India. The Cameroon Red Dwarf is an ornamental palm, and can also be planted in gardens for landscaping. As with most Dwarf varieties, it is sensitive to drought and subject to alternate bearing.

The palms are dwarf statured attaining a height of 4.4 m at 18 years of planting. The palm does not possess bole but the stem is not very slender. The palms start flowering 4-6 years after field planting. The palm is generally self-pollinated and produces orangered coloured, medium sized, oval shaped fruits with a pointed apical end. The husked fruits are also oval, medium sized with strong shell and thick kernel. The palms tend to bear in alternate years with an average bunch production of 10 per palm per year. The average nut yield is 80 fruits per palm per year. The fruit weighs about 450-900 g, with a smaller percentage of husk to whole fruit weight (27.8%). The Cameroon Red Dwarf fruits have a higher potential copra content of up to 200 g. The tender nut water is very good in taste and the tender nut water content ranges from 250-400 ml. Cameroon Red Dwarf selection can be grown for tender nut as well as copra purpose.

6.4 San Ramon Tall

San Ramon Tall is a coconut cultivar of Philippines, bearing very large-sized fruits, introduced to India during 1955. This is a robust palm, with comparatively closely spaced leaf scars and a conspicuous bole. The palms of this cultivar grow to a height of about 8 to 10 m about 40 years after planting. The palms start flowering in 7 to 8 years after planting and produce 12 to 13 inflorescences per year. The inflorescences are long (above 120 cm) with long spikelets. The fruits are large in size, green or greenish brown in colour and round to oval in shape. The husked fruits are flat bottomed with a pointed posterior. The copra content in this accession ranges from 250-350 g. The tender water content is around 700-900 ml. This cultivar exhibits tolerance to

San Ramon Tall - large fruit size, high copra content

Niu Leka Green Dwarf - high copra content

leaf rot and root (wilt) disease of Kerala. San Ramon Tall selection can be grown for higher copra output. However, the nut yield is lower, an average of 66 nuts/ palm/year, due to the large size of the fruits.

6.5 Niu Leka Green Dwarf

Niu Leka Dwarf is a unique coconut type of Fiji islands in the Pacific Ocean region, with dwarf plant stature and higher copra content. The palms of this cultivar, unlike other dwarfs are pre-dominantly cross pollinated and are characterized with very slow vertical growth and a large trunk.

The palms of the Niu Leka Green Dwarf selection developed by CPCRI are very dwarf with fruit characteristics and pollination behaviour similar to talls. The average weight of husked fruit is about 800 g with kernel weight of about 450 g yielding about 260 g of copra. The palms are dwarf characterized with higher number of leaf scars (over 33 in one metre) on the stem. The stem of the palms are robust with stem girth at one metre being over 100 cm, which is unlikely in other dwarf accessions. The stem is intermittently constricted which is a unique trait of this cultivar. The palms come to flowering in about 4 to 5 years after planting; the leaves are shorter and stiff, leaflets closely arranged, allowing less light below the crown. The fruits are green in colour, oblong to round in shape, with a cavity volume of over 300 ml in mature nuts. The tender nuts are large with an average of 470 ml of sweet tender nut water. Niu Leka Dwarf can be grown as a dwarf type for higher copra out turn and tender nut yield.

7. Quality planting material production

7.1 Establishment of seed gardens

To ensure availability of planting material to the farmers in sufficient quantities, it is essential to develop seed gardens

in the coconut growing tracts of the country. CPCRI promotes establishment of seed gardens both in the public and private sector. The institute has developed modalities to commercialize the varieties developed at the institute through licensing and supplies quality planting material of parental lines and also provides technical guidance for establishment of seed gardens. In the case of hybrid varieties, seed garden should include both the male and female parents of the hybrid variety. Further, farmers/nurseries, supplying planting material of coconut, should also take into account seed and seedling standards, while selecting quality planting material for supply to the growers.

7.2 Standards for planting material

In order to ensure the quality of the seed/ planting material of the varieties supplied by different agencies to the growers, the Indian Council of Agricultural Research has undertaken a massive exercise to develop minimum quality standards for seed/seedlings in horticultural crops. Accordingly, the minimum standards prescribed for seed and seedlings of coconut are provided below.

Seed standards for coconut

Parameter	Standards
Germination	>80%
Purity	>98%
Fruit weight (g)	>400 g - Dwarfs >600 g - Talls
Nut water	Present
Health	Free from pests and diseases

Seedling standards for coconut

Parameter	Standards
Age of the seedling	12 months
Number of leaves	6 and above
Girth at collar region	Dwarfs - more than 8 cm; Hybrids/talls - more than 10 cm
Height	Dwarfs - more than 80 cm; Hybrids/talls - more than 100 cm
Petiole colour	Dwarfs to exhibit petiole colour of parent Hybrids to exhibit intermediate petiole colour of parents
Health	Free from pests and diseases

8. Conclusion

The institute supplies seeds/seedlings of commercial varieties and parental lines and seedlings of released hybrids to farmers, NGOs, developmental agencies and research organizations. Seed nuts are supplied all through the year, depending on the availability, while seedling sales are initiated during June and continue during the rest of the year, depending on availability. The institute also looks forward to liaison with farmers/nursery men/seed companies in order to boost quality planting material production of the improved varieties and facilitate area expansion under these varieties.

For planting material requirements and further information contact:

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