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STATUS AND PROSPECTS OF CROP IMPROVEMENT IN ARECANUT

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Arecanut (*Areca catechu* L.) is one of the important cash crops in Western Ghats, East and North Eastern regions of India. Arecanut is a tall, slender plant reaching a height of 15-20 m. It is an important masticatory substance for the people particularly of Asian origin. Apart from its masticatory property it is the important element of religious, cultural and social celebrations. This is one of the main reasons for the economic well-being of families in India who grows arecanut. It is used in the name of *Pooga* in Ayurvedic medicine and also used in veterinary medicines. The habit of chewing arecanut is confined to Indian subcontinent and its neighbourhood. Even though, the production of areca is localized in few states, but the commercial product is widely distributed throughout the country. Arecanut provides a decent livelihood for more than three million people and assured employment of 10 million man-days annually (Nair, 2021).

The widespread occurrence of the habit of betel chewing is itself an indication of its great antiquity. In Somadeva's 'Katha Sarit Sagara' there is a mention of betel-nuts flavoured with five fruits. Reference to betel chewing is available in the *Jatakas* and in several other Pali works as well as in Jain scriptures. In the Hitopadesa, betel-nut is described as pungent, spicy, bitter and sweet; it is also said to expel wind, to remove phlegm, to kill germs and to subdue bad odour, to beautify the mouth, to remove impurities and to induce love. The saint, Sushruta has mentioned in the first century A.D. that after a meal, the intelligent eater will take either some fruit of an astringent, pungent or bitter taste or chew betel leaf prepared with broken arecanut, camphor, nutmeg or clove. Some of the early travellers who visited India mentioned the custom of betel chewing and the use of arecanut. Abd Allah Ibn Ahmad has paid a tribute to betel chewing in India in his treatise on drugs. He has quoted several Arab authors and mentioned Sheriff chiefly, according to whom 'the betel brightens the mind and drives away the cares, whoever uses it becomes joyful; he has a perfumed breath and perfect sleep, betel-nut replaces wine among Indians by whom it is widely used'. Chau Ju- Kua in 1250 A.D. spoke in his work on the Chinese and Arab trade of arecanut in Annam and of arecanut wine of the East coast of Sumatra. He has also mentioned Ceylonese kings making use of arecanut paste and pearl ashes; he spoke of arecanut as one of the products of the Coromandel Coast, Java, Borneo and the Philippines (Meenakshi, 1958).

The present production of arecanut in the world is about 1.937 MT from an area of 1.422 million hectares. Arecanut is primarily grown

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in India, Bangladesh, China, Indonesia, Sri Lanka and Myanmar. India ranks first in both area (49%) and production (50%) of arecanut. In India, arecanut is cultivated in an area of 396.8 thousand hectares with an annual production of 559 thousand tonnes, mainly confined to states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Assam, West Bengal and Meghalaya. Stagnating market prices and increasing cost of production, especially the skilled labour charges in the recent times, have generated livelihood concerns of arecanut farmers in India. Surging imports, which is around 12% of the domestic production, certainly has a significant role in price volatility. Market studies reveal that around 75% of the arecanut trade is in the hands of private trades, which certainly provide ample scope for market manipulations and low price realization. From a long-term perspective, low priority in area expansion and more priority for encouraging adoption of scientific methods of cultivation, especially the arecanut based cropping/farming systems; by strengthening the transfer of technology activities would certainly benefit the arecanut farmers in terms of long-term sustainability and livelihood security (Nair, 2021).

At present, the area under arecanut in India, is about 7,43,777 ha with the production of 12,64,680 MT. Karnataka is bestowed with 5,00,000 ha area under arecanut and 9,50,000 tonnes production.

Arecanut has got several health benefits. Since time immemorial, arecanut is being used for chewing as it is believed to have lots of medicinal properties. It has an important place in the ancient Indian systems of medicine such as Ayurveda, Unani and Homeopathy. The WHO has listed out as many as 25 different beneficial effects of arecanut on mankind. Chewing arecanut sweetens the breath, removes bad taste from the mouth, strengthens the gums and checks perspiration. It has potent antioxidant, anti-inflammatory and analgesic, antiulcer, hypolipidemic, antidiabetic and neuroprotective properties. It is also traditionally used in a number of ailments for its laxative, digestive, carminative, antiulcer, anti-diarrhoeal, anthelmintic, antimalarial, anti-hypertension, diuretic, pro-healing, antibacterial, hypoglycaemic, anti-heartburn properties.

The major contribution of arecanut research is from ICAR-CPCRI, Regional Research Centre, Vittal. With respect to crop improvement; many selections are made by identification of elite mother palms. However only two inter varietal hybrids are released by using Hirehalli Dwarf as female parent. There are certain limitations in arecanut breeding. The following limitations may be highlighted.

1. Areca nut is a tall perennial palm
2. It is a cross pollinated
3. Difficulty in production of hybrid seeds
4. Lack of availability tissue cultured plantlets of improved types
5. Low yield of dwarf hybrid plants (Av. Yield 2.5 kg/palm) compared to tall selections
6. Hybrids are not suitable for famous multi-storey cropping system
7. Even hybrid plants are available, protection of nuts from theft from the grown up plants is a serious problem as the nuts are available at very low height.

Therefore, introduction and selection of elite mother palms with higher nut yielding

potential is comparatively easy and quick method.

The following points are considered while selection of mother palms.

1. Mother palms should be of more than 12 years old
2. They should be regular bearer
3. Early bearing nature (36-40 months after planting)
4. Partially drooping or drooping crown
5. More no. of leaves (>10 nos.) and shorter internodes
6. Higher fruit set (>55% set) around 350-400 fresh nuts/palm/year
7. Consistent yield of about 3 kg or more dry kernel (*chali*)/palm/year
8. High recovery of *chali* from fresh fruits (> 25%)
9. Palm should be free from diseases and pest incidence
10. Palms should be selected based on the processing i.e., for tender nuts or *chali*.

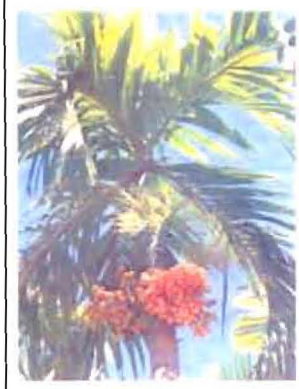
Based on these criteria many selections made in arecanut from traditional cultivation areas of India with special characters and are listed hereunder.

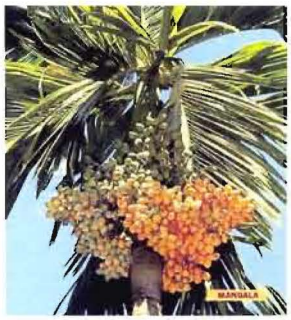
Distribution of characters in different selections

Specific character	Selections
High yield	Mangala, Sumangala, Sreemangala, Mohitnagar, Samrudhi, Swarnamangala, Madhuramangala, Nalbari, Shatamangala
Early bearing	Mangala
Greater number of fruits/bunch	Thirthahalli Local
Better quality	Sreevardhan
Fruit size (large)	South Kanara Local
Regular bearing	South Kanara Local
Semi tall	Mangala, Srivardhan, Madhuramangala, Shatamangala
Dwarfness	Hirehalli Dwarf

Descriptive characters of important selections released for cultivation in the country are given below :

Sl. No.	Name of selection	Character	Photo
1.	South Canara/ Kasargod Local	Largely grown in South Canara district of Karnataka and Kasaragod district of Kerala; Tall, sturdy, uniform bearing, large sized nuts and good for making *chali* Average *chali* yield - 2kg/ palm/ year	

2.	Sreewardhan Local	Grown widely in the Raighad and Ratnagiri districts of Maharashtra and Coastal Karnataka, Tall, oval shape nuts with large endosperm. Av. *chali* yield-2.2kg/palm/year.	
3.	Thirthahalli Local	Grown extensively in hilly areas of Chikmagalur and Shivamogga districts of Karnataka; Tall variety, oblong shaped and small nuts preferred for tender nut processing; Av. ripe nut yield-12 kg/palm/ year (Av. 1.2 kg dry nuts).	
4.	Sagar Local	Grown in Uttara Kannada and Shivamogga districts of Karnataka Tall type, sturdy stem, erect bunches Small and round shape nuts, good for making both chali and tender nut Av. *chali* yield - 2.25 kg/palm/year.	
5.	Mettupalayam Local	Grown in Coimbatore, Erode and Salem districts of Tamil Nadu. Tall type, sturdy stem, erect bunches, oval shape nuts, good for tender nut processing. Av. nut yield-3.0 kg/ palm/ year.	
6.	Hirehalli Local	It is a tall type and mainly cultivated in maidan parts especially, very popular in Tumkur, Mandya and parts of Hassan and Bangalore districts of Karnataka. Palms of this variety possess medium thick stem with partially drooping crown. The nuts are medium sized, round to oval which are placed in erect bunches. Suitable both for tender nut and *chali*. Average yield is 3.20 kg chali/palm/year	

7.	Mangala	Released in 1972 by CPCRI, RS, Vittal Semi tall, medium thick stem, shorter internodes; Leaflets have crinkling at the tip; Medium sized, oval-round fruits are compactly arranged, early bearing variety. Flower initiation: 36-40 months after planting. Suitable for coastal Karnataka and Kerala, *Chali* yield: 3.00 kg/palm	
8.	Sreemangala (VTL-17)	Released in 1985 by CPCRI, RS, Vittal Tall, sturdy stem, long internodes, round and bold nuts. Introduction, selection and evaluation from acc. VTL 17, introduced from Singapore. Flower initiation: 44-48 months after planting Relatively tolerant to water limited condition. Recommended for Karnataka and Kerala. *Chali* yield: 3.18 kg/palm.	
9	Sumangala (VTL-ll)	Tall, medium thick stem, long internodes; Compactly arranged yellow-orange oval fruits; Introduction, selection and evaluation from acc. VTL 11, introduced from Indonesia; Flower initiation: 42-46 months after planting Relatively tolerant to water limited condition;Recommended for Karnataka and Kerala; *Chali* yield: 3.28 kg/palm; Released in 1985 by CPCRI, RS, Vittal.	
10.	Mohitnagar	Tall, medium thick stem, long internodes; Loosely arranged oval - round fruits; Homogeneous population Selection and evaluation from indigenous acc. VTL 60 (West Bengal) Flower initiation: 48 months after planting; Relatively tolerant to water limited condition; Recommended for Karnataka, Kerala and West Bengal *Chali* yield: 3.67 kg/palm; Released in 1991 by CPCRI, RS, Vittal.	

11.	Swarnamangala	Introduction, selection and evaluation from acc. VTL 12, introduced from Vietnam; Tall, medium thick stem, shorter internodes, well-spaced bunches; Homogenous population Oblong to round, orange-deep yellow fruit; Flower initiation: 46 months after planting; Recommended for Karnataka and Kerala; *Chali* yield: 3.88 kg/palm Released in 2005 by CPCRI, RS, Vittal.	
12.	Kahikuchi Tall	Tall, medium thick stem, long internodes; Uniform population and consistent yield; Orange colored, bold and round fruits; Evaluation and selection from indigenous acc. VTL 64 Flower initiation: 50-52 months after planting; Recommended for Assam and Meghalaya; *Chali* yield: 3. 7 kg/palm Released in 2008 by CPCRI, RS, Vittal.	
13.	Samrudhi (Calicut-17)	Tall palms with longer internodes Consistent and high yielding with well-placed bunches, Round and bold nuts Recommended for Andaman & Nicobar Islands; *Chali* yield: 4.37 kg/palm, developed by ICAR-CPCRI, RS, Vittal during 1995. Tall type, regular bearer, separated bunching type, Round nuts with better yielding.	
14.	Madhura Mangala	Evaluation and selection from indigenous acc. VTL 62 (Maharashtra) Semi tall, medium thick stem, shorter internodes; Orange to yellow colored, oval and round shaped medium fruits Regular bearer, Less arecoline and more polysaccharides, Flower initiation: 42 months after planting Recommended for Karnataka and Maharashtra, *Chali* yield: 3.67 kg/palm Dry processed tender nuts: 2.95 kg/palm, Released in 2011 by CPCRI, RS, Vittal.	

15.	Nalbari	Evaluation and selection from indigenous acc. VTL 75, Tall, medium thick stem, longer internodes, Yellow colored, round fruits, High recovery of kernel (25.18%), Flower initiation: 48 months after planting, Recommended for Karnataka, North Bengal, N-E Region, *Chali* yield: 4.15 kg/ palm, Released in 2011 by CPCRI, RS, Vittal.	
16.	Shata Mangala	Palms are semi-tall with shorter internodes, Homogenous population Consistent yielder, Synchronized maturity of nuts, Fruits are orange colored, round shaped, High dry recovery (26.8%), Dry kernel yield: 3.96 kg/palm/year, Dry tender nut yield: 3.26 kg/palm/year; Suitable for Karnataka and Gujarat, Released by CPCRI, RS, Vittal in 2016.	

Hybrids

1.	VTLAH 1 (Vittal Areca Hybrid 1) (Hirehalli Dwarf x Sumangala)	Dwarf, sturdy stem, superimposed nodes, Yellow, medium sized, round-oval nuts, High recovery of kernel, Flower initiation: 45 months after planting, Meets standard quality of *chali*/raw nut, Suitable for irrigated condition, *Chali* yield: 2.54 kg/ ha.	
2.	VTLAH 2 (Vittal Areca Hybrid 2) (Hirehalli Dwarf x Mohitnagar)	Dwarf, medium stem, superimposed nodes, Deep yellow, medium sized oval nuts, High recovery of kernel, Flower initiation: 43 months after planting, Meets standard quality of chali, Recommended for irrigated condition, *Chali* yield: 2.64 kg/ha.	

A comparative yield potential of these released selections (including hybrids) revealed that dry nut yield ranges from 1.2 kg (Thirthalli local) to 4.37 kg (Samrudhi) per palm per year.

Many State Agricultural & Horticultural Universities are also working on the crop improvement and disease management of arecanut. In this regard, the Horticultural Research and Extension Centre (HREC) at Sirsi (Uttara Kannada dist.), Karnataka also working on mother palm selection of arecanut for hill zone of Karnataka. The Research Centre is established during 1965 under UAS, Bengaluru and transferred to UAS, Dharwad during the bifurcation of the UAS, Bengaluru in 1987. During 2008, it was again transferred to UHS, Bagalkot. The selection of improved mother palm in the hill zone is one of the major research activities of this centre. The research efforts yielded the following three high yielding selections. The detailed characters of the selections are given under.

1.	Sirsi Areca Selection-1 (SAS-1)	A variety recommended for hill zone of Karnataka. It is tall with compact canopy and is a regular bearing variety. Nuts are round and even sized and closely arranged on compact bunches. Suitable for both tender and ripe nut processing. It has high curing percentage Released during 1996, Compact fruit bunching habit, Regular bearing with uniform ripening, Higher yielding capacity 5.25 kg dried nuts/palm/year. Better storage of dried nuts.	
2.	Sirsi Areca Selection-2 (SAS-2) (IC - 616049)	Identified during 2014-15. It bears compact bunches. The nuts are flat shaped nuts (*Chali*). It has Uniform maturity with higher yield of dried nuts (6.4 kg/palm/yr), Yield potential is over >23% over SAS-1.	
3.	Sirsi Areca Selection-3 (SAS-3) (IC - 616050)	This selection is identified during 2014-15. Bears compact bunches Nuts are of round shaped nuts (dried nuts). Uniform maturity. Higher yielding of dried (*chali*) nuts (6.2 kg/palm/yr); Yield potential is over >18% over SAS-1.	

The dry nut yield of these improved selections ranged from 5.25 kg (SAS-1) to 6.4 kg (SAS-2) per palm per year. All these selections are quite popular in the state. They have covered an estimated about 15-20% of areca nut cultivation area. These selections are superior nut-yielders when compared to all those released from the Central Institutes so far. The research work on identification of high yielding mother palms is carried out continuously. Many high yielding mother palms are selected from the farmers' field of Sirsi and Yellapur taluks of Uttara Kannada dist., where intensive arecanut cultivation is being done with modern cultivation practices. There is very good scope for selection of mother palms from the farmers' field as some the plantations are having very high yielding potential with a dry nut yield nearly of 4.0 to 5.0 tons (dry kernel yield) per ha per year. In this regard, some promising types have been identified and evaluated for their yield potential. The results of four years evaluation trial in the farmers' field is given here under.

Based on the evaluation data, SBH-16 is selected as elite mother palm with superior characters. The dry nut yield recorded in this palm is 10.37 kg per year which is 67.25% higher than that of SAS-3 which is relased from our centre recently. Individal kernel weight is high and it gives more than three bunches per year.

Mean values of characters of promising mother palms (2015-16 to 2018-19)

Sl. No.	Character	Elite Selection				
		SBH-9	SBH-16	SBH-17	SBH-21	SAS-3 (Control)
1	No. of bunches /palm	3.75	3.00	3.75	4.25	3.50
2	Fresh bunch wt. /palm (kg)	48.0	63.50	49.25	56.0	42.00
3	No. of nuts/ palm	1088.8	1027.0	1129.8	1210.8	900.8
4	Length of fresh nut (mm)	16.68	14.11	15.38	15.54	14.60
5	Breadth of fresh nut (mm)	26.42	26.62	26.65	26.8	20.60
6	Husk thickness (mm)	9.05	12.82	7.89	8.87	8.43
7	Length of Dry nut (mm)	16.68	14.11	15.38	15.54	14.6
8	Breadth of dry nut (mm)	26.42	26.62	26.65	26.8	20.6
9	Tender nut recovery(%)(Red)	52.2	53.1	52.8	52.5	51.15
10	Dry wt. of nuts/palm (in kg)	7.74	10.37	7.77	6.74	6.20
11	Dry recovery (%) (Chali)	29.7	30.6	30.58	29.29	29.18

Seedlings of SBH-series produced for

Compact Bunch of SBH-16

Single Fresh Bunch weight (19.0 kg)

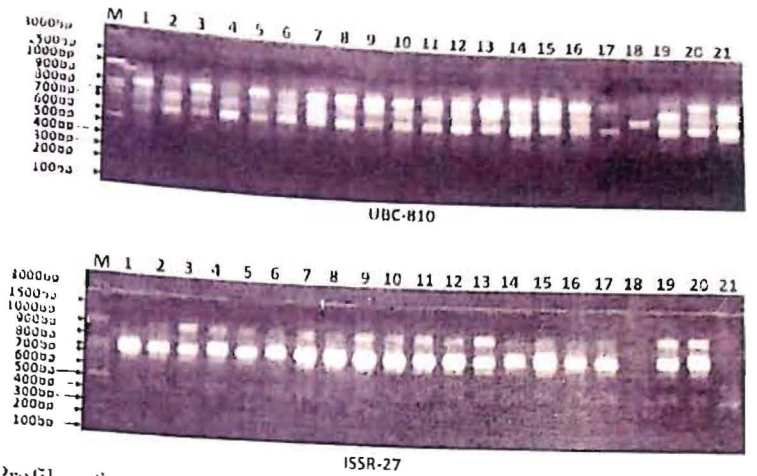


Figure 1e: Profile of arecanut samples from Horticulture Research and Extension Station. Karnataka Lane 1: Baner. Lane 1- 21 are the sample numbers as described above in the list. M is the size standard.

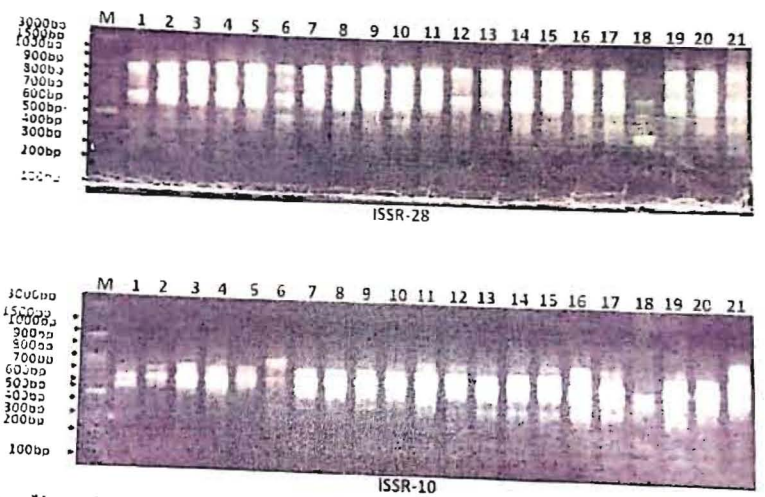


Figure 1d: Profile of arecanut samples from Horticulture Research and Extension Station. Karnataka Lane 1: Baner. Lane 1- 21 are the sample numbers as described above in the list. M is the size standard.

DNA Analysis of Different selections

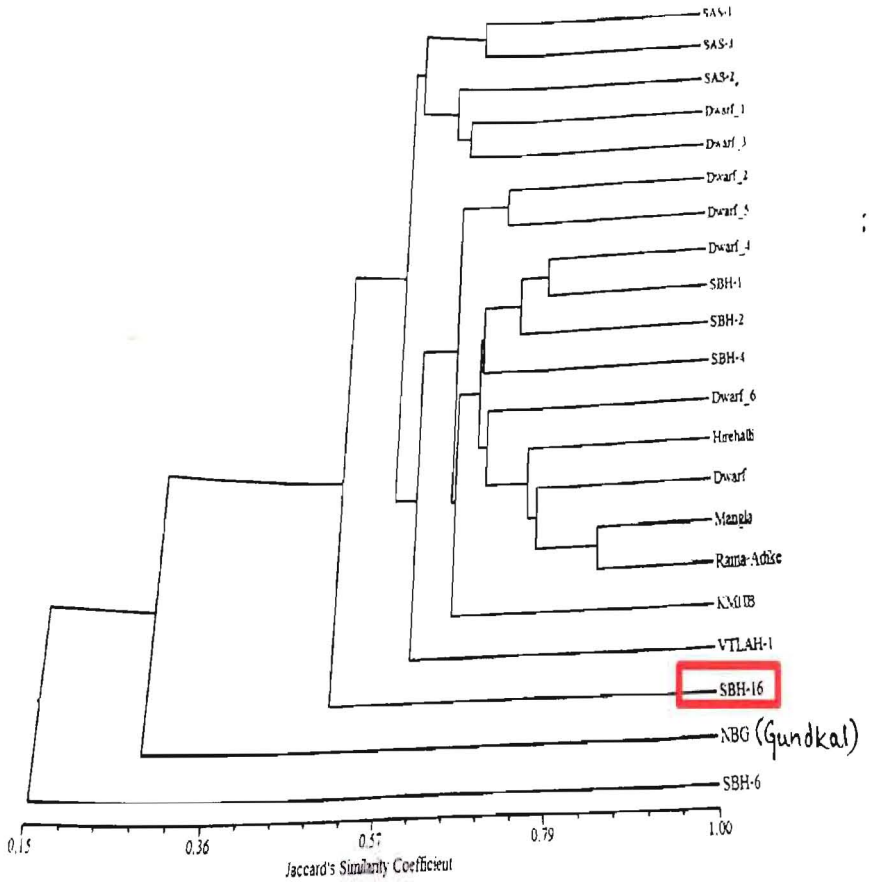


Figure 2: Dendrogram depicting genetic relationships among 21 areca nut samples

Dendrogram showing the genetic relationship of SBH-16 with other selections

Important characters of SBH-16 are:

- Tall type, drooping leaves
- 11 to 12 number of leaves per palm
- Very compact bunches with bright orange coloured nuts
- Regular, heavy yielder
- Suitable both for tender and ripe nut processing
- No incidence of kole roga during observation period
- No incidence of serious pests
- Mean wt. of dry nut: 6.5 g
- Estimated dry nut yield per palm (4 yrs): 10.37 kg
- Per cent improvement over SAS-3: 67.25%

The DNA analysis through IISR marker of SBH-16 is done, the dendrogram clearly indicates the separate and distant group for this elite palm among several entries. This selection is being registered with PPV & FRA as Farmer's varieity. This superior type will definitely revolutionise the arecanut cultivation in the hilly track of Karnataka.

The efforts are also on to continue search for higher yielding palms in the farmers field of Uttara Kannada dist. One of the main objectives of the selection programme is to identify the mother palms with higher individual kernel weight. This can be considered as more

advanatgeous as cost of harvesting and processing can be reduced. The selection based on the higher kernel weight is better than the more number of smaller nuts as finally dry nut weight per unit area is economically important than the bulk weight.

A higher kernel weight per palm is noticed in our selection programme from different farmers' plantations. We have observed a superior mother palm having individual dry nut weight of 11.2 g resulting in just 78-80 nuts required per kg against about 120 to 140 nuts per kilogam in normal palms. The salient features of this palms are as follows:

The elite palm yields minimum two bunches per palm while the dry weight of the nut per palm will be of 4.80kg which is higher than the existing released varieities. The owner of this palm is selling these nuts at a premium price in the market every year. The

No. of bunches per palm (nos.)	02
Total bunch weight/palm (kg)	24.27
No. of fresh nuts/palm (nos.)	428
Total wt. of fresh nuts/palm(kg)	21.82
Mean fresh nut wt. (g)	50.98
Dry wt. of individual nut (kernel) (g)	11.20
No. of nuts (kernel) required per kg	78-80
Dry weight of nut(kernel) per palm (kg)	4.80

multiplication and further evaluation of this elite palm is on. Such types are also reported from South Canara region of Karnataka. Padaru (2020) reported a selection from Mangala variety made by the farmer himself by crossing and selecting elite types. The important characters reported are as under.

1. Total fresh nut weight (kg): 1.3457 (from 380 nuts)
2. Average individual fresh nut weight (g) : 35.5
3. Total dry nut weight(g): 531
4. No. of nuts per kg: 69
5. Nut to husk ratio: 75%
6. Good cutting quality

The studies review indicated that there is ample scope to carryout extensive survey in arecanut growing areas for selection of superior types of mother palms. The major objective of such selection must be to select higher weight of kernel per palm irrespective of number of bunches per palm. Further, there needs to be identified superior region specific selections for coastal region, upghat region and for plains by selecting palms separtely in these area. It can be concluded that the area expansion of arecanut should be strictly restricted and old garden should be replaced by elite palms. By this objective alone will easily be doubled the income of the farmers as the average nut yield per palm in the state is just around 2.5 kg whereas the elite palms have the potential of yielding four times the existing yield.

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