

Improved varieties of Coconut, Arecanut and Cocoa for higher productivity

Plantation crops in the Indian context, are important contributors to the agrarian economy of the nation, supporting ancillary industrial development and providing livelihood security to millions of farm families across the country. Among the plantation crops, coconut, arecanut and cocoa are predominantly grown by small land holders and about 12 million people in the country are dependent on these crops for their livelihood. Hence, development of improved varieties with higher productivity is imperative.

ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), which hosts the National Active Germplasm site (NAGS) for plantation crops, is actively involved in conservation of coconut, arecanut and cocoa diversity and supplies germplasm to the stakeholders. ICAR-CPCRI maintains a large collection of coconut (455 accessions), arecanut (182 accessions) and cocoa germplasm (530 accessions). In addition, the Institute also hosts the International Coconut Genebank for South Asia and Middle East (ICG-SAME) at its Regional Centre Kidu, Karnataka, India. Concerted efforts over the years, involving evaluation and utilization of these genetic resources, have resulted in development and release of improved high yielding varieties and contributed to enhanced production, productivity and profitability of the mandate crops. The crop varieties developed by ICAR-CPCRI and their salient features are presented below.

COCONUT

India is one of three leading coconut (*Cocos nucifera* L.) producing nations in the world. However, the national average productivity (9346 nuts/ha) is relatively less than the potential yield of elite palms in research stations and hence warrants productivity enhancement to improve profitability of the coconut farming. ICAR-CPCRI, has so far, developed 21 improved varieties of coconut for cultivation in different agro-ecological zones of the country. The varieties suitable for cultivation in the country are grouped under two broad categories, viz. selection and hybrids, based on breeding strategy adopted and as dwarf, semi-tall and tall varieties based on plant habit. The released varieties of ICAR-CPCRI are described under three broad heads, namely dwarf/semi-tall selections, tall selections and hybrids.

A. Dwarf/semi-tall varieties

Selections from indigenous germplasm

Chowghat Orange Dwarf: A dwarf tender nut

variety, developed from indigenous germplasm, bears attractive orange coloured, medium sized, round fruits and also has potential in landscaping as an ornamental palm. The tender nut water content is around 350 mL and very sweet in taste. The palms commence flowering 3-4 years after planting, with adult palms yielding 112-192 nuts/palm/year, under irrigation and good management. Regular harvesting of tender nuts ensures that the fruit yield is at least one and half times higher.



Chowghat Orange Dwarf

Kalpasree: A root (wilt) disease resistant, early flowering (24-30 months after planting) dwarf variety, the fruits of this variety are dark green in colour, oblong in shape with a characteristic “beak” in mature fruits. It has superior quality of coconut oil, sweet tender nut water (240 mL), copra content of 96 g and produces annual yield of 90-107 nuts/palm in the root (wilt) disease endemic tract. Caution is advised to adopt plant protection measures against major pests particularly red palm weevil, when large scale commercial plantings are adopted.



Kalpasree

Selections from exotic germplasm

Kalpa Jyothi: A dwarf tender nut variety with drooping frond tip and attractive yellow coloured, medium-sized, oval shaped fruits, and also has potential in landscaping as an ornamental palm. The fruits contain good quality of tender nut water (380 mL). The palms commence flowering about 3 years after planting, with adult palms yielding 114-169 nuts/palm/year, under irrigation and good management. When harvested for tender nuts, fruit yield is expected to be at least one and half times higher.



Kalpa Jyothi

Kalpa Surya: A dwarf tender nut variety with drooping frond tip. The palms bear attractive orange coloured fruits and has potential in landscaping as an ornamental palm. The variety has good quality and quantity (400 mL) of tender nut water, with fruits being medium in size and oval in shape. The palms commence flowering 3-4 years after planting, with adult palms yielding 123-182 nuts/palm/year, under irrigation and good management. With regular harvesting of tender fruits, yield increments are expected in subsequent years.



Kalpa Surya

Kalparaksha: A semi tall, root (wilt) disease tolerant variety; the palms commence flowering 4-5 years from planting, and produce green coloured fruits. The variety gives an annual yield of 65-77 nuts/palm in root (wilt) disease affected tracts. Fruits are medium in size and round in shape, with a copra content of 185 g. Under disease-free and rainfed condition, it gives an annual yield of 87-101 nuts/palm, with good quality of tender nut water (290 mL).



Kalparaksha

B. Tall varieties

Selection from indigenous germplasm

Chandra Kalpa: This is a high yielding, moisture-deficit stress tolerant variety, recommended for copra and oil production. The variety produces oblong-shaped, greenish yellow to yellow-green, medium-sized fruits, with sweet tender nut water (285 mL). The copra

content is around 176 g, with high oil content (72%). The variety yields 100-136 nuts/palm/year, under good management. The variety is suitable for inflorescence sap (*Kalparasa*[®]/*neera*) production. The *neera* tapped can be consumed directly or converted to palm sugar/jaggery.

Kalpa Dhenu: This is a high yielding variety, suitable for copra and oil production. Fruits are predominantly green, oval in shape, large in size with high proportion of husk and good copra content. The variety is relatively tolerant to moisture deficit stress and gives annual yield of 86-128 nuts/palm, depending on the management.

Kalpatharu: This is a high yielding, moisture-deficit stress tolerant variety, suitable for production of premium quality ball copra. The variety produces brown/brownish green fruits, which are medium in size and oval in shape, with copra content of 175 g. The variety yields 117-149 nuts/palm/year, depending on the management. The variety is suitable for cultivation under both rainfed and irrigated conditions, in the traditional coconut growing tracts of the country.

Kera Keralam: It is a high yielding, moisture-deficit stress tolerant variety, suitable for production of copra and oil. It is also suitable for ball copra and inflorescence sap (*Kalparasa*[®]/*neera*) production. Fruits are green yellow, medium in size and oval in shape, with copra content of 176 g/nut. The variety is suitable for cultivation under both rainfed and irrigated conditions, in the traditional coconut growing tracts of the country. It gives higher yield of 152-213 nuts/palm/year, under irrigation and good management. The husk is of



Chandra Kalpa



Kalpa Dhenu



Kalpatharu



Kera Keralam

good quality and extensively used for making coir and coir products.

Kalpa Haritha: It is a high yielding, dual purpose variety, suitable for both copra and tender nut production and with lesser eriophyid mite infestation. The variety bears green, medium-sized fruits with sweet tender nut water (>400 mL) and good copra content (216 g). It is unsuitable for ball copra production due to its early germinating nature. The variety comes to flowering within four years of planting and produces 118-205 nuts/palm/year, depending on the management.



Kalpa Haritha



Kera Chandra

Selection from exotic germplasm

Kera Chandra: Kera Chandra is a high yielding, dual purpose variety, suitable for copra and tender nut production. The variety produces large, green fruits, round in shape with sweet tender nut water (>400 mL). The mature fruits contain 189 g copra/nut. The variety gives yield of 110-140 nuts/palm/year, depending on the management. The variety is unsuitable for ball copra production due to early germinating nature of the fruits.



Kalpa Pratibha

Kalpa Pratibha: Kalpa Pratibha is a high yielding dual purpose variety, suitable for copra and tender nut purpose. Fruits are predominantly green, large in size and round in shape with sweet tender nut water (>400 mL) and high copra content. The variety yields 98-131 nuts/palm/year, depending on the management. The variety is unsuitable for ball copra production due to its early germinating nature.



Kalpa Mitra

Kalpa Mitra: This is a high yielding, relatively moisture-deficit stress tolerant variety, suitable for copra and oil production. It

is also suitable for production of ball copra, a premium product. Fruits are relatively large, yellowish green in colour, oval in shape with good copra content (241 g). The variety gives yield of 80-126 nuts/palm/year, depending on the management.

Kalpa Shatabdi: This is a high yielding, dual purpose variety, with large attractive fruits, suitable for copra and tender nut production. It bears greenish yellow fruits with greater volume (612 mL) of good quality tender nut water and good copra content. It is unsuitable for ball copra production due to early germinating nature of the fruits. This variety shows lesser incidence of Rhinoceros beetle damage.



Kalpa Shatabdi

The variety takes about seven years for flowering under rainfed conditions and produces 105-168 nuts/palm/year, depending on the management.

Kalpa Ratna: This is a high yielding multi-purpose variety, suitable for copra, tender nut and inflorescence sap (*Kalparasa*[®]/*neera*) production. The quantity of tender nut water is around 500 mL and very good in taste, while copra content varies from 184-236 g. The inflorescence sap yield (31 L/inflorescence), under average management, is 34.78% higher than the sap yield of West Coast Tall (WCT) palms. The variety takes about 51 months for flowering, with fruit yield of about 148-187 nuts/palm/year, depending on the management.



Kalpa Ratna

C. Hybrid varieties

Chandra Sankara (COD × WCT): This is a high yielding, dual purpose D × T hybrid, suitable for copra/oil and tender nut production and is produced by crossing Chowghat Orange Dwarf (COD as female parent) with pollen from elite WCT (male parent). The variety bears brown, medium-size fruits, with sweet tender nut water (350 mL) and copra content of 208-225 g. This variety commences flowering in 3-4 years, much earlier than the WCT parent, and yields 110-210 nuts/palm/year, depending on the management. This variety is sensitive



Chandra Sankara

to low moisture stress and performs well only under irrigation and good management.

Chandra Laksha (LCT × COD): This is a high yielding moisture-deficit stress tolerant, dual purpose T × D hybrid, suitable for copra/oil and tender nut production. It is produced by crossing Lakshadweep Ordinary Tall (female parent) with pollen from COD (male parent). The variety bears brown, oblong fruits, with sweet tender nut water (339 mL) and good copra content (195 g). The variety commences flowering within four years of planting, much earlier than the LCT parent. This variety yields 109-175 nuts/palm/year, depending on the management.



Chandra Laksha

Kera Sankara (WCT × COD): It is a high yielding relatively drought tolerant, dual purpose T × D hybrid, recommended for copra and oil production. It is produced by crossing WCT (female parent) with COD (male parent). The variety bears brown, medium-sized, oblong fruits, with 187 g copra/nut. The palms commence flowering within four years of planting, much earlier than the WCT parent and yields 108-213 nuts/palm/year, depending on management.



Kera Sankara

Kalpa Samrudhi (MYD × WCT): This is a high yielding, dual purpose D × T hybrid, recommended for copra and tender nut production. It is produced by crossing Malayan Yellow Dwarf (MYD) (female parent) with WCT (male parent). The variety commences flowering within 3-4 years of planting and bears green, medium sized fruits, with very good quality of tender nut water (346 mL) and good copra content (220 g). The variety yields 117-141 nuts/palm/year, depending on management. The variety is relatively tolerant to moisture-deficit stress and exhibits higher nitrogen use efficiency.



Kalpa Samrudhi

Kalpa Sankara (CGD × WCT): This is a root (wilt) disease tolerant, dual purpose D × T hybrid suitable for copra and tender nut production. This variety is produced by crossing Chowghat Green Dwarf (female parent)

with WCT (male parent). The variety flowers within 3-4 years of planting, bears green, medium sized fruits, with sweet tender nut water (375 mL) and 170 g copra/nut. It is relatively tolerant to water deficit stress and yields 84-112 nuts/palm/year in root (wilt) affected tracts.

Kalpa Sreshta (MYD × TPT): It is a high yielding, dual purpose D × T hybrid, suitable for copra and tender nut production. It is produced by crossing MYD (female parent) with Tiptur Tall pollen (male parent). The variety bears green, medium sized, oval fruits, with good quality tender nut water (368 mL) and 216 g copra/nut. The variety comes to flowering within four years of planting, under irrigated conditions and produces 167-186 nuts/palm/year, depending on the management.



Kalpa Sankara



Kalpa Sreshta

ARECANUT

Arecanut (*Areca catechu* L.) is one of the important cash crops of our country, cultivated in an area of 730.82 thousand ha, with production of 1208.94 thousand tonnes. Karnataka is the major producing state, followed by the states of Kerala and Assam. Arecanut improvement programme at ICAR-Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka, encompasses comprehensive collection, conservation and evaluation of both indigenous and exotic germplasm. On the basis of comparative yield trials of indigenous and exotic accessions, promising tall and semi tall cultivars have been identified and released as varieties. The tall varieties are prone to wind damage and the tall nature of the palm makes operations like spraying, harvesting, etc. more labour intensive and cumbersome. Therefore, arecanut breeding programs in addition to yield improvement are also aimed at development of dwarf varieties/hybrids. Hirehalli Dwarf, a natural mutant identified for its short stature, is a good genetic source for arecanut improvement and is being exploited for breeding dwarf statured hybrid varieties with high yield potential. The 11 arecanut varieties developed by the Institute are classified under two major heads, viz. tall varieties developed through selection from germplasm and dwarf hybrids, developed through intra-varietal hybridization involving Hirehalli Dwarf and released varieties.

A. Tall varieties

Selection from indigenous germplasm

Mohitnagar: Mohitnagar is a selection from the

indigenous accession and is a consistent high yielder with an average *chali* yield of 3.67 kg/palm/year. This variety is recommended for cultivation in arecanut growing areas of West Bengal, and coastal areas of Karnataka and Kerala.

Kahikuchi: The Kahikuchi variety is a selection from indigenous germplasm and is a consistent high yielder with an average yield of 3.70 kg dry kernel/palm/year. The variety is recommended for commercial cultivation in West Bengal and North Eastern region of the country.

Madhuramangala: It is a selection from indigenous germplasm and is suitable for both tender nut and ripe nut processing. The variety fetches premium price in the market because of its quality and marble appearance of the split nut. The average yield is 2.95 kg dry tender processed nuts/palm/year or 3.54 kg dry kernel/palm/year. The variety has been notified for commercial cultivation in Karnataka and Maharashtra.

Nalbari: Nalbari is a selection from indigenous germplasm and is suitable for ripe nut processing. The variety is high yielding, with medium thick stem and longer internodes. The average yield is 4.15 kg dry kernel/palm/year. The variety has been notified for cultivation in Karnataka, West Bengal and North Eastern region.

Shatamangala: It is a high yielding, early flowering, semi tall, dual purpose arecanut variety, suitable for both tender nut and ripe nut processing. The average yield is 3.26 kg dry tender processed nuts/palm/year or 3.96 kg dry kernel/palm/year. The variety has been notified for commercial



Mohitnagar



Kahikuchi



Madhuramangala



Nalbari



Shatamangala

cultivation in Karnataka and Gujarat.

Selection from exotic germplasm

Mangala: Mangala possesses number of desirable characters such as early bearing, more number of female flowers per inflorescence, higher nut set, initial and cumulative higher yield, quicker stabilization of production and lesser height. The leaflets are dark green in colour with characteristic crinkling at the tip. The average yield of this variety is 2.90 kg *chali*/palm/year. The variety is released for commercial cultivation in the coastal areas of Karnataka and Kerala.

Sumangala: Sumangala is a tall variety with partially drooping crown and is recommended for *chali* production. The average yield recorded is 3.28 kg *chali*/palm/year. The variety is released for cultivation in coastal Karnataka and Kerala.

Sreemangala: The variety Sreemangala is tall with longer internodes and sturdy stem. It is a high yielder with average *chali* yield of 3.18 kg per palm per year. This cultivar is released for cultivation in coastal areas of Karnataka and Kerala.

Swarnamangala: It is a tall, high yielding variety with medium thick stem and uniform bearing. The average yield of this variety is 3.88 kg *chali*/palm/year. It is recommended for cultivation in Karnataka and Kerala.

B. Dwarf hybrids

VTLAH-1: The Vittal Arecanut Hybrid-1 is a dwarf hybrid between Hirehalli Dwarf (female parent) and Sumangala (male parent). The palms have sturdy stem with super imposed nodes and smaller compact canopy.



Mangala



Sumangala



Sreemangala



Swarnamangala

The average *chali* yield of this hybrid is 2.54 kg/palm/year. This variety is recommended for cultivation in Karnataka.

VTLAH-2: The Vittal Arecanut Hybrid-2 is a hybrid between Hirehalli Dwarf (female parent) and Mohitnagar (male parent). It is dwarf in habit with medium thick stem, super imposed nodes and smaller compact canopy. The average *chali* yield of this hybrid is 2.64 kg/palm/year. This variety is recommended for commercial cultivation in Karnataka.



VTLAH-1



VTLAH-2

COCOA

Cocoa (*Theobroma cacao* L.) in India is cultivated as a mixed crop in palm based cropping systems covering irrigated arecanut, coconut and oil palm gardens, apart from Western Ghats hills and plain regions. Currently, area under cocoa cultivation is 97,563 ha, encompassing the states of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh, with production of 27,000 tonnes. To meet the 60,000 tonnes demand of the chocolate industries, high yielding varieties are vital to increase the productivity. ICAR-CPCRI had initiated a cocoa research at its Regional Station, Vittal in Karnataka in the year 1969. Four decades of intensive cocoa improvement programs resulted in identification of elite clones and varieties. The nine cocoa varieties released from the Institute are classified under two major heads, viz. hybrids and clonal selections.

A. Cocoa hybrids

VTLCH-1: This variety is a stable, high yielder, withstands both biotic (black pod rot and tea mosquito bug) and abiotic stresses (low moisture). Pods of VTLCH-1 (Vittal Cocoa Hybrid-1) are green to yellow in colour having smooth surface and shallow furrows. Trees with a medium canopy (16 m²) yields 50 pods/tree/year at the age of 6-12 years as hybrids and clones, both under arecanut and coconut. Pods are of 350 g weight with 40 beans/pod. With a single dry bean weight of 1-1.1 g, this hybrid recorded the highest yield of 1.4 kg/tree/year and the yield/ha is 959 kg. The variety has a shelling percentage of 13%, nib recovery of 87% and 54%



VTLCH-1

fat content and is suitable for chocolate industry.

VTLCH-2: Pods of VTLCH-2 (Vittal Cocoa Hybrid-2) are green to yellow in colour, having smooth surface and shallow furrows. Trees with a medium canopy (15 m²) yields 50 pods/tree/year at the age of 6-12 years as hybrids and clones, both under arecanut and coconut. Pods are of 350 g weight with 40 beans/pod. With a single dry bean weight of 1-1.15 g, it recorded the highest yield of 1.5 kg/tree/year and the yield/ha is 1030 kg. This is suitable for chocolate industry with a shelling percentage of 11%, nib recovery of 89% and 54% fat content. This variety is a stable, high yielder with medium sized tree, and both parents and progenies are tolerant to black pod rot.



VTLCH-2

VTLCH-3: VTLCH-3 (Vittal Cocoa Hybrid-3) is characterized by pods which are green to yellow in colour. Trees with an optimal canopy (18 m²) yield 41 pods/tree/year at the age of 6-12 years as hybrids and clones, both under arecanut and coconut. Pods are of 440 g weight with 41 beans/pod. Having a single dry bean weight of 1-1.05 g, this hybrid recorded the highest yield of 1.7 kg/tree/year and the yield/ha is 1150 kg. This is suitable for chocolate industry with a shelling percentage of 15%, nib recovery of 87% and 51% fat content. This variety is suitable for water limited conditions with favourable physiological parameters.



VTLCH-3

VTLCH-4: Pods of VTLCH-4 (Vittal Cocoa Hybrid-4) are red to orange in colour. Trees with an optimal canopy (18 m²) yield 40 pods/tree/year at the age of 6-12 years as hybrids and clones, both under arecanut and coconut. Pods are of 440 g weight with 40 beans/pod. With a single dry bean weight of 1-1.07 g, this hybrid recorded the highest yield of 1.6 kg/tree/year and the yield/ha is 1090 kg. This is suitable for chocolate industry with a shelling percentage of 15%, nib recovery of 87% and 51% fat content. This variety is suitable for water limited conditions with favourable physiological parameters.



VTLCH-4

VTLCH-5 (Nethra Centura): Nethra Centura is an early bearing, high yielding variety, moderately tolerant to

black pod rot, tea mosquito bug and low moisture stress. Pods of this variety are green to yellow in colour. Trees with an optimum canopy (16-17 m²) yield 66 pods/tree/year, at the age of 6-13 years as hybrids and clones both under arecanut and coconut. Pods are of 400-450 g weight with 43 beans/pod. With a single dry bean weight of 1-1.11 g, this variety recorded the highest yield of 2.5-3.0 kg/tree/year and the yield/ha is 1500-1800 kg. This is suitable for chocolate industry with a shelling percentage of 11%, nib recovery of 88% and 52% fat content. This variety is suitable for high density planting.



VTLCH-5

B. Cocoa clonal selections

VTLCC-1: Pods of VTLCC-1 (Vittal Cocoa Clone-1) are green to yellow in colour, with smooth surface and shallow furrows. Trees with a small to medium canopy (12 m²) yields 55-70 pods/tree/year, at the age of 6-12 years as clones, under arecanut, coconut and oil palm gardens. Pods are of 350 g weight with 35 beans/pod. With a single dry bean weight of 0.9-1.05 g, this clone recorded the highest yield of 1.3 kg/tree/year and the yield/ha is 890 kg. This variety has industrial value, with 12% shell, 88% nib recovery and 50% fat content. The variety is a heavy and early bearer with small to medium canopy, suitable for high density planting, and being a self compatible line, it performs well in North-Eastern zones of the country.



VTLCC-1

VTLCS-1: Pods of VTLCS-1 (Vittal Cocoa Selection-1) are attractive, red to orange in colour and with smooth surface and shallow furrows. Trees with a medium canopy (12 m²) yield 55 pods/tree/year at the age of 12-14 years as clones, under arecanut, coconut and oil palm gardens. Pods have around 360 g weight with 42 beans/pod. With a single dry bean weight of 1.13 g, this clone recorded the highest yield of 2.52 kg/tree/year and the yield/ha is 1700 kg. The variety has industrial value with 11% shell, 89% nib recovery and 52% fat content. This variety is a stable, high yielder, and withstands both biotic (black pod rot and tea mosquito bug) and abiotic stresses (low moisture). It is suitable as a parental line for hybrid



VTLCS-1

development as well.

VTLCS-2: Pods of VTLCS-2 (Vittal Cocoa Selection-2) are green to yellow in colour. Trees with a medium canopy (15 m²) yield 55 pods/tree/year as clones, both under arecanut and coconut. Pods have around 400 g weight with 41 beans/pod. Beans are very bold with 3 cm length, 1.5 cm width, 1.21 g weight, 15% shell, 85% nib recovery and 53% fat content. The dry bean yield is 2.7 kg/tree/year and the yield/ha is 1840 kg. This variety has high cropping efficiency, best bean traits, high yielding behaviour and exhibits tolerance to pests (tea mosquito bug) and diseases (black pod rot).



VTLCS-2

CONCLUSION

These improved varieties have the potential to produce more than two fold higher yield than the conventionally grown local varieties. ICAR-CPCRI supplies planting material of these improved varieties for establishment of plantations to enhance the crop productivity and net returns. The Institute also provides breeder seed material of improved varieties for establishment of seed gardens to address quality planting material needs of the farming community.

In coconut and arecanut, development of blocks of single variety is desirable for maintaining uniformity and ease of seed production. However, in the case of cocoa, due to the issues of self-incompatibility, planting of multiple varieties is recommended for obtaining good seed set. Further, it is advised to collect seed pods from well-designed bi-clonal and poly-clonal orchards established with self-incompatible but cross-compatible parental clones. In cocoa, systematic pruning and training, under different cropping systems, is to be undertaken every year for maintaining desired canopy architecture.

For the research achievements of the national institute (ICAR-CPCRI) to reach the stakeholders and to enable growth and prosperity of the growers, effective collaboration is required with different agencies viz. the All India Coordinated Research Project on Palm (AICRPP) centres, the crop-centric developmental agencies, viz. CDB (Coconut Development Board), DASD (Directorate of Arecanut and Spices), DCCD (The Directorate of Cashewnut and Cocoa Development), allied cooperatives such as CAMPCO (The Central Arecanut and Cocoa Processing Marketing Co-operative Ltd.) and also farmer-producer organizations/companies.

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