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# Indian Coconut Journal

## Millets as inter crops in Coconut gardens

### Farmer Participatory assessment in ICAR CPCRI Farmer FIRST Program (FFP)

## The Use of Three-way cross Hybrid Coconut Varieties as an Alternative Measure to increase Farmers' Income in 4.0 G

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# Coconut Development Board

The Coconut Development Board is a statutory body established by the Government of India for the integrated development of coconut cultivation and industry in the country. The Board which came into existence on 12th January, 1981, functions under the administrative control of the Ministry of Agriculture and Farmers Welfare, Government of India, with its headquarters at Kochi in Kerala State and Regional Offices at Bangalore, Chennai, Guwahati and Patna. There are six State Centres situated in the states of Orissa, West Bengal, Maharashtra, Andhra Pradesh, Gujrat and in the Union Territory of Andaman & Nicobar Islands. DSP Farms are located at Neriyamangalam (Kerala), Vegiwada (Andhra Pradesh), Kondagaon (Chhattisgarh), Madehpura (Bihar), Abhayapuri (Assam), Pitapalli (Orissa), Mandya (Karnataka), Palghar (Maharashtra), Dhali (Tamil Nadu), South Hichachara (Tripura) and Fulia (West Bengal) besides a Market Development cum Information Centre at Delhi. The Board has set up a Technology Development Centre at Vazhakulam near Aluva in Kerala.

**Functions**

❒ Adopting measures for the development of coconut industry. ❒ Recommending measures for improving marketing of coconut and its products. ❒ Imparting technical advice to those engaged in coconut cultivation and industry. ❒ Providing financial and other assistance for expansion of area under coconut. ❒ Encouraging adoption of modern technologies for processing of coconut and its products. ❒ Adopting measures to get incentive prices for coconut and its products. ❒ Recommending measures for regulating imports and exports of coconut and its products. ❒ Fixing grades, specifications and standards for coconut and its products. ❒ Financing suitable schemes to increase the production of coconut and to improve the quality and yield of coconut.

❒ Assisting, encouraging, promoting and financing agricultural, technological, industrial or economic research on coconut and its products. ❒ Financing suitable schemes where coconut is grown on large scale so as to increase the production of coconut and to improve its quality and yield and for this purpose evolving schemes for award of prizes or grant of incentives to growers of coconut and the manufacturers of its products and for providing marketing facilities for coconut and its products. ❒ Collecting statistics on production, processing and marketing of coconut and its products and publishing them. ❒ Undertaking publicity activities and publishing books and periodicals on coconut and its products.

The development programmes implemented by the Board under the project Integrated Development of Coconut Industry in India are- production and distribution of planting material, expansion of area under coconut, integrated farming for productivity improvement, technology demonstration, market promotion and Information and Information Technology. Under the Technology Mission on Coconut, the programmes implemented by the Board are development, demonstration and adoption of technologies for management of insect pest and disease affected coconut gardens, development and adoption of technologies for processing and

# Index

Dear friends,

The coconut sector which had been facing severe price fall since March 2022 experienced a slight recovery this month, to the relief of the millions of small-holder coconut farmers. Procurement operations at Minimum Support Price under the Price Support scheme is also ongoing in the major coconut producing states, with Government of India increasing the targets for quantity of copra to be procured.

The visit of the senior bureaucrats in the Central Government to coconut growing areas in Pollachi in Coimbatore district of Tamil Nadu and interactions with the farmers and industry to understand their issues has also rejuvenated the coconut sector. The manifold uses of coconut were demonstrated to the team of officials which reiterated the value of this crop. The potential for processed products from coconut ranging from coconut oil, desiccated coconut, coconut milk, Neera and its products, coconut milk powder, coconut sugar, coconut water, coconut chips, coconut vinegar etc established the prospects for the crop to address the sustainable development goals including food security and nutritional security. The various non food products from coconut shell like coconut shell powder, coconut shell charcoal and activated carbon, and the products from coconut wood, coconut husk and the biomass which could be put to various uses established the crop as a zero waste crop which is most suited for sustainable agriculture.

Coconut is a crop which provides for different products at different stages of maturity. For instance, during the immature inflorescence stage, Neera can be produced and marketed as a healthy beverage or converted into various value added products like syrup, honey, jaggery and sugar. Once the nuts are produced, they can be harvested at the 6-7 month stage as tender coconut and marketed. Tender coconut is a healthy, nutritious and natural drink which is not only thirst quenching and refreshing, but is also rich in electrolytes and is prescribed by doctors. At the 8 month stage, the nuts could be harvested to produce products like coconut chips which is a healthy snack and is not fried. Once mature, at 12 month stage, coconut can be put to a variety of uses and diversified processed products can be produced.

The multifaceted uses of coconut could be utilized by the small-holder farmers through a proper harvesting calendar at different growth stages in accordance with a defined marketing plan, thereby avoiding the chances of market glut and price fall. Since coconut farmers are predominantly small and marginal, initiatives like formation of Farmer Producer Organisations promoted by Government of India would be helpful in facilitating the farmers realize remunerative returns and undertake coconut cultivation as a commercial profitable enterprise.

Chairman,

Editorial Board

# Millets as inter crops in Coconut gardens

## Farmer Participatory assessment in ICAR CPCRI Farmer FIRST Program(FFP)

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Millets are small seeded, hardy and unique due to its short growing season and are considered to be one of the oldest foods of mankind and may be first cereal grain crops farmed for domestic consumption. India is the largest millet producer (2021 data) with 41 percent of world production followed by Niger (12%), and China (8%) and millets were an integral part of Indian diet for centuries. United Nations at the behest of Government of India declared 2023 as the 'International Year of Millets". Data indicated that the estimated yield of millets in our country has more than doubled since 1966 and the average yield of millets is 1208 kg per hectare as on 2021-22, even though the per capita availability was fluctuating and was one of the lowest in 2019. Sorghum known as the great millet is the 4$^{th}$ most important food grain cultivated in 3.84 million hectares in India after rice, wheat and maize. India is the top most producer of barnyard millet (99.9%), kodo and little millet (100%), Ragi or finger millet (53.3%) and pearl millet (44.5%), with Rajasthan being the highest area under millet cultivation, followed by Maharashtra, Karnataka, Uttar Pradesh, Madhya Pradesh, Gujarat and Tamil Nadu. It is interesting to note that millet cultivation and production is higher in western India and is referred as 'Nutricereals' considering the nutrient richness of the grains. FAO reported that world millet production is 89.17 million metric tonnes from 74-million-hectare area.

Millets are one of the earliest foods of mankind with multiple health benefits for both human and planet as well. Millet crops are cultivated in an area of 12.1 million hectares producing over 13 million tonnes and sorghum is the major crop after rice wheat and maize in area. Globally India ranks first in production of barnyard, finger, kodo, little and pearl millet and Rajasthan occupies the highest area under millet cultivation followed by Maharashtra, Karnataka, Uttar Pradesh, Tamil Nadu and Madhya Pradesh. The area and yield of millets has recorded an upward trend due to the policies and interventions during the National Millet Year 2018.


Little millet in coconut gardens (ICAR FFP)

Millets are small seeded cereals grown for nutrition rich grains that can be cultivated with low water and input requirements with climate resilience. India is the largest producer and the second largest exporter of millet globally. India is determined to revive millet crops for strengthening the value chain and scaling up cultivation in other countries and enable higher consumption through better awareness and global campaigning.

### Millet- The crop of multiple goodness

Millets are good for our health in terms of slow digestive starch, dietary fibre, good fat, high mineral contents like calcium, potassium, magnesium, iron, manganese, zinc and B complex vitamins and ideal for diabetic and other diseases now prevailing due to lifestyles. It is good for the planet earth itself, with its low water footprint, making it thriving in arid regions of 300-400 mm water. Millets are known for 'Zero carbon and low energy Footprint' due to the carbon absorption from environment equal to the emitted carbon equivalent to per kg of production, which is double in many other cereal crops, energy efficient with less input requirement as well. The millet crops are good for the farmers in terms of short duration of cultivation, ideal for crop rotation and as inter crop providing high yield under good management. Millet is a secure crop for marginal farmers due to climate resilience and a future crop also for human kind.

Shri P Prasad, Agriculture Minister, Kerala, Shri Arif M P, Adv. U Prathibha, MLA and Dr. T N Seema in the FFP plot of Millet in coconut Gardens of Devikulangara panchayath

Fermented millets are excellent pro-biotic with gut protection qualities.

## Coconut and millets- Appropriate combination

Coconut and millets are one of the best nutritive combination and was integral in the diet diversity in earlier periods among rural communities of Kerala state. Traditionally Ragi or finger millet with coconut milk and coconut sugar is considered as one of the best weaning food for infants. The area under millet crops in Kerala is meagre and concentrated in Palakkad and Idukki districts only, that too majorly in Attappady the tribal areas, in two cropping seasons. According to Department of Economics and Statistics, in Kerala State, sorghum or jowar, ragi or finger millet and little millet are the major crops in these districts and in other districts it is absent or negligible. Agriculture in the state is characterized with its diversity of resources, agro-climatic conditions and cropping intensity of 128 percent in marginal land holdings of coconut gardens. Scope for including more diverse crops offers potential for food security.

The recommended spacing of 7.6 X 7.6 m permits sufficient sunlight infiltration through the canopy and basins with 1.8 m radius in effect offers 75 percent of the area for coconut based cropping systems, thus increasing resource use efficiency according to research reports. The spatial and temporal dimensions of coconut based homestead systems is unique and in tune with the 'Niche-complementary hypothesis' of Harper (1977) with more crops species resulting in high levels of utilization and partitioning of natural resources making it more productive than mono cropping or less diverse systems. The niche complementarity hypothesis states that niche differences among species, such as differences in resource use, should lead to more efficient acquisition of limiting resources and therefore higher productivity. Hence there is ample scope for including millet crops as inter crops in coconut gardens

## The millet crops reported suitable for Kerala state

| Millet crops | Scientific name | Common name |
|---|---|---|
| Pearl Millet / Bajra | *Pennisetum glaucum* | Cumbu |
| Sorghum | *Sorghum bicolor* | Jowar |
| Finger Millet | *Eleusine coracana* | Ragi |
| Foxtail Millet | *Setaria italic* | Thina |
| Barnyard Millet | *Echinochloa frumentacea* | Kudiravali |
| Kodo Millet | *Paspalum scorbiculatum* | Varagu |
| Proso Millet | *Panicum miliaceum* | Panivaragu |
| Little millet | *Panicum sumatrense* | Chama |

## Millet crops in Farmer FIRST Program (FFP) of ICAR CPCRI

ICAR CPCRI is implementing Farmer FIRST program (FFP) since 2016-17 in Pathiyur panchayat of Alappuzha district among 1000 farm families in an area of 1657 ha in 19 wards. Farmer participatory demonstration of Finger millet or Ragi was done on pilot basis in Alappuzha district as inter crop in 40 acres each, in coconut gardens and participatory variety selection for the locality was also done for finger millet in the period 2018, 2019 and 2020, in tune with declaration of the National Millet Year 2018 in India. Varieties Payur 1 and Payur 2 (TNAU) and KMR340 (UAS Bangalore) were found to be best suited for the Onattukara tract with sandy loam soil realizing an average yield of 750 to 850 kg per hectare. Farmers opined that there is very high market demand for finger millet. Following the success other panchayats also adopted finger millet cultivation as coconut inter crop in 2021.

In the action plan of ICAR CPCRI Farmer FIRST Programme (FFP), for 2022-23, demonstration and

community based cultivation of three millets crops varieties released from UAS Bangalore (Proso millet, Jowar and little millet) for farmer participatory evaluation and demonstration in 100 acres as inter crops in coconut gardens was proposed. Seven on-farm training programs on millet cultivation were organized in three panchayats viz. Pathiyur and Devikulangara of Alappuzha and Ochira panchayat of Kollam district. A total of 55 women groups participated in the millet cultivation programme.

Coconut farming communities can play a very purposeful role as partners in 'Shree Anna Yojana' of Government of India inter cropping millet crops, increasing demand and consumption of millets in their diet and as an income crop with less resources.

**Social interventions for introducing and promoting millets**

- Land consolidation strategies to overcome challenges of fragmented holdings (marginal and sub marginal land holdings) posing problems of viable cultivation and production for marketable surplus
- Convergence mapping of MGNREGS participants in all the wards of panchayats for millet cultivation through joint liability groups (JLG)
- Technology awareness campaigns and organizing skill training programs for farmers across the panchayats, extension officials and peoples' representatives
- Introducing millet crops of HYV from various universities and ICAR institutes for participatory assessment for the locality and conditions
- Quality seed material supply, critical inputs, regular field visits, technical backstopping, advisories, field problem solving and being with them to motivate and building confidence
- Triangulation of the results and responses with public, experts and extension officials
- Yield estimates and documentation of the success, failures and lessons learned

The cultivation practices of the millet crops presently being cultivated as inter crops in coconut gardens

**The field experiences of millet cultivation in coconut gardens is furnished as below.**

**Sorghum - Good performance in coconut gardens**

Sorghum is one of the most energy efficient crops in utilizing solar energy and water in terms of food and biomass. Sorghum considered to be originated in north-eastern Africa, domesticated around 5,000–8,000 years ago. The secondary Centre of origin of sorghum is the Indian Subcontinent, cultivating about 4500 years before. More than 0.5 billion people depend on sorghum as dietary mainstay and for livelihood. Scientific name is *Sorghum bicolor L.* is scientifically a C4 crop, and also known as the 'King of millets'. The vernacular names in different languages are Jwari (Marathi), Juar (Bengali, Gujarati), Jola (Kannada), Cholam (Malayalam), Tamil), Janha (Oriya), Jonnalu (Telugu). This crop is from gramineae family is a staple food of millions in semi-arid regions of the world.

Jowar or Sorghum the great millet in coconut Gardens -Farmers FIRST Program

Sorghum is a major source of slow digestible starch, protein and fat. It is known fact that non communicable diseases are significantly influenced due to oxidative stress and high level of free radical production. Sorghum derived phenolic chemicals act as natural defence against oxidative stress, by converting them into excretable harmless metabolites. Sorghum was cultivated in 20 acres in the FFP area, and seeds had been distributed by the end of February. By second week of March, soil was prepared and applied lime and cow dung as recommended. Sowing completed by April first week, followed by thinning. By third week of April,

infestation of leaf-eating caterpillars were observed and successfully managed. Flowering initiated by 45 to 50 days after planting. Bird attack noted during milky stage of the grains (May second week), and flowering completed by May last week. The crop was harvested during first to third week of June. Sorghum was assessed as suited crop for Onattukara sandy loam soils and in water limiting conditions and proved to thrive and yield in wide range of climate conditions. Generally, sorghum requires 26 to 30ºC temperature for good growth. Grain sorghum (Variety 35-1) which is being grown in FFP panchayats performed well in Onattukara sandy soil demonstrated as successful initiative, and thrived during the hottest months of February and April 2023.

**Uses:** The crop could meet the fodder and feed for animals and poultry which is stated as one of the major field problems of small and marginal farmers of the locations during Participatory Rural Appraisal (PRA) sessions. Other usages are source of bio fuel, starch, food products and for preparation of beverages offering nutritional and livelihood options.

**Nutrition contents:** 100g of sorghum contains an average of 349 kcal of energy, 10.4g of protein, 72.6g of carbohydrate, 1.6g of crude fibre, 25mg of calcium and 4.1 mg of iron.

**Finger millet: *Eleusine coracana***

This crop is popular among rural populations of Southern India and Eastern& Central Africa. Ragi or finger millet is very nutritious and had excellent malting properties making it probiotic food and is believed to be originated in the hilly regions of Western Tanzania or Ethiopian highlands, later spread to Asia like India, Nepal and China.

Very popular in East Africa and Asia known as Ragi in India and Nepal and as finger millet since the spikes are arranged like fingers in palms. The tiny grains are rich in dietary fibre, proteins, polyphenols and minerals and traditionally used as weaning food for children and pregnant women. Finger millet is one of the richest source of calcium and potassium and suited for people suffering from diabetes, obesity and malnutrition. Some literature also indicates that ragi supports proper functioning of kidneys, brains and muscles for smooth working.

100g of finger millet contains 328 kcal energy, 7.3 g protein, 72g carbohydrate, 2.6g crude fibre, 344 mg calcium and 8.9mg iron.

**Proso millet: *Panicum miliaceum L.***

This is a short season crop, also known as common millet and considered to be the true millet of the history of mankind and believed to be the first domesticated cereal grain crop, which is being cultivated in Asia, Africa, Europe, Australia and North America. Usually hulled grains of proso millet which is nutritious and palatable and is used for preparing unleavened bread or cooked. Evidences point to the central or eastern Asiatic origin and the diversity increases towards yellow river valleys of China (also considered as origin), Mongolia and Eastern Asia. Proso millet requires low water, well adapted to wide range of soils and climate conditions like plateau and high elevations as well.

This millet crop, which is gluten free, also was assessed for suitability as inter crop (Variety: DHPM 2769) in coconut gardens for the first time and demonstrated to be suitable in terms of yield and growth. Proso millet was grown in 25 acres in the FFP region, and the seeds were provided by February end. By second week of March, soil preparation and application of lime and cow dung was done. Sowing completed by April first week, followed by thinning after a week. Aphid infestation which was noticed during third week of April was managed with neem oil emulsion spraying. Flowering started on the 37$^{th}$ day after sowing. Rice bug infestation occurred during May first week coinciding the milky stage of the grains, and flowering completed by May second week. Harvesting was completed during May and June months. Proso millet is rich in fibre, polyphenols, vitamins and protein. Proso millet contains high levels of lecithin supportive of the neural health system, vitamins such as niacin, B complex and folic acid, minerals like phosphorus, calcium, zinc and iron and methionine and cysteine which are essential amino acids.

Proso Millet - Suitable for Onattukara region, Alappuzha district

Jowar harvest- Suitable coconut intercrop(1)

100g of Proso millet contains 309 kcal of energy, 8.3g of protein, 65.9g of carbohydrate, 9mg of crude fibre, 27mg of calcium and 0.5 mg of iron.

**Little Millet: *Panicum miliare***

Little millet is shorter, smaller panicles and seeds looking similar to proso millet, and is grown with minimum care. Considered as endemic to India, this crop having vernacular names in most of Indian languages is cultivated throughout India and Srilanka, Most of the wild species and diversity are found in India suggestive to its Indian origin.

Little millet was introduced in FFP panchayats of Alappuzha districts, Little millet is a traditional crop of several Indian states. Little millet (Variety: DHLM 36-3)was cultivated in 25 acres in the FFP area, and the seeds were provided during the last week of February. Land preparation, lime and cow dung application was done during the second week of March. The sowing was completed during the first week of April, followed by thinning to ensure scientific plant density. Aphid attack was noticed in the seedling stage. Flowering was initiated from 37$^{th}$ day after sowing. Rice bug incidence was observed in milky stage of the grains, and by May second week, the flowering was completed. Harvesting was started by last week of May and was completed by first week of June. The expected yield of little millet is 450–600 kg/acre. The grains of little millet are smaller than proso millet and featured with low carbohydrate content, slow digestibility and low water soluble gum content which improves glucose metabolism. It is also characterized with slow release of sugar in the blood and slowed glucose absorption. Nutrient content in 100g of little millet is 314 k cal of energy, 10.13g protein, 65.55g carbohydrate, 7.72 mg crude fibre, 32mg calcium and 1.3 mg iron. *(Sources: Nutritive value of Indian food, NIN, ICMR 20)*

Thus in general millets contains bio active phytochemicals, insulin resistant starch, sterols, phenolic compounds which have roles as antioxidant, anti- carcinogenic, anti-inflammatory, anti-viral and neuro protective and reported to be beneficial against diseases like cancer, cardio vascular disease, diabetes, high blood pressure, high cholesterol, metabolic syndrome and Parkinson's disease. They are also excellent sources of dietary fibers and probiotics for healthy gut.

**Millet utilization prospects**

The utilization of millets Sorghum is treading towards self-sufficiency in India and 12 percent of the production is utilized for animal feed preparation and 8 percent for value added products and 5 percent for alcohol production as estimated by ICAR Indian Institute of Millet research (IIMR). Similarly, approximately 69 percent of Bajra is also utilized for human consumption, 15 percent for animal feed, 5 percent for value addition and 10 percent for alcohol production. As Sorghum three fourth production of Ragi is utilized for human consumption and 13 percent for animal feed. Millets are also used for the production of animal feed or as component of compound feeds due to its highest metabolizable energy.

Utilization of millets in distilleries is another industrial potential, even though there seems to have an upward consumption trend due to rising health consciousness. Since India preponed the target ethanol blending with petrol by five years to cut its dependence on costly oil imports, millets attain importance in food and feed production roles even in changing the climate scenario.

**Risks and problems of millet cultivation- Field lessons**

Higher levels of productivity as inter crop in coconut gardens could push millets as one of the notable crops for food self-sufficiency. Though the general assumption that millets have minimal pest and disease incidence, in the areas where the crop is widely cultivated in FFP panchayats, incidence of rice bug (up to 80 percent yield loss in some plots), birds attack and swamps of birds scavenging grains upto 30 percent is recorded. Hence effective

documentation and mapping of biological risks in various Agro Ecological Zones with effective management measures in package of practices is the need of the hour. Wide scope for area expansion in Kerala which is mostly non-traditional area except Wayanad is established through this participatory assessment of millet crops as inter crops in coconut gardens in the FFP panchayaths by ICAR CPCRI. Participatory assessment of varieties of millets needs to be further taken forward for evaluation of nutritional aspects and suitability for value addition and specific products for consumers and commercial production.

Availability of quality seeds in adequate quantities and choice of varieties is currently curtailing the cultivation to large areas suitable to millets needs to be strengthened responsibly. Hulling facility of different millets is absent in most of the panchayats of Kerala state. Studies are needed for assessing the loss of nutritive qualities while processing and exclusive millet food products is still to be developed for wider consumption. Nutraceutical potentials of prebiotic and probiotics of millets is an unexplored area supportive to millet cultivation and acceptance.

Millet crops as champions of climate resilience is an accepted moto in advocating for large scale adoption, and policy support is required for changing notion that millets are poor man's food. So far millets are not widely supported for distribution through public distribution systems or in anganwadis or nutritional programs. Seasonal suitability of each millet in various Agro Ecological Units (AEU) should be evolved through research for higher yield and profitability. Awareness programs should be derived and standards for millet products may be approved as per rules and regulations for FSSAI, export promotions as well as for start up ecosystem.. Other than human consumption the role of millets in the animal feed sector and distilleries are some other important areas for focal consideration. Millet crops are tolerant or resilient to drought, flood, and toughest environments and could meet the demand of grain foods in future.

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# Scientific Study on Decreasing Trend of Copra Price in Karnataka

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## 1. Introduction:

The coconut palm often referred to as the "Tree of Life," holds a special place in the agricultural landscape of Karnataka, India. Karnataka, with its favorable tropical climate and extensive coconut plantations shares 33.8% percent of total production of coconut in India. In 2021-22, area, production and productivity of coconut in Karnataka were 604.23 thousand hectares, 5177.63 million nuts and 8569.00 Nuts/hectare respectively (Directorate of Economics and Statistics, DES). In Karnataka the major coconut producing districts were Tumkur, Chitradurga, Chikmagalur, Mandya, Mysore and Hassan. As regards the total contribution from districts, Tumkur stands first in respect of area (28.88%), whereas in production also Tumkur stands first (28.88%). Dakshina Kannada has high productivity with 11,049 Nuts/ha. Copra is an important by-product of coconut. In India two main types of copra (milling and ball copra) are produced. Milling copra is primarily used for extracting oil, while ball copra is more commonly used in traditional Indian cuisine for its distinct flavor. Karnataka, Kerala and Tamilnadu are the major copra producing states. It is estimated that 40 percent of total coconut production is processed into copra in Karnataka. Copra has been a cornerstone of the state's agricultural economy and a key source of income for countless farmers and traders. However, recent months have witnessed a significant and concerning trend – the steady decline in the price of copra.

## 2. Current marketing scenario Copra

**Price trends in Karnataka during April-2022 to August-2023**

The data analysis reveals a consistent and substantial decreasing trend in copra prices in

| Month | Tiptur | Turuvekere | Arasikere | Gubbi | Huliyar |
|---|---|---|---|---|---|
| April. 22 | 16,748 | 17,015 | 16,058 | 15,125 | 17,008 |
| May. 22 | 15,016 | 15,136 | 14,202 | 13,750 | 13,838 |
| June. 22 | 13,684 | 14,122 | 13,431 | 13252 | 12,855 |
| July. 22 | 14,065 | 14,475 | 14,008 | 14,002 | 14,594 |
| Aug. 22 | 13,958 | 14,230 | 13,519 | 13,676 | 13,869 |
| Sep. 22 | 13,530 | 13,845 | 13,453 | 13,850 | 13,234 |
| Oct. 22 | 13,580 | 13,741 | 13,446 | 13,300 | 13,457 |
| Nov. 22 | 12,683 | 12,577 | 12,218 | 11987 | 12,401 |
| Dec. 22 | 11,692 | 11,755 | 11,686 | 11,266 | 11,877 |
| Jan. 23 | 11,049 | 11,214 | 11,035 | 11,160 | 10,784 |
| Feb. 23 | 10,373 | 10,508 | 10,385 | 10,324 | 10,472 |
| Apr. 23 | 8,908 | 9,188 | 9,081 | 9,200 | 8,850 |
| May. 23 | 9,160 | 9,343 | 9,081 | 9,277 | 8,970 |
| June.23 | 8,218 | 8,409 | 8,260 | 8,510 | 7,789 |
| July.23 | 8,352 | 8,725 | 8,439 | 8,400 | 8,425 |
| Aug.23 | 8,904 | 9,111 | 8,890 | 8,643 | 9,145 |

Table-1: Modal price of copra from April-2022 to August-2023 in major markets of Karnataka

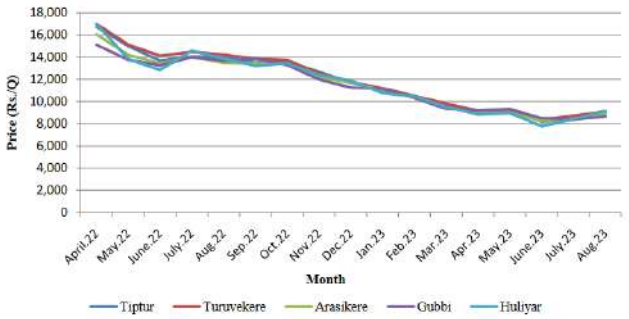


Figure 1: Trends in modal price of copra from April-2022 to August-2023 in major markets of Karnataka

Karnataka over a past few months. This trend has affected various regions of the state and is of paramount concern to stakeholders in the coconut industry. Figure 1 shows the trends in modal price of copra from April-2022 to August-2023 in major markets of Karnataka. From the graph we can observe that the modal price of copra has decreased continuously from April-2022 to August-2023 *i.e.*, it has reached to 8,600 Rs. /Q– 9,100 Rs. /Q in August 2023, whereas modal price per quintal of copra was 15,000 Rs. /Q –17,000 Rs. /Q in April 2022. Nearly, 40 percent decline in the price has been observed in a span of 17 months.


Figure 2: Trends in minimum, maximum and modal price of copra from April-2022 to August-2023 in Tiptur APMC

Figure 2 shows the minimum, maximum and modal price of copra from April-2022 to August-2023 in Tiptur APMC, largest Copra market of Karnataka. Downward movement of minimum, maximum and modal price was observed in Tiptur APMC. During April-2022 to August-2023, maximum and minimum price of copra fell nearly 40 percent (from 17,400 Rs. /Q to 10,006 Rs. /Q) and 56 percent (from 15,500 Rs. /Q to 6,800 Rs. /Q) respectively

## 3. Objectives:

Understanding the causes behind decline in copra price is not only crucial for the livelihoods of coconut farmers but also for the broader agricultural and economic stability of the state. As the area, production, productivity and export-import dynamics are closely linked and play significant roles in determining copra price; this scientific study aims at the following objectives.

- To study area, production, productivity and export dynamics of coconut and copra.
- To investigate and analyze the factors contributing to the decreasing price of copra in Karnataka and suggest measures to address this pressing issue.

| Month | Minimum Price | Maximum Price | Modal Price |
|---|---|---|---|
| April.22 | 15,500 | 17,400 | 16,748 |
| May.22 | 12,800 | 17,125 | 15,016 |
| June.22 | 12,000 | 14,650 | 13,684 |
| July.22 | 12,100 | 15,200 | 14,065 |
| Aug.22 | 12,800 | 15,011 | 13,958 |
| Sep.22 | 12,500 | 15,500 | 13,530 |
| Oct.22 | 12,000 | 15,000 | 13,580 |
| Nov.22 | 11,000 | 15,001 | 12,683 |
| Dec.22 | 10,600 | 14,900 | 11,692 |
| Jan.23 | 10,000 | 13,000 | 11,049 |
| Feb.23 | 8,600 | 11,500 | 10,373 |
| Mar.23 | 8,000 | 12,000 | 9,628 |
| Apr.23 | 8,000 | 10,100 | 8,908 |
| May.23 | 8,000 | 10,001 | 9,160 |
| June.23 | 6,800 | 10,000 | 8,218 |
| July.23 | 6,800 | 10,206 | 8,352 |
| Aug.23 | 6,800 | 10,006 | 8,904 |

Table-2: Minimum, maximum and modal price of copra from April-2022 to August-2023 in Tiptur APMC Karnataka

Source: Krishimaratavahini.kar.nic.in.

## 4. Research methodology:

To study the causes of decrease in the copra market price, both secondary and primary data was used. Primary data was collected through both telephonic and direct interview from the farmers using unstructured interview method. Telephonic interview was used for farmers of Arasikere and Tiptur taluks and direct interview was conducted in Kadur taluk. Secondary data was collected from krishimaratavahini, Directorate of Economics and Statistics (DES) and DGCI&S (Directorate General of Commercial Intelligence and Statistics) websites.

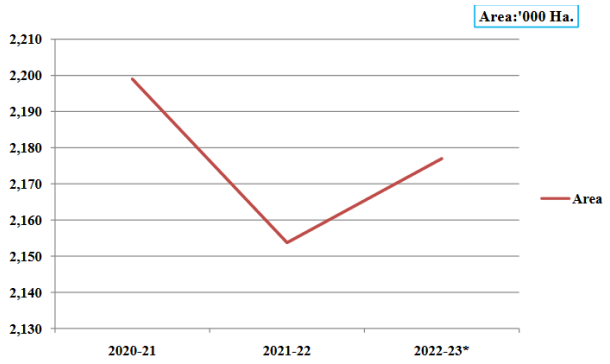


Fig. 3: Area of Coconut in India for the period from 2020-21 to 2022-23

Area: '000 Hectares, Production:'000 Tonnes, Productivity: Nuts/ha.

## 5. Area, Production and productivity of coconut and copra:

### Indian Scenario

Table 3, Fig. 3 and Fig. 4 depicts the area, production and productivity of coconut in India. The data shows that the area and production of coconut was 14,301 '000 tonnes and 2,199'000 hectares respectively in 2020-21 and it decreased to 13,317 '000 tonnes and 2,154 '000 hectares respectively in 2021-22 (6.88 percent and 2.06 percent)

| Sl. No. | Year | Area | Production | Productivity |
|---|---|---|---|---|
| 1 | 2020-21 | 2,199 | 14,301 | 9,430 |
| 2 | 2021-22 | 2,154 | 13,317 | 8,966 |
| 3 | 2022-23* | 2,177 | 13,518 | NA |

Table 3: All-India Area, Production and Productivity of Coconut

Source: Department of Agriculture and Farmers Welfare, *1st advance estimate Coconut development Board

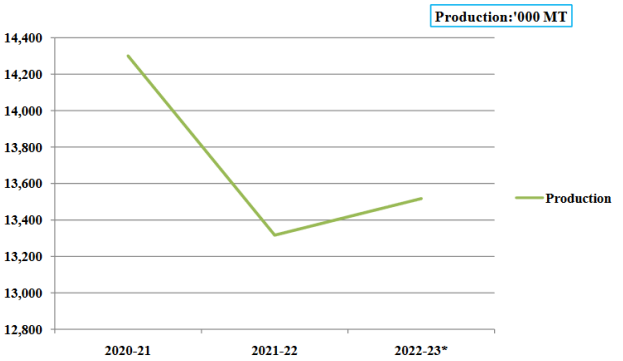


Fig. 4: Production of Coconut in India for the period from 2020-21 to 2022-23

### • Major producing states of Coconut in India

Table 4 and Fig. 5 depicts the major coconut producing states in India and their contribution towards total pool of production of coconut during the period 2021-22. Kerala stands first in respect of area with 765.44 '000 ha. (35.54 %) followed by Karnataka (28.05%), Tamil Nadu (20.72%) and Andhra Pradesh (4.91%), whereas in production Kerala stands first with 5,522.66 million nuts (28.60%) followed by Karnataka (26.81%), Tamil Nadu (26.37%) and Andhra Pradesh (8.75%). Andhra Pradesh has high productivity with 15,964 Nuts/ha.

| Sl. No. | States /Union Territories | Area ('000 Hectares) | % share | Production (Million nuts) | % share | Productivity (Nuts/ha) |
|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 105.80 | 4.91 | 1,689.09 | 8.75 | 15,964 |
| 2 | Assam | 21.03 | 0.98 | 156.52 | 0.81 | 7,444 |
| 3 | Gujarat | 25.60 | 1.19 | 212.62 | 1.10 | 8,307 |
| 4 | Karnataka | 604.23 | 28.05 | 5,177.63 | 26.81 | 8,569 |
| 5 | Kerala | 765.44 | 35.54 | 5,522.66 | 28.60 | 7,215 |
| 6 | Maharashtra | 30.32 | 1.41 | 238.45 | 1.23 | 7,863 |
| 7 | Odisha | 52.82 | 2.45 | 397.57 | 2.06 | 7,527 |
| 8 | Tamil Nadu | 446.15 | 20.72 | 5,091.83 | 26.37 | 11,413 |
| 9 | West Bengal | 32.63 | 1.52 | 406.10 | 2.10 | 12,447 |
| 10 | Others | 69.73 | 3.24 | 417.43 | 2.16 | NA |
| Total | | 2153.74 | | 19,309.90 | | 8,966 |

Table 4: Area, Production and Productivity of Coconut in major Producing States

Source: Coconut Development Board

• **Karnataka scenario:**

Table 5 and Fig. 6 depict the area, production and productivity of coconut in Karnataka. The data shows that the production of coconut was 3392.08 '000 tonnes in the year 2020-21. It increased to 20.52 percent and reached 4088.00 '000 tonnes in the year 2021-22 (due to increase in productivity of coconut from 5280 Kg/ha to 6767 Kg/ha during 2020-21 to 2021-22).

**Major producing district of Coconut in Karnataka:**

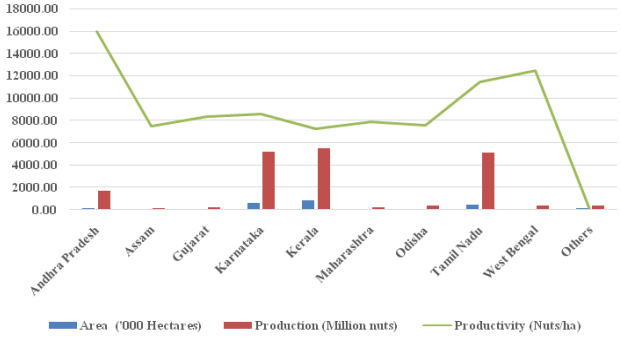


Fig. 5: Area, Production and Productivity of Coconut in major producing states (2021-22)

| Sl. No. | Years | Area('000 Hectare) | Production ('000 tonnes) | Productivity (Kg/Hectare) |
|---|---|---|---|---|
| 1 | 2020-21 | 2,199 | 14,301 | 9,430 |
| 2 | 2021-22 | 2,154 | 13,317 | 8,966 |
| 3 | 2022-23* | 2,177 | 13,518 | NA |

Table 5: Area, Production and Productivity of Coconut in Karnataka

Table 6 indicates district-wise area, production and productivity of coconut in Karnataka and their contribution towards total pool of

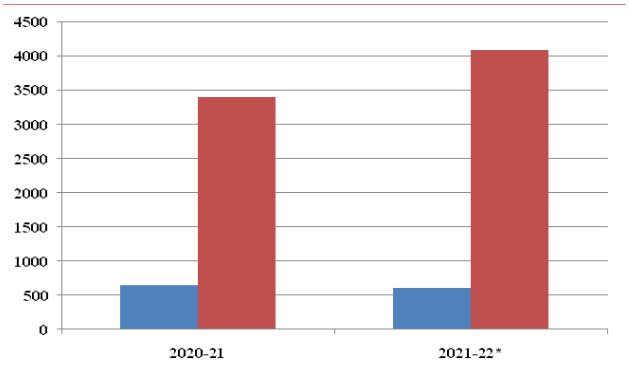


Fig. 6: Area and Production of Coconut in Karnataka for the period from 2020-21 to 2021-22

production of coconut in 2020-21. In Karnataka the major coconut producing districts were Tumkur, Chitradurga, Chikmagalur, Mandya, Mysore and Hassan.

As regards the total contribution from districts, Tumkur stands first in respect of area (28.91%) followed by Hassan (15.85%), Mandya (10.85%), Chikmagalur (8.37%) and Chitradurga (7.42%), whereas in production Tumkur stands first (26.65%) followed by Mandya (12.20%), Hassan (9.67 %), Chikmagalur (9.51%) and Chitradurga (8.94%).

**Copra production in India**

The main commercial product from the coconut palm is copra. Two types of copra, namely the milling and the edible, are made in India. The milling copra is used to extract oil while the edible copra is consumed as a dry fruit. Edible copra is made in the forms of balls and cups. The milling copra production is mainly concentrated in Kerala and Tamil Nadu. Kerala had the largest share accounting for 49.3 percent of total milling copra production in the country during 2020-21, while the share of Tamil Nadu was 43 percent, followed by Karnataka (4.1%). In case of edible copra, Karnataka accounted for 64.9 percent of total production, while Kerala's share was 15.2 percent and Tamil Nadu share was 10.8 percent in 2020-21. In Karnataka, from total coconut production 40 percent of coconut goes to copra production. (Source: Price Policy for Copra, 2022 session)

**6. Export dynamics of coconut and its products:** Table 7 and Fig. 7 show India's Export Value of Coconut and its Products excluding Coir from 2020-21 to 2022-23. The Export Value of Coconut and its Products has increased significantly from Rs 2294.81 in Crore in 2020-21 to Rs 3554.23 in Crore in 2022-23.

| Sl. No. | Districts | Area ('000 Ha) | % share | Production (Lakh Nuts) | % share | Productivity |
|---|---|---|---|---|---|---|
| 1 | Tumkur | 178.75 | 28.91 | 13123.68 | 26.65 | 7342 |
| 2 | Hassan | 98.00 | 15.85 | 4759.81 | 9.67 | 4857 |
| 3 | Mandya | 67.11 | 10.85 | 6009.34 | 12.20 | 8955 |
| 4 | Chikmagalur | 51.78 | 8.37 | 4684.20 | 9.51 | 9046 |
| 5 | Chitradurga | 45.87 | 7.42 | 4402.60 | 8.94 | 9598 |
| 6 | Dakshina Kannada | 36.86 | 5.96 | 2537.95 | 5.15 | 6885 |
| 7 | Ramanagar | 30.02 | 4.85 | 2306.21 | 4.68 | 7683 |
| 8 | Udupi | 26.71 | 4.32 | 3476.18 | 7.06 | 13016 |
| 9 | Mysore | 22.59 | 3.65 | 2627.34 | 5.34 | 11629 |
| 10 | Chamarajanagar | 12.57 | 2.03 | 1483.88 | 3.01 | 11804 |
| 11 | Shimoga | 11.97 | 1.94 | 952.85 | 1.94 | 7963 |
| 12 | Davangere | 10.90 | 1.76 | 867.65 | 1.76 | 7963 |
| 13 | Uttar Kannada | 10.49 | 1.70 | 835.48 | 1.70 | 7963 |
| 14 | Others | 14.75 | 2.39 | 1174.61 | 2.39 | NA |
| | Total | 618.36 | | 49241.78 | | 7963 |

Table 6: Area, Production and Productivity of Coconut in major producing Districts of Karnataka 2020-21

*Source: Department of Agriculture and Farmers Welfare, *3rd advance estimate*

| Sl. No. | Years | Export Value (Rs in Crore) | % variation over previous year |
|---|---|---|---|
| 1 | 2020-21 | 2294.81 | 30.23 |
| 2 | 2021-22 | 3236.83 | 41.05 |
| 3 | 2022-23 | 3554.23 | 9.81 |

Table 7: India's Export Value of Coconut and its Products excluding Coir

*Source: Coconut Development Board*

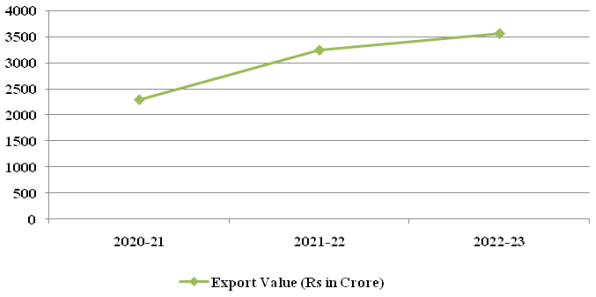


Fig. 7: India's Export Value of Coconut and its Products excluding Coir

| Sl. No. | Coconut products | Major destinations |
|---|---|---|
| 1 | Activated Carbon | USA, Sri Lanka and Germany |
| 2 | Coconut Fresh | UAE, Oman and Qatar |
| 3 | Coconut Oil | UAE , Saudi Arabia, USA |
| 4 | Coconut Dried | Malaysia, Afghanistan and UAE |
| 5 | Copra | Nepal, Hong Kong and USA |
| 6 | Desiccated Coconut | UAE, USA and Iran |

Table 8: Major destination's of India's exports of coconut products

*Source: Directorate General of Commercial Intelligence and Statistics (DGCIS), GOI*

| Sl. No. | Markets | Arrivals from | Peak Months | Major Destination | Quantity (in quintals) |
|---|---|---|---|---|---|
| 1 | Tiptur | Mandya, Chikkamangaluru, Hassan, Chitradurga, Tumkur, Davangere | Jun-Dec | Uttar Pradesh | 1,61,150.00 |
| | | | | Maharashtra | 84,034.00 |
| | | | | Rajastan | 56,571.00 |
| | | | | Tamil Nadu | 62,510.00 |
| 2 | Arasikere | Arasikere, Chennarayapatna, Kadur,Chikkamangaluru, Huliyar | Aug-Dec | Rajastan | 33,929.00 |
| | | | | Bihar | 25,171.00 |
| | | | | Maharashtra | 26,162.00 |
| | | | | Uttar Pradesh | 22,323.00 |
| 3 | Turuvekere | Arasikere, Chennarayapatna, Huliyar | Jun-Nov | Uttar Pradesh | 17,836.00 |
| | | | | Madya Pradesh | 8,039.00 |
| | | | | Maharashtra | 10,047.00 |
| | | | | Rajastan | 1,229.00 |
| 4 | Gubbi | Arasikere, Chennarayapatna, Kadur,Chikkamangaluru, Huliyar | Aug-Dec | Uttar Pradesh | 7,259.00 |
| | | | | Madya Pradesh | 3,470.00 |
| | | | | Maharashtra | 3,569.00 |
| | | | | Tamil Nadu | 1,803.00 |

Table 9: Copra arrivals and its major export destinations in Karnataka APMC's in 2021-22

| Sl. No. | Markets | Arrivals from | Peak Months | Major Destination | Quantity (in quintals) |
|---|---|---|---|---|---|
| 1 | Tiptur | Mandya, Chikkamangaluru, Hassan, Chitradurga, Tumkur, Davangere | Jun-Dec | Uttar Pradesh | 1,41,686.00 |
| | | | | Rajastan | 48,804.00 |
| | | | | Maharashtra | 63,783.00 |
| | | | | Tamil Nadu | 71,432.00 |
| 2 | Arasikere | Arasikere, Chennarayapatna, Kadur,Chikkamangaluru, Huliyar | Aug-Dec | Rajastan | 38,059.00 |
| | | | | Uttar Pradesh | 31,803.00 |
| | | | | Bihar | 25,173.00 |
| | | | | Maharashtra | 30,252.00 |
| 3 | Turuvekere | Arasikere, Chennarayapatna, Huliyar | Jun-Nov | Madya Pradesh | 10,102.00 |
| | | | | Uttar Pradesh | 9,240.00 |
| | | | | Tamil Nadu | 4,240.00 |
| | | | | Maharashtra | 4,102.00 |
| 4 | Gubbi | Arasikere, Chennarayapatna, Kadur,Chikkamangaluru, Huliyar | Aug-Dec | Madya Pradesh | 5,162.00 |
| | | | | Uttar Pradesh | 4,481.00 |
| | | | | Maharashtra | 3,770.00 |
| | | | | Tamil Nadu | 617.00 |

Table 10: Copra arrivals and its major export destinations in Karnataka APMC's in 2022-23

*Source: Krishimaratavahini.kar.nic.in*

## 7. Factors affecting decreasing copra price in Karnataka:

The sustained decrease in copra prices in Karnataka is a complex issue with multifaceted causes. After taking interview with the farmers and analyzing the secondary data, the study identified agricultural practices, weather-related disruptions, global market dynamics and recent APMC amendment act as the multiple factors that have played a significant role in driving down copra prices in Karnataka.

**I. Agricultural Practices:**

Over the past decade, many coconut farmers in Karnataka have shifted their agricultural practices due to various factors, which have indirectly led to a decrease in copra prices. Source: *ReMS, GOK*

**a) Change in Crop Diversification and neglected Coconut Maintenance:**

In response to market demands and government incentives, some coconut farmers in Karnataka have gradually shifted away from traditional coconut monoculture towards diversifying their crops. They have started cultivating cash crops like rubber, areca nut, or oilseeds, which offer higher returns per acre compared to coconut farming. With reduced focus on coconut farming, some farmers have neglected proper maintenance practices for coconut trees. This includes irregular fertilization, inadequate pest control, and suboptimal irrigation, leading to lower coconut yields and quality

**b) Aging Coconut Trees:** As farmers allocate fewer resources to coconut cultivation, older coconut trees are not being replaced with younger, more productive ones. Older trees produce fewer coconuts and lower-quality copra.

**c) Reduced Copra Quality:** Due to the lack of attention, the quality of copra produced in Karnataka has deteriorated. This lower quality is less appealing to buyers in both domestic and international markets.

**d) Loss of Bargaining Power:** With the diversification of their crops, coconut farmers may become less reliant on copra as their primary income source. This reduces their bargaining power in negotiating prices with buyers, who are aware of the farmers' dependence on other crops.

**II. Weather-related disruptions:**

Copra quality in Karnataka has also been affected by the excessive rainfall events in the previous year. Coconut growing regions of Karnataka has received excess rain in 2022 and a prolonged period of rain has lead to increased moisture levels in the harvested nuts. High moisture content makes copra prone to mold and fungal growth, reducing its shelf life, quality and market value. Some of the respondent farmers have reported that their copra produce have been rejected in the market by traders and processors due to high moisture content that forced them to sell their produce at a lower price than market price, which has lead to financial loss for the farmers.

**III. Global market dynamics:**

Coconut and copra prices in India have been historically integrated with the coconut oil prices (Jnanadevan, 2018). Coconut oil competes with other oils such as soybean, palm, sunflower, rapeseed etc. in the world market. Therefore, price of copra is influenced by the supply and demand of competing vegetable oils price. Figure 8 depicts the India's vegetable oils import during 2021-22 and 2022-23. India's vegetable oils imports rose by nearly 20% from 8167227.91 metric tonnes in 2021-22 to 9812608.96 metric tonnes in 2022-23. Due to increase in import of vegetable oils, price of vegetable oils has been decreased. This has partially led to decrease in price of coconut oil and copra in southern states of India.

**IV. APMC Amendment Act,** 2020: Karnataka has implemented significant changes in its agricultural marketing regulations through the APMC Amendment Act, 2020 resulting in the deregulation of agricultural markets.

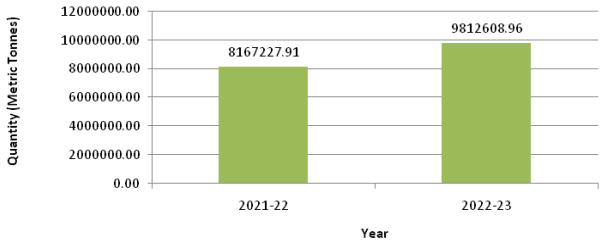


Figure 8: India's vegetable oils import during 2021-22 and 2022-23

This deregulation of markets has resulted in increase in the number of village merchants in the rural areas. Earlier farmers used to sell their copra produce in APMC's through e-tender system, which helped them to get competitive price for their produce. But, due to increase in the number and influence of village merchants farmers used to sell copra to merchants at the farm gate at a less price. The deregulation has introduced price volatility in the copra market. With multiple buyers and sellers operating independently, copra prices have become more responsive to supply and demand dynamics.

Rajanna, coconut grower (Kallapura village, Kadur taluk) said that "As there is no license to be taken to trade the commodity and exemption from market fee to trade outside APMC, many village merchants have been evolved in the field of coconut and copra trading in rural areas. Farmers were selling coconut and copra at their farm gate to avoid risks, transportation and other expenses but village merchants were making profits by purchasing from farmers at lower price and selling it to other traders. Village merchants were not enforcing strict quality standards, leading to the influx of lower quality copra into the market. This can affect the overall reputation and pricing of Karnataka copra".

## 8. Conclusion:

The challenges faced by the coconut sector in Karnataka are enormous. The reduced profitability due to the increasing cost of cultivation and price volatility has resulted in an alarming situation for the coconut economy in India and Karnataka. Many factors contributed towards decreasing copra price in Karnataka. While diversification may benefit farmers in the short term, it has inadvertently affected the quantity and quality of copra produced in the state, leading to market challenges and declining prices. It's the need of the hour to implement several strategies on the

part of government and also from the farmers to protect coconut growers in the state.

## 9. Suggestions:

To address the declining copra prices in Karnataka, the following recommendations are suggested:

**1. Market intelligence and price forecasting:** Market intelligence and price forecasting schemes need to be carried out for coconut and coconut products so that it will help the farmers to tide over the price uncertainties.

**2. Research and Development:** Develop and promote the cultivation of climate-resilient coconut varieties that exhibit tolerance to extreme weather events, such as excessive rainfall or drought.

**3. MSP Procurement throughout the year:** Copra is not a seasonal crop. The market arrivals patterns in Karnataka were found to be evenly distributed throughout the year and hence the current procurement time period of six months was not sufficient and there is a need to carry out procurement process throughout the year.

**4. Crop Insurance:** Provide farmers with crop insurance to mitigate the financial risks associated with weather-related disasters.

**5. Value addition and Export Promotion:** Promoting value addition and exports through formation of FPO's can increase demand for Karnataka's copra and coconut-based products, thereby stabilizing prices.

**6. Revising import duty:** There is also an urgent need to revise the import duty structure of edible oils.

# The Use of Three-way cross Hybrid Coconut Varieties as an Alternative Measure to increase Farmers' Income in 4.0 G

**Abstract**

The Three-way cross hybrid coconut varieties experiment was carried out in 1990 at Chumphon Horticulture Research Center (CHRC). Unfortunately, this experiment could not proceed for some years, due to the shortage of budget. However, the experiment resumed again between 2014-2017. This experiment aims to increase productivity and to improve some inferior characteristics of the single cross hybrid coconut such as low tolerance to drought, and small size of the nut. The experiment has a randomized complete block design with 4 replications 4 treatments namely (RNTxWAT)xTT, (MYDxWAT)xTT, (MYDxTAT)xTT, (MRDxRNT)xTT, with 12 recorded palms per plot. The results obtained from this experiment indicated that two promising hybrid varieties produced high productivity, and the nut sizes were medium to large, with a high percentage of oil content. The two promising hybrid varieties were (RNTxWAT)xTT and (MYDxWAT)xTT. Firstly (RNTxWAT)xTT produced 102 nuts/palm/year or 14,075 nuts/ha/yr, copra 4,787 kgs./ha/yr, copra per nut was 337 grams. In addition, the oil content was 61%. Secondly (MYDxWAT)xTT produced 108 nuts/palm/year or 14,285 nuts/ha/yr, copra 3,650 kgs/ha/yr, copra per nut was 250 g and oil content was 62%. Results of this experiment showed that both three-way cross hybrids have more advantages of fruit composition and other characteristics than that of Sawi Hybrid no.1 and including Chumphon hybrid no.2, were more tolerant to pests and diseases such as coconut hispiine beetle: *Brontispa longissima* (Gastro) and coconut black headed caterpillar: *Opisina arenosella* (Walker) and bud rot and nut fall disease *Phytophthora palmivora* (Butler). In addition, they were responsive to the fertilizer application recommended by the Department of Agriculture. It is expected that these two three-way cross hybrids will meet the needs of farmers and the coconut industry, subsequently, and reduce the import of coconut and coconut products.

**Introduction**

The coconut palm (*Cocos nucifera L.*) is an important economic crop of Thailand. It provides not only the basic necessities of life for Thai people, but also for coconut, coconut products export and processing industries. The coconut breeding program was initiated in 1974, up to the present at CHRC the agricultural industries have been in 4.0 G. *i.e.* the digital age for agriculture. Although the coconut breeding program has been set up for a long time. The problem of coconut production still remains such as low yielding, the small size of the nut, and low adaptability to adverse environments *i.e.* drought, infertile soil, etc. Therefore, this situation is challenging the coconut breeders on how to find measures to solve these problems, eventually the three-way cross hybrids were applied to produce the hybrids. Subsequently, four TWC hybrids had been produced and assigned in a varieties trial at Chumphon Horticulture Research Centre (CHRC) in 1991.

**Materials and Method**

This experiment is divided into two phases, the first phase was in the juvenile stage (before bearing) which began in 1990-1995 at CHRC, Chumphon, south, Thailand unfortunately during the experiment.

**Tippaya Kraitong[1], Yokthip Sudaree[1], Parinda Hrunheem[1], Wilaiwan Twishsri [2], Seree Yusathid[1,] Darakorn poawchow[1], Pairat Chauytem[1], Anupap Thirakul[3], Boonchana wongchana[1], Supapon Chumpong[1], Krirkchai Dhanarak[3], Supattra Lertwatanakiat [2], Supaporn Sachati[2], Sombat tongtao[3],**

[1] Chumphon Horticulture Research Centre, Horticulture Institute Research, Department of Agricultural
[2] Horticulture Institute Research, Department of Agricultural, Thailand
[3] Advisor to the Department of Agriculture, Thailand

There was a shortage of budget resulting in not proceeding with this experiment. However, the experiment resumed again between 2014 to 2017.

**Phase 1:** Preparation for planting materials. The single cross hybrids were used as the female parent and crossed with selected, Thai Tall (TT) as the male parent to produce TWC hybrids seeds (Fig.1) namely (RNTxWA)xTT, (MYDxWAT)xTT, (MYDxTAT and (MRDxRNT)xTT, All 4 TWC hybrids seeds were sown in seedbeds in 1990. (Incorporated in hybrids varieties trial project at CHRC in 1990, then seeds from 4 TWC hybrids.) After germination, the healthy seedlings of 4-5 months old were selected and planted in the same year. Other information were also recorded such as meteorological data performances of recorded palms, broke out of diseases and insect pest. The experiment has Randomized Complete Block Design (RCBD) and the 5 replication with 4 treatments (above mention) recorded palms were 12 palms per treatment. Growth performance after planting had been recorded at 6 months intervals regularly *i.e.* height, girth, the number of leaves increase, total leaves production, and leaf length (leaf no.3) before bearing.

**Phase 2:** When the palms had been in the bearing stage, all recorded palms were harvested at a one-month interval regularly, the number of harvested nuts were recorded, and two nuts were taken as simple for fruit component analysis (FCA). All parts of fruit components were weighed *ie.* Whole fruit, dehusked nut, husk, shell, water, meat, copra, including % oil content an oil content was analyzed by Soxhlet apparatus

**Results**

The first five years of evaluation, this stage was called the juvenile phase, from 1991 to 1995. There was significant differences at the age of 3 years old,

| Year | Sequence of work | Site |
|---|---|---|
| 1974 | The F1 hybrid seed of 4 hybrid varieties ie RNT x WAT, MYD x WAT, MYD x TAT and MRD x RNT were introduced to CHRC, Chumphon south, Thailand. All seeds were sown in seed beds but the rate of germination was very low therefore the seedlings were incorporated into the hybrid variety trial project and planted as guard row in the trial in 1975. | CHRC |
| 1990 | Preparation for producing TWC hybrid seeds. All palms of 4 F1 hybrids were used as the female parent and then selected the palms whose good yield of copra was 20 kg/year or over 60 nuts/palm/yr. Once the process of male parent palm selection began, using the same criteria that were used in selecting the female parent palms and R-value was also applied. The TWC hybrid seeds were produced by controlled natural pollination, once the fertilized female flowers were ripe the female palms' parents were harvested after that all seeds were sown in seed beds after germination all healthy seedlings were selected and planted in a variety trial project in 1991. | CHRC |
| | The TWC hybrid variety trial consisted of 5 replications, and 4 treatments in Randomized Complete Block Design (RCBD) the treatments were (RNT x WAT)x TT, (MYDxWAT)xTT, (MYDxTAT)xTT and (MRDxRNT)xTT | |
| 1996-2013 | Upkeep the experimental field | CHRC |
| 2014-2017 | The palms reached a mature stage, Therefore all recorded palms in the treatments were harvested at one monthly interval sampling 2 nuts from recorded palms were used in FCA. Oil content was also analyzed, during the experimental period, meteorological data, broke out of diseases and insects pests, responsive to fertilizer were recorded. Two high-yielding TWC hybrids were chosen due to they had the following characters ie high yielding, nut sizes were medium to large, and high oil content, in addition, its better adaptable to adverse environments. | CHRC |
| 2018 | Proposed the performance report to the DOA for considering to certify these 2 TWC hybrids. Finally, the DOA committee approved of certification to these 2 TWC hybrids and gave their names as Chumphon three-way cross hybrid no.2 (MYDxWAT)xTT and Chumphon three-way cross hybrid no.1 (RNTxWAT)xTT presently TWC hybrids seed gardens to produce 1 TWC hybrid have been undertaken. | CHRC |

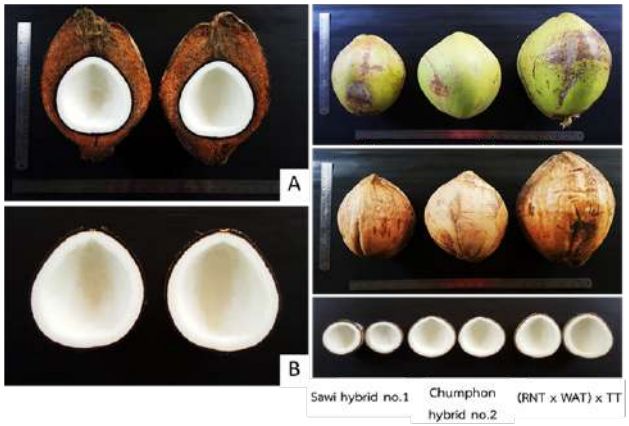


Figure 3. Characteristic of (RNT x WAT) x TT compare with coconut hybrid

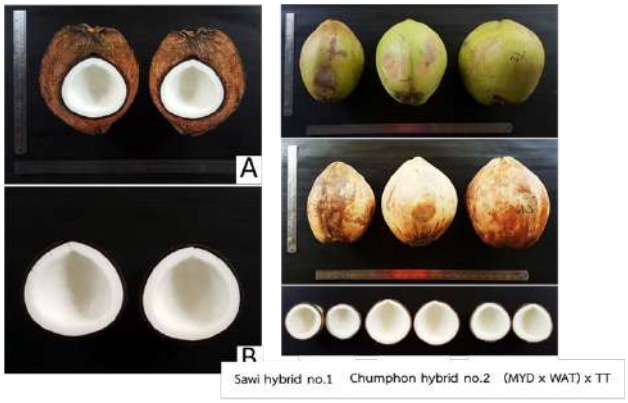


Figure 4. Characteristic of (RNT x WAT) x TT compare with coconut hybrid

(RNTx WAT) x TT had higher height than (MRDxRNT)xTT but (RNTxWAT)xTT was not different from (MYDxWAT) xTT, and also (MYDxTAT)xTT, however there were no differences among (MYDxWAT)xTT, (MYDxTAT)xTT and (MRDxRNT)xTT. When the palms in every treatment were 4-5 five years old (RNTxWAT)xTT tended to be the highest variety (Table 1-5).

| Treatments | coconut height (cm) | | | | | Average |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 1/ | 1994 | 1995 | |
| 1 (RNTxWAT)xTT | 208.84 | 568.67 | 624.16 a | 745.33 | 870.66 | 603.53 |
| 2 (MYDxWAT)xTT | 188.01 | 528.33 | 591.66 ab | 687.50 | 819.92 | 563.08 |
| 3 (MYDxTAT)xTT | 199.60 | 533.33 | 585.66 ab | 694.16 | 700.75 | 542.70 |
| 4 (MRDxRNT)xTT | 198.50 | 523.96 | 559.16 b | 680.13 | 807.93 | 553.94 |
| CV (%) | 7.70 | 7.30 | 6.80 | 6.80 | 19.50 | |

Table 1. Average height of hybrid coconut derived from the three-way cross in 1991 – 1995.
1/ Means the same column by common letter are not significantly different at the 5% level by DMRT

The girth average measurement of three-way cross hybrids in Table 2 shows that the significant difference just began in the fourth year after planting, (RNTxWAT)xTT had the biggest girth at 4 and 5 years old than the other 3 hybrid varieties *i.e.* (MYDxWAT)xTT, (MYDxTAT)xTT and (MRDxRNT)xTT.

| Treatments | Girth (cm) | | | | | Average |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 1/ | 1995 2/ | |
| 1 (RNTxWAT)xTT | 50.48 | 124.67 | 134.41 | 147.33 a | 169.16 a | 125.21 |
| 2 (MYDxWAT)xTT | 43.64 | 117.25 | 126.66 | 130.83 b | 145.92 b | 112.86 |
| 3 (MYDxTAT)xTT | 46.98 | 125.91 | 126.16 | 131.42 b | 146.25 b | 115.34 |
| 4 (MRDxRNT)xTT | 45.53 | 94.62 | 124.08 | 132.47 b | 148.08 b | 108.96 |
| CV (%) | 8.86 | 24.00 | 7.10 | 5.90 | 5.60 | |

Table 2. Average girth stem of hybrid coconut derived from the three-way cross in 1991 – 1995.
1/ Means the same column by common letter are not significantly different at the 5% level by DMRT
2/ Means the same column by common letter are not significantly different at the 1% level by DMRT

The average number of total leaves from three-way cross hybrids is shown in Table 3. There were no significant differences among the three-way cross hybrids.

| Treatments | Number of leaf (leaf) | | | | | Average |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 1/ | 1994 | 1995 2/ | |
| 1 (RNTxWAT)xTT | 8.43 | 14.41 | 14.16 | 18.06 | 25.56 | 16.12 |
| 2 (MYDxWAT)xTT | 7.76 | 15.60 | 15.52 | 18.90 | 26.41 | 16.84 |
| 3 (MYDxTAT)xTT | 9.05 | 15.90 | 16.20 | 20.08 | 27.40 | 17.73 |
| 4 (MRDxRNT)xTT | 8.70 | 14.80 | 15.22 | 18.14 | 25.56 | 16.48 |
| CV (%) | 14.67 | 6.10 | 9.20 | 11.00 | 8.30 | |

Table 3. Average number of leaf for hybrid coconut derived from three-way cross in between 1991 – 1995.

The average number of leaf increases from three-way cross hybrids is shown in Table 4. The performances of the number of leaf increase was same as the number of total leaves *i.e.* there were no significant differences among 4 hybrid varieties.

| Treatments | Number of leaf increase (leaf) | | | | | Average |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 | 1995 | |
| 1 (RNTxWAT)xTT | 6.31 | 7.18 | 4.86 | 8.21 | 13.84 | 8.08 |
| 2 (MYDxWAT)xTT | 7.00 | 7.86 | 5.08 | 8.16 | 14.28 | 8.48 |
| 3 (MYDxTAT)xTT | 7.07 | 8.14 | 4.98 | 8.68 | 14.90 | 8.75 |
| 4 (MRDxRNT)xTT | 6.73 | 7.43 | 4.93 | 7.80 | 13.88 | 8.15 |
| CV (%) | 6.90 | 7.50 | 9.40 | 9.60 | 4.30 | |

Table 4. Average number of leaf increased for hybrid coconut derived from the three-way cross in 1991 – 1995.

The average leaf length of the three-way cross hybrids is shown in Table 5. The results show that leaf length significantly differences as 3 year old (RNTxWAT)xTT had the longest leaf length but no differences from (MYDxWAT)xTT, and (MYDxTAT)xTT, however (MRDxRNT)xTT was the shortest leaf length and also there were not differences from (MYDxWAT)xTT and (MYDxTAT)xTT. When the palms became 4 year old the leaf length of all four hybrid varieties were not significantly different but when they became 5 years old there were significant differences again and showing a clear cut that (RNTxWAT)xTT had the longest leaf length than the other 3 hybrid varieties, namely, (MYDxWAT)xTT, (MYDxTAT)xTT and (MRDxRNT)xTT 576.43, 556.60,

| Treatments | leaf length (cm) | | | | | Average |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 | 1995 | |
| 1 (RNTxWAT)xTT | 115.43 | 474.50 | 522.56 a | 560.50 | 576.43 a | 449.88 |
| 2 (MYDxWAT)xTT | 101.62 | 456.70 | 517.00 ab | 546.33 | 556.60 b | 435.65 |
| 3 (MYDxTAT)xTT | 111.83 | 454.60 | 491.46 ab | 531.66 | 553.43 b | 428.60 |
| 4 (MRDxRNT)xTT | 112.35 | 450.20 | 487.33 b | 535.21 | 557.59 b | 428.54 |
| CV (%) | 15.00 | 5.20 | 4.50 | 3.70 | 1.30 | |

Table 5. Average leaf length for hybrid coconut derived from the three-way cross in 1991 – 1995.
2/ Means the same column by common letter are not significantly different at the 1% level by DMRT

553.43, 557.59 cm respectively. The comparison of the average yield of three-way cross hybrids from 2014 to 2017 is shown in Table 6. When the palms came into a full bearing stage at the age of 23-27 years old, the number of nut/palm/yr were recorded. It showed that in 2014, there were no significant differences among 3 hybrid varieties *i.e.* (RNT x WAT)xTT had 105.20 nut/palm/yr, (MYDxTAT)xTT produced 108.60 nut/palm/yr and (MRDxRNT)xTT produced 90.20 nut/palm/yr and no significant differences between (MYDxTAT)xTT and (MRDxRNT)xTT produced 77.30 nut/palm/yr, 90.20 nut/palm/yr respectively. It is of interest that in 2015

there were no significant differences among 4 TWC hybrids, but in 2016, there were significant differences among 4 TWC hybrids. Their performances were similar to 2014. Whereas in 2017 there were no significant differences again among 4 TWC hybrids. The performance of fruit bearing habit of TWC hybrids when used

| Treatments | yield (nuts/palm/year) | | | | Average |
|---|---|---|---|---|---|
| | 2014 1/ | 2015 | 2016 1/ | 2017 | |
| 1 (RNTxWAT)xTT | 105.20 a | 103.40 | 105.00 a | 95.82 | 102 |
| 2 (MYDxWAT)xTT | 108.60 a | 96.67 | 108.20 a | 117.74 | 108 |
| 3 (MYDxTAT)xTT | 77.30 b | 99.07 | 77.20 b | 91.63 | 86 |
| 4 (MRDxRNT)xTT | 90.20 ab | 124.07 | 90.27 ab | 103.45 | 102 |
| CV (%) | 17.70 | 23.00 | 14.00 | 18.30 | |
| Sawi Hybrid no.1 | | | | | 105 |
| Chumphon hybrid no.2. | | | | | 82 |

Table 6. Comparison average yield of hybrid coconut derived from three-way cross in between 2014 – 2017.

Tall x Tall, F1 hybrid as the female parent and then cross with Tall the irregular bearing trait was transferred into TWC hybrids, not only in TallxTall hybrids but it did in Dwarf xTall hybrids also.

The comparison of the average yield of nut/ha/yr from 2014-2017, is shown in Table 7. It showed that there were significant differences among four hybrids in the treatments in 2014, there were 2 hybrid varieties not significant differences namely (RNTxWAT)xTT produced 14,460 nut/ha/yr, (MYDxWAT)xTT produced 14,932 nut/ha/yr, but (MRDxRNT)xTT was not different from (MYDxTAT)xTT. In 2015 it showed that there were significant differences among the hybrids in nut/ha/yr, (MRDxRNT)xTT produced the highest yield than the other three hybrids *i.e.* 17,056, 13,618 (MYDxTAT)xTT, 13,287 (MYDxWAT)xTT and 14,218 (RNTxWAT) xTT and there were no significant differences among three hybrids *i.e.* (RNTxWAT)xTT, (MYDxWAT)xTT and (MYDxTAT)xTT.

| Treatments | Yield (nut/palm/ha) | | | | Average |
|---|---|---|---|---|---|
| | 2014 2/ | 2015 2/ | 2016 2/ | 2017 1/ | |
| 1(RNTxWAT)xTT | 14,460a | 14,218b | 14,438a | 13,175b | 14,075 |
| 2(MYDxWAT)xTT | 14,932a | 13,287b | 14,877a | 16,870a | 14,825 |
| 3(MYDxTAT)xTT | 10,628b | 13,618b | 10,615b | 12,598b | 11,868 |
| 4(MRDxRNT)xTT | 12,402b | 17,056a | 12,411b | 14,223ab | 14,025 |
| CV (%) | 10.30 | 9.92 | 11.9 | 12.8 | |
| Sawi hybrid No.1 | | | | | 14,375 |
| Chumphon hybrid No.2 | | | | | 11,450 |

Table 7. Comparison of the average yield of TWC hybrids nut/ha/yr. in 2014-2017

1/ Means the same column by common letter are not significantly different at the 5% level by DMRT

2/ Means the same column by common letter are not significantly different at the 1% level by DMRT

In 2016 the yields of 4 TWC hybrids produced nut/ha/yr that is similar as in the year 2014. That were no significance between (RNTxWAT)xTT, 14,438 and (MYDxWAT)xTT, 14,877 and also (MRDxRNT)xTT were not significant from (MYDxTAT)xTT, *i.e.* 12,411 and 14,877.

In 2017, the (MYDxWAT)xTT produced the highest nut production per ha per yr, 16,870 which was significant from the other 3 TWC hybrids namely, (RNTxWAT)xTT, 13,175 and (MYDxTAT)xTT, 12,958 but there were not significances among (RNTxWAT)xTT, 13,175, (MYDxTAT)xTT,12,598 and (MRDxRNT)xTT, 14,223.

| Treatments | Copra Yield (kg/ha /year) | | | | Average |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | |
| 1(RNTxWAT)xTT | 4,411a | 4,749 | 5,089 | 4,890 | 4,787 |
| 2(MYDxWAT)xTT | 3,518ab | 3,708 | 3,551 | 3,819 | 3,650 |
| 3(MYDxTAT)xTT | 3,133b | 4,181 | 3,194 | 4,447 | 3,737 |
| 4(MRDxRNT)xTT | 4,425a | 5,451 | 3,696 | 4,072 | 4,412 |
| CV (%) | 19.10 | 16.90 | 25.0 | 24.10 | |
| Sawi hybrid No.1 | | | | | 3,575 |
| Chumphon hybrid No.2 | | | | | 3,125 |

Table 8. Comparison of the average yield of 4 TWC hybrid with the single cross hybrid, Sawi hybrid No.1 and Chumphon hybrid No.2

[1/] Means the same column by common letter are not significantly different at the 5% level by DMRT

Table 8 Comparison of the average yield of 4 TWC hybrid between 2014 and 2017. The copra yield of three-way cross hybrids are shown in Table 8. In 2014 there were significant differences among 4 TWC hybrids in yields of copra/ha/yr (MRDxRNT)xTT produced the highest yield of copra, 4,425 kg/ha/yr, and the (MYDxTAT) xTT produced the lowest yield of copra, 31,33 kg/ha/yr, but there were no significant differences between (RNTxWAT)xTT, (MYDxWAT)xTT and (MRDxRNT)xTT also and there is no significant difference between (MYDxWAT)xTT, and (MYDxTAT)xTT). It is of interest that from 2015 up to 2017, there were no significant differences among 4 TWC hybrids in copra products per ha per year and this can be explained, because there was a five-month continuous drought from January up to May, when rain distribution was less than 10 mm/ month and this caused the abortion of initiated inflorescence bud (Figure 2).

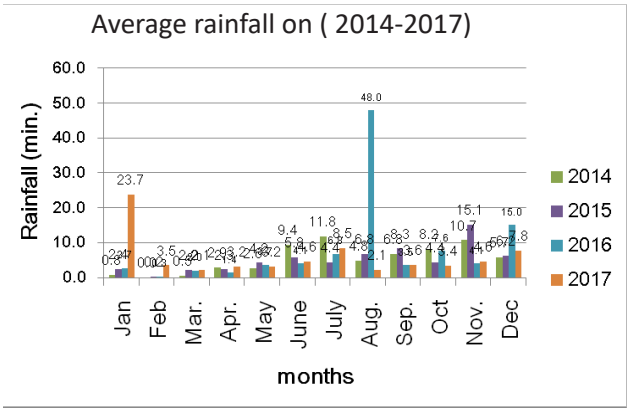


Figure 2 . Rainfall in Sawi weather station in 2014-2017

In 2016 it showed that there were significant differences in the average copra yield per ha per year of 4 TWC hybrids. The (RNTxWAT)xTT produced highest copra yield, that is 5,089 kg/ha, which was different from the 3 other hybrid varieties, (MYDxWAT)xTT, 3,551 kg/ha, (MYDxTAT)xTT,3,194 kg/ha and (MRDxRNT)xTT , 3,696 kg/ha.

In 2017 it showed that there were no significant differences in the average copra yield per ha per year of TWC hybrids. It is of interest that all four TWC hybrids can produce more yield providing that there are suitable environments and good farm management. It can be seen in Fig. 2 that the average

| Treatments | oil content (%) | | | | Average | oil yield (kg./ palm/yr) |
|---|---|---|---|---|---|---|
| | 2014 [2/] | 2015[2/] | 2016[2/] | 2017[1/] | | |
| 1 (RNTxWAT)xTT | 60.44 | 59.16 a | 61.56 ab | 62.00 a | 61 | 21 |
| 2 (MYDxWAT)xTT | 61.64 | 59.17 a | 62.65 a | 63.00 a | 62 | 17 |
| 3 (MYDxTAT)xTT | 60.12 | 52.22 b | 60.34 b | 58.39 b | 58 | 16 |
| 4 (MRDxRNT)xTT | 61.70 | 57.76 a | 60.11 b | 61.62 a | 60 | 20 |
| CV (%) | 3.30 | 6.50 | 1.70 | 1.80 | | |
| Sawi hybrid No.1 | | | | | 68 | 16 |
| Chumphon hybrid No.2 | | | | | 66 | 14 |

Table 9. Comparison of average oil content of copra 4 TWC hybrid with the single cross hybrid, Sawi hybrid No.1 and Chumphon hybrid No.2

rainfall of the year 2015, 2016, and 2017, where the rainfall distribution was good from March to August for three consecutive years. This phenomenon matches the fruit setting and development which occurred in the 49 months old fruits, which were ripe and ready to be harvested.

| Treatments | Number of coconuts palm | Level of damage 1/ | Number of coconut palm damage | | | | Average |
|---|---|---|---|---|---|---|---|
| | | | 2014 2/ | 2015 2/ | 2016 2/ | 2017 1/ | |
| 1 (RNTxWAT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| 2 (MYDxWAT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| 3 (MYDxTAT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| 4 (MRDxRNT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |

Table 10. The number of coconut palms that were damaged by coconut hispine beetle from several hybrid coconuts at different levels of damage in 2014-2017.

Mark:: Amporn et.al (2017)
1/ 0 = not detect 0 leaf

| Treatments | Number of coconuts palm | Level of damage 1/ | Number of coconut palm damage | | | | Average |
|---|---|---|---|---|---|---|---|
| | | | 2014 2/ | 2015 2/ | 2016 2/ | 2017 1/ | |
| 1 (RNTxWAT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| 2 (MYDxWAT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| 3 (MYDxTAT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| 4 (MRDxRNT)xTT | 60 | 0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |

Table 11. The number of coconut palms were attacked by *Opisina arenosella* from several hybrid coconuts at different levels of damage in 2014-2017.

Mark:: Amporn et. al (2560)
1/ 0 = not detect 0 leaf

| Treatments | Number of coconuts palm | Level of damage 1/ | Number of coconut palm damage | | | | Average |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | |
| 1 (RNTxWAT)xTT | 60 | 0 | 58.0 | 59.0 | 59.0 | 60.0 | 59.0 |
| | | 1 | 2.0 | 1.0 | 1.0 | 0 | 1.0 |
| 2 (MYDxWAT)xTT | 60 | 0 | 60.0 | 59.0 | 56.0 | 60.0 | 59.0 |
| | | 1 | 0 | 1.0 | 4.0 | 0 | 1.0 |
| 3 (MYDxTAT)xTT | 60 | 0 | 57.0 | 60.0 | 58.0 | 59.0 | 58.0 |
| | | 1 | 3.0 | 0 | 2.0 | 1.0 | 2.0 |
| 4 (MRDxRNT)xTT | 60 | 0 | 59.0 | 58.0 | 60.0 | 58.0 | 59.0 |
| | | 1 | 1.0 | 2.0 | 0 | 2.0 | 1.0 |

Table 12. The number of coconut palms were attacked by *Oryctes rhinoceros* from several hybrid coconuts at different levels of damage in 2014-2017.

A comparison of the average oil content of copra from TWC hybrids, between 2014 to 2017 is shown in Table 9. It showed that there were significant differences in oil content percentage in copra of TWC hybrid in 2015, 2016, and 2017. It seemed that the presence of WAT increases the oil content percentage.

The percentage of oil content increases in the tall parent. In TWC hybrid, appears to be WAT>RNT>TAT. In addition, there was conversion of oil content percentage to oil yield produced per palm per year *i.e.* (RNTxWAT)xTT, 21 kg/palm/yr, (MYDxWAT) xTT, 17 kg/palm/yr, (MYDxTAT)xTT, 16 kg/palm/ yr and (MRDxRNT)xTT, 20 kg/ha/yr. Interestingly, if compared with the F1 hybrid, the oil produced per palm per year were lower than the TWC hybrids though the F1 hybrid had higher oil content percentage than TWC hybrids.

Pest and diseases were observed in a large plot that can be divided into two parts, first part was the observation of the damaged level of coconut hispine beetle from 2014-2017. It showed that there were damage by the coconut hispine beetle, and also there was no damage to the palms by black headed caterpillar (Table 11) and only a few palms were damaged by coconut *Oryctes rhinoceros* (Table 12.) There was no attack on the palms by coconut weevil (*Rhynchophorus sp.*). No severe diseases have been found such as nut fall, bud rot which is caused by *phythopthora palmivora.* In conclusion there were no severe pest or disease problems has been found. (Table 10-12)

**Conclusion**

Three-way cross hybrids (RNTxWAT)xTT and (MYDxWAT)xTT, both hybrid varieties possess superior characteristics that match the breeding criteria *i.e.* yield, copra production, fruit size, and % oil content. If we compare the quality of production and other characteristics of Three-way cross hybrids with single cross hybrids, It shows that (RNTxWAT) xTT produces 14,075 nut/ha/yr while Chumphon hybrid No.2 produces 11,250 nut/ha/yr which is lower than (RNTxWAT)xTT by approx. 20%. In the comparison of copra production per hectare per year, (RNTxWAT)xTT produces copra 4,793.75 kg, whereas Sawi hybrid No.1 produces 3,575 kg which is lower than (RNTxWAT)xTT about 25% and Chumphon hybrid No.2 produces copra 3,125 kg which is lower than (RNTxWAT)xTT about 34%. In the comparison of fruit sizes, it showed that (RNTxWAT)xTT has large fruit with an average fruit weight of approximately 1,882.32 g and (MYDxWAT)xTT has medium fruit weight of 1,500-1,510 g.

It is of interest that the three-way cross hybrids have % oil content lower than single cross hybrid *i.e.* (RNTxWAT)xTT has oil content 61% and (MYDxWAT) xTT has an oil content of 62%, whereas Sawi hybrid No.1 has oil content of 68% and Chumphon hybrid No.2's oil content is 66%.

The Three-way cross hybrids are more adaptable to adverse environments than single cross hybrids, The yield of nut per palm per year will be good evidence to show which hybrid varieties were more tolerant to long drought spells. (RNTxWAT)xTT has an average yield from 2014-2017 of 105.20,103.40,105.00 and 95.82 nut/palm/year respectively (Table 6). It can be seen that both three-way cross hybrids are very consistent in producing fruits even when there was a 3 months of consecutive drought (Fig. 2), *i.e.* very dry from February to April (average rainfall lower than 10 mm), with regard to the diseases and insect pests interaction, there is no damaged coconut palms Coconut hispine beetle: *Brontispa Longissima* (Gane) and coconut black head caterpillar (*Opisina arenosella Walker*) and no break out of bud rot and nut fall disease (*Phytophthora palmivora Butler*)

Finally. Three-way cross hybrids (RNTxWAT) xTT and (MYDxWAT)xTT were proposed to DOA for certification so both hybrid varieties were certified and given name: Chumphon Three-way cross hybrid No.1 (RNTxWAT)xTT and Chumphon Three-way cross hybrid No.2 (MYDxWAT)xTT.

**Acknowledgement**

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2008-2012, who help in managing this experiment feasible and Mrs. Peyanoot Naka advisor to the DOA, who kindly advised in budget management and lastly. All staff members of CHRC to make this experiment feasible

**Utilization of Three-way cross hybrid**

It is known that coconut palm is a perennial crop that takes at least 4-5 years to produce fruit. Although now two Three-way cross hybrids were already certified the planting materials, seedlings are not available to the farmers yet. However the process of work for producing seedlings has been planned ahead namely, female parent palms (RNT x WAT) have been planted 1,760 palms on 12.8 ha of land. It is anticipated that between 2027 and 2031, the female parent palms come into bearing and could produce Chumphon Three-way cross hybrid no.1 seeds which could produce 44,350 seedlings that will be able to plant in 320 ha and from 2,032 the female parent palms come in full bearing which will be able to produce, about 107,700 seedlings per year that will be able to plant in 782.41 ha per year.

In addition, in the case of Chumphon Three-way cross hybrid No.2 (MYD x WAT), the female parent of the seed garden for producing this Three-way cross hybrid is already planted which could be planted in 106.4 ha, and from 2022-2027, from which around 329,400 seedlings per year that will be able to plant in 2,395.2 ha per year and since 2028 the seedlings production per year will be 500,400 seedlings which can be, planted in 3,632 ha. At present, the three-way cross process has been transferred to private sectors that are interested in producing a three-way cross hybrid. This model will support the distribution of seedlings to farmers more effectively. It is anticipated that in the near future three-way cross hybrids will be available as an alternative for farmers besides local Thai Tall, single cross hybrids such as Sawi hybrid No.1, Chumphon hybrid No.2. Other superior characteristics of Chumphon Three-way cross hybrid No.1 and No.2 are adaptability to be planted in a wide range of locations such as heavy clay soil, sandy loam soil, and their yield are more than 100 nut/palm/yr or 14,000 nut/ha/yr. Chumphon Three-way cross hybrid No.1 produces 4,787 kg/ha/yr of copra, and Chumphon Three-way cross hybrid no.2 produces 3,650 kg/ha/yr of copra, with high oil content of 61-62%.

These two varieties of Three-way cross hybrid are suitable for new plantations or replanting projects to extend the coconut planted area to support the demand of coconut production for coconut industries while also stabilizing local coconut prices that reduce the import of coconut and coconut products.

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# Innovating for Tomorrow:
## Nava Design & Innovation

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In a world where technology is transforming industries at an unprecedented pace, Nava Design and Innovation Pvt Ltd, Kochi has emerged as a model of innovation in the agri-tech sector. The start-up founded in 2016, has harnessed the power of artificial intelligence and robotics to revitalize agriculture. The new innovation is a tapping robot that is attached to a coconut inflorescence and taps neera and toddy. This robot is expected to benefit coconut farmers and farmer producer organizations across the country.

Nava Design and Innovation was started to find solutions to the challenges in agriculture sector using technology. The founder of Nava Design and Innovation, Mr. Charles Vijay had great fascination with Neera since childhood. He had given about a dozen of coconut palms to tap toddy. Since then, Charles has had the opportunity to taste Neera. It was in 2013 that the Coconut Development Board started the Neera project and Charles heard the news about it. Being a B-Tech graduate and cartoonist, Charles came up with an idea to build a robot for tapping.

The biggest difficulty in extracting the sap is that the climbers have to climb the coconut tree three times in a day to collect the sap. Then Charles thought that things would be easier if he attached a battery-operated device to the inflorescence for two or three months and tapped the neera and collected it through a tube with a container kept below. If this idea is working out successfully, it will also help to increase the production of neera.

Later, Charles's journey was to make this dream a reality. The concept was fully developed in 2016 and the company Nava Design and Innovation was registered in August and received a professional patent in the same year. Charles, who was working as an assistant unit manager in a trading company in Oman, contacted the Coconut Development

Board before coming home for vacation in 2017 and requested an opportunity to present his idea of a tapping robot before the Board.

The then Deputy Director Shri. Sardar Singh Choyal made arrangements to present his idea in the conference hall of Coconut Development Board. Shri. Sardar Singh Choyal encouraged Charles for the accomplishment of this project. Inspired from Board, Charles decided to go ahead with the project. He resigned from his job abroad and returned during the first week of July 2017 and started working in the micro village and then proceeded with the activities of shaping this tapping robot.

This project was effectively launched in 2017. Many problems were faced in the initial phase. Not even knowing what tapping was, the first thing Charles did was to hire a traditional coconut climber to learn how to tap neera. With him, he climbed upon the coconut tree every day and observed and understood the subsequent procedures of tapping.

Later in 2018, a team was formed and proceeded with the construction of the robot. Another problem faced in this was getting the traditional workers to understand about it. It is possible to program the tapping machine in the same way only by showing the exact tapping method, dimensions etc.

A process that is done by a skilled worker very laboriously is done by a new innovation using a robot. Similarly, its inflorescence needs to be cut very cleanly. For this the robot has a very delicate cutting mechanism.

Another feature of this is the technology to connect the mobile phone with the robot so that when the entire neera is collected from an inflorescence, the farmers can access the information on their mobile phones. At the end, the farmer receives a message that it is time to dismantle the device. Similarly, the health condition of the coconut palm can also be checked by the difference in the speed in the flow of the sap collected. All this will enable more production of neera in the future. Also this device is solar powered, which makes it a green energy powered device.

Tapping Robot has received several grants from organizations like Bharat Petroleum, Kerala Startup Mission, Millennium Alliance and TIDE. Also, Nava

Innovation was able to proceed with this project due to proper receipt of funds from the Central and State Governments. Nava Innovation has received the Prime Minister's National Startup Award 2020. The invention of the Tapping Robot enabled Nava Innovation to become the first winner of this award. Also got National Award of Coconut Development Board in 2022 for best Research Worker in machinery/ equipment development category.

Nava Design and Innovations has received capital support from two angel investors. Christo George Hicon CMD and Manoj V. Raman an NRI businessman have invested in this start-up. Their investment amount will be used for commercial production of the robot. It will be available in the market within nine months.

Tapping robots are in high demand not only in India but also in countries like Malaysia, Philippines and Indonesia. Nava Innovation is becoming an important and promising venture in coconut sector. Nava Innovation's dedication to fostering creativity, research and development can revolutionize industries and improve the lives of farmers through such innovative tools.

The success of new innovation is the result of a collective effort of talented professionals from different backgrounds. As innovation surges forward, we can expect more exciting breakthroughs in the near and distant future. Nava's relentless pursuit of innovation is not only commendable but also a source of inspiration for others in the industry. Let this be a model for talented young entrepreneurs to come forward and create a revolution in the agricultural sector.

# Meeting on complete value chain of coconut

A delegation of Senior Officials under the Chairmanship of Shri. Manoj Ahuja IAS, Secretary Agriculture, Ministry of Agriculture and Farmer's Welfare visited Coimbatore and Pollachi of Tamil Nadu on 13th October 2023. The members of the team included Shri. Sajjan Yadav, Additional Secretary ( Finance), Shri. Priya Ranjan, JS(MIDH), Dr. Prabhat Kumar, Horticulture Commissioner and Chief Executive Officer, CDB, Shri. D. Kuppuramu, Chairman, Coir Board, Shri. Anupam Mitra, Member CACP, Shri. Bharat Prakash, JDC, MSME, Thiru. C. Samayamoorthy IAS, APC, Tamil Nadu, Officials of Coconut Development Board and Tamil Nadu Agriculture University and State Department of Agriculture, Tamil Nadu.

The team visited Laurico Private Ltd, manufacturer of virgin coconut oil, MCT coconut oil and coconut flour, Indian Coconut Products, Pollachi, desiccated coconut powder unit, Impex coir factory, Pollachi, Vinayaga Coconut Producer Company Limited, Vadakipalayam, Pollachi manufacturers of Neera and Coconut Sugar, KG Farms and few other farmer's fields in Pollachi. Later the team had interaction meeting with industry stakeholders and farmers organizations at NGM College, Pollachi followed by interaction with Scientists of TNAU, CPCRI, Coir Board, NIST, CDB etc at Tamil Nadu Agricultural University, Coimbatore.

The team assured that appropriate action will be taken to address the concerns raised by the entrepreneurs and farmers during the occasion.


# Coconut Development Board observed Swachhata Campaign 3.0

As part of the 'Swachhata Pakhwada – Swachhata Hi Seva 2023' launched by the Hon'ble Prime Minister of India, Shri. Narendra Modi, Coconut Development Board organized cleanliness drive at Ernakulathappan Ground, Kochi, Kerala on 1st October 2023. Officers and Staff of the Board actively participated in the programme. Unit Offices of the Board across the country also organized similar campaign in areas under their jurisdiction. The programme was organized in commemoration of the 154th birth anniversary of Mahatma Gandhi. The campaign is being organized to create awareness among the general public on the importance of maintaining higher order of cleanliness to achieve the vision of garbage free India.

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# Cultivation practices for coconut
## November

### Irrigation for seedlings

- Seedlings are to be given irrigation either through drip or basin method. If drip irrigation is adopted provide on an average 10 litres of water per seedling per day. Through other methods like basin irrigation 40 litres of water once in four days is sufficient.

### Irrigation for adult palms

- Irrigation can be started in coconut gardens, except in localities which receive rain through north east monsoon. Even in localities where rainfall through north east monsoon is not received in adequate quantity (rainless period extending for more than 10 days) irrigation has to be provided to the palms.
- If basin irrigation method is adopted, provide irrigation once in four days @ 200 litres per palm.
- Drip irrigation is the ideal method of irrigation for coconut. Small pits of 1'x 1' 1' size should be taken 1 m away from the tree trunk at four equidistant points within the basin. The pits are to be filled with coir pith. The drippers/microtubes are to be placed sub surface in these pits through a polythene conduit pipe. The number of dripping points should be six for sandy soils and four for other soil types. 30-45 litres of water per palm per day is to be provided through drip irrigation system.

### Drainage

- Ensure adequate drainage facilities in coconut gardens in localities which receive rain through north east monsoon. Depending up on the soil type and water table drainage channels of appropriate size, minimum of 50 cm depth and width, can be taken either manually or mechanically. Drainage channels are to be constructed for every two rows of palms.

### Manuring

- Drip fertigation may be started for coconut palms. Water soluble fertilizers like urea and Muriate of potash can be given along with drip irrigation system. For the coconut palms, these fertilizers as per the general recommendation (50% of the recommended dose ie 545 g urea and 1000 g of Muriate of potash per palm per year) can be given in equal splits through monthly fertigation schedule. However, quantity of chemical fertilizers is to be worked out based on soil test results and yield targeted.
- Wherever Boron deficiency is noticed 100 g Borax may be applied in the basin.
- For coconut palms showing yellowing of leaves due to Magnesium deficiency, 0.5 kg of magnesium sulphate can be applied in the basins.

### Green manuring

- In regions benefitted by north east monsoon like Tamil Nadu, the green manure plants can be ploughed back in to the interspace of coconut garden if the plants have attained 50 percent flowering. Similarly, green manure plants grown in the coconut basins also can be incorporated into the soil.

### Mother palm selection

- Select mother palms for seed nut collection to raise quality planting material.
- In tall varieties, seed nuts should be collected from mother palms which should have attained an age of 20 years, yielding constantly more than 80

and 120 nuts per palm per year for rain fed and irrigated conditions respectively with nut weight more than 600 g and copra weight of 150 g and above. Further, the palm should have a minimum of 30 leaves and free of any disease. The trees should have short and strong petioles with wide leaf base firmly attached to the stem. The bunch stalk should be short, stout, strong and should not show any tendency to droop down or buckle. Palms which produce barren nuts or those shedding large number of immature nuts should be discarded. Very old age palms i.e., above 60 years may be avoided and growing in very favourable conditions e.g. trees near manure pits are to be avoided. Palms showing alternate bearing tendency also should be avoided. In dwarf varieties seed nuts can be collected from mother palms which have attained an age of 12 years or more and yielding more than 60 and 100 nuts per year for rain fed and irrigated condition, respectively. Further it should have a minimum of 30 leaves with nut weight more than 400 g.

## Nursery management

- Weeding should be done in the nursery.
- Five month old ungerminated nuts and dead sprouts should be removed from the nursery.
- Mulching with coconut leaves or dried grass or live mulch by raising green manure crops can be done in the nursery
- Provide irrigation
- Need based plant protection measures against pests and diseases are to be undertaken. Soil drenching of chlorpyriphos @ 2ml/litre is to be done in the nursery, if termite infestation is observed. Spraying of water on the leaves can be done against white fly infestation in the coconut nursery.

## Mulching

- Mulching of palm basins can be undertaken if not done earlier. Fallen dried coconut leaves available in the coconut garden can be used for mulching. In the non traditional areas like Bihar, Madhya Pradesh, Chhattisgarh and North Eastern states, ensure thick mulching in the basin to regulate soil temperature. Irrigation can be started to negate the effect of low temperature in such areas.

## Plant protection

Currently, a drastic shift in pest damage level on coconut is being experienced in the event of unprecedented weather vagaries. Gradient outbreak of the invasive rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) in Peninsular and North-East India, black headed caterpillar (*Opisina arenosella* Walker) in Karnataka and slug caterpillar (*Darna nararia* Moore) in Andhra Pradesh and Karnataka are classical examples to support this phenomenon. Rhinoceros beetle (*Oryctes rhinoceros* Linn.) and red palm weevil (*Rhynchophorus ferrugineus* Olivier) are cosmopolitan pests recorded predominantly in monsoon and post-monsoon periods in Peninsular India. The most unnoticed and a serious sucking pest observed during North-East monsoon phase is the attack by coreid bug (*Paradasynus rostratus* Distant). At least 2-3 bunches would be affected with complete button shedding leading to barren bunches. Incidence of bud rot disease, nut fall, leaf rot, stem bleeding and Basal Stem Rot/*Ganoderma* wilt also cause damage to coconut. Under the changing weather conditions systematic monitoring is very crucial to suppress outbreaks of pests and diseases in coconut. Regular observation and monitoring should be done in the coconut garden to identify incidence of pests

and diseases and need based and appropriate plant protection measures are to be adopted to avoid crop loss. Recommendations for the management of pests and diseases in coconut for the month of November are furnished below.

## Integrated Pest Management

### ▶ *Rhinoceros beetle*

- Adopt mechanical method of control by extracting beetles with beetle hooks, without causing further injury to the growing point of the palm
- The top most leaf axils may be filled with powdered neem cake/marotti cake (*Hydrocarpus sp/* pongamia) @ 250 g + fine sand (250g) per palm as a prophylactic measure
- Filling the innermost three leaf axils with 4 g each of naphthalene balls covered with sand (12 g/ palm) for juvenile palms
- Placement of two perforated sachets containing chlorantraniliprole a.i. 0.4% (5 g) or fipronil (3 g) or one botanical cake (2 g) developed by ICAR-CPCRI
- Incorporation of the biomass of weed plant *Clerodendron infortunatum* Linn. in the cow dung/ compost pit
- The breeding sites may be treated with green muscardine fungus (*Metarhizium anisopliae*)

### ▶ *Red Palm Weevil*

- Avoid causing injury to the palms, as they would attract the weevil to lay eggs. Mechanical injury if any, caused should be treated with coal tar
- While cutting fronds, petiole to a length of 120 cm is to be left on the trunk to prevent the entry of weevils into the trunk
- Removal and burning of palm at advanced stage of infestation would aid in destruction of various stages of the pest harboured in the trunk
- Prophylactic leaf axil filling suggested for rhinoceros beetle is very essential as this pest pave way for red palm weevil
- If damage occurs in the crown, the damaged tissue has to be removed and insecticide suspension, imidacloprid (0.02%) @1 ml/L of water may be poured in. In case of entry of weevil through the trunk, the hole in trunk may be plugged with cement/tar and the top most hole is made slanting with the aid of an auger and the insecticide solution is poured through this hole with funnel

### ▶ *Leaf eating caterpillar*

- Cutting and burning the heavily infested and dried outer most 2 - 3 leaves helps to prevent the spread of the pest.
- Improving soil and infested palm health through balanced dose of chemical fertilizers and organic manures.
- Since a very rich natural enemy fauna is associated with the pest in the field, chemicals are generally not encouraged for management of *O. arenosella.* As this pest is subject to parasitism by a good number of indigenous larval and pupal parasitoids, biological suppression is a feasible and viable approach. Augmentative release of stage specific parasitoids viz., the larval parasitoids *Goniozus nephantidis* (Bethylidae) @ 20 parasitoids/palm, *Bracon brevicornis* (Braconidae) @ 20 parasitoids/ palm, the prepupal parasitoid, *Elasmus nephantidis* (Elasmidae) @49/100 pre-pupae, and the pupal parasitoid *Brachymeria nosatoi* (Chalcididae) @32/100 pupae at the appropriate time was found effective in the sustainable management of the pest. Combined release of the parasitoids is required in multi-stage prevalence of the pest in the field. Conditioning of parasitoids on larval frass before release enhanced the field level parasitism.

### ▶ *Eriophyid mite*

- Spraying on the terminal five pollinated coconut bunches with neem oil garlic soap mixture @ 2 per cent concentration (neem oil 200 ml, soap 50 g and garlic 200 g mixed in 10 litres of water)
- or spraying neem formulations containing 1 per cent azadirachtin @ 4 ml per litre of water
- or spraying palm oil (200 ml) and sulphur (5g) emulsion in 800 ml of water
- Root feeding azadirachtin 10,000ppm @ 10 ml + 10 ml water is also effective
- Along with the recommended dose of manures and fertilizers, 5 kg neem cake should be applied

### ▶ *Coreid bug*

- Spraying of neem oil-soap emulsion (0.5%) on the pollinated bunches. The emulsion can be prepared by adding 5 ml neem oil and 8 g bar soap in one litre water.

### ▶ *Rugose Spiralling Whitefly*

- No chemical insecticide should be sprayed on leaves
- Application of 1% starch solution on leaflets to flake out the sooty moulds.
- In severe case, spray neem oil 0.5% and no insecticide is recommended.
- Installation of yellow sticky traps on the palm trunk to trap adult whiteflies.
- Encourage build up of parasitoids (*Encarsia guadeloupae*) and re-introduce parasitized pupae to emerging zones of whitefly outbreak.
- *In situ* habitat conservation of the sooty mould scavenger beetle, *Leiochrinus. nilgirianus.*

## Integrated Disease Management

### ▶ *Bud rot*

- Remove the infected tissues of the spindle completely. Two or three healthy leaves adjacent to the spindle may have to be removed, if necessary, for easy removal of all rotten portions and thorough cleaning. After removing the affected tissues apply 10% Bordeaux paste and cover the wound with a polythene sheet to prevent entry of rain water. The protective covering has to be retained till normal shoot emerges.
- Destroy the infected tissues removed by burning or deep burying in the soil
- Spray 1% Bordeaux mixture to the surrounding palms

### ▶ *Stem bleeding*

- Avoid burning of trashes near the tree trunk
- Avoid injury to the tree trunk
- The affected tissues should be completely removed using a chisel and smear the wound with 5% hexaconazole (5 ml in 100 ml of water) and drench the basins @ 25 lit. of 0.1% solution
- Smearing paste of talc based formulation of *Trichoderma harzianum* on the bleeding patches on the stem (The paste can be prepared by adding 50 g of *Trichoderma* formulation in 25 ml of water)
- Soil application of *Trichoderma harzianum* enriched neem cake @ 5kg per palm and adopt recommended irrigation/moisture conservation practices.

### ▶ *Leaf rot*

- Remove rotten portion of the spindle leaf and 2-3 successive leaves and pour fungicide solution containing 2 ml hexaconazole 5 EC in 300 ml water/ palm or talc based formulation of *Pseudomonas fluorescens* or *Bacillus subtilis* @ 50 g in 500 ml water/palm into the well around the base of the spindle leaf
- Undertake prophylactic measures to prevent rhinoceros beetle attack

### ▶ *Basal Stem Rot/Ganoderma wilt*

- Removal of dead palms, palms in advanced stages of the disease and destruction of the bole and root bits of these palms
- Isolation of diseased palms from healthy palms by digging isolation trenches of 2 feet depth and one feet width around the basin
- Avoiding flood irrigation or ploughing in infected gardens to prevent spread of the inoculum.
- Addition of 50 kg of farmyard manure or green leaves per palm per year.
- Application of *Trichoderma harzianum* enriched neem cake@ 5 kg per palm and irrigating the palm once in 4 days and mulching around the basin
- Raising banana as intercrop wherever irrigation is possible
- Root feeding of hexaconazole @ 2% (100 ml solution per palm) or soil drenching with 0.2% hexaconazole / 1 % Bordeaux mixture @ 40 litre solution per palm. ■

*Prepared by : C. Thamban, P. Subramanian, Joseph Rajkumar and S. Jayasekhar, ICAR-Central Plantation Crops Research Institute*

# Market Review – September

## Domestic Price

### Coconut Oil

During the month of September 2023, the price of coconut oil opened at Rs. 13000 per quintal at Kochi and Alappuzha market and Rs.14200 per quintal at Kozhikode market.

The price of coconut oil closed at Rs. 12800 per quintal at Kochi, Rs. 12900 per quintal at Alappuzha market and Rs. 13800 per quintal at Kozhikode market with a net loss of Rs. 200 per quintal at Kochi, Rs. 100 per quintal at Alappuzha market and Rs. 400 per quintal at Kozhikode market and it showed a downward trend during the month except for slight increase during the last week.

During the month, the price of coconut oil at Kangayam market opened at Rs. 11133 per quintal and closed at Rs. 11000 per quintal with a net loss of Rs. 133 per quintal.

| Weekly price of coconut oil at major markets Rs/Quintal) | | | | |
|---|---|---|---|---|
| | Kochi | Alappuzha | Kozhikode | Kangayam |
| 01.09.2023 | 13000 | 13000 | 14200 | 11133 |
| 09.09.2023 | 13000 | 13000 | 14200 | 11133 |
| 16.09.2023 | 12800 | 12800 | 14000 | 10867 |
| 23.09.2023 | 12700 | 12700 | 13800 | 10800 |
| 30.09.2023 | 12800 | 12900 | 13800 | 11000 |

### Milling copra

During the month, the price of milling copra opened at Rs. 8350 per quintal at Kochi, Rs. 8300 per quintal at Alappuzha and Rs. 8650 per quintal at Kozhikode market.

The prices of milling copra closed at Rs. 8200 per quintal at Kochi market, Rs. 8250 per quintal at Alappuzha market and Rs. 8550 per quintal at Kozhikode market with a net loss of Rs. 150 per quintal at Kochi, Rs. 50 per quintal at Alappuzha market and Rs. 100 per quintal at Kozhikode market and it showed a downward trend during the month except for slight increase during the last week.

During the month, the price of milling copra at Kangayam market opened at Rs. 7750 and closed at Rs. 7800 with a net gain of Rs. 50 per quintal during the month.

| Weekly price of Milling Copra at major markets (Rs/Quintal) | | | | |
|---|---|---|---|---|
| | Kochi | Alappuzha (Rasi Copra) | Kozhikode | Kangayam |
| 01.09.2023 | 8350 | 8300 | 8650 | 7750 |
| 09.09.2023 | 8350 | 8300 | 8650 | 7800 |
| 16.09.2023 | 8200 | 8150 | 8500 | 7700 |
| 23.09.2023 | 8100 | 8050 | 8400 | 7600 |
| 30.09.2023 | 8200 | 8250 | 8550 | 7800 |

### Edible copra

During the month the price of Rajpur copra at Kozhikode market opened at Rs. 9000 per quintal expressed an upward trend during the month and closed at Rs. 9400 per quintal with a net gain of Rs. 400 per quintal.

| Weekly price of edible copra at Kozhikode market (Rs/Quintal) | |
|---|---|
| 01.09.2023 | 9000 |
| 09.09.2023 | 9000 |
| 16.09.2023 | 9200 |
| 23.09.2023 | 9200 |
| 30.09.2023 | 9400 |

### Ball copra

The price of ball copra at Tiptur market opened at Rs. 8300 per quintal and closed at Rs. 8326 per quintal with a net gain of Rs. 26 per quintal.

| Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal) (Sorce: Krishimarata vahini) | |
|---|---|
| 01.09.2023 | 8300 |
| 09.09.2023 | 8400 |
| 16.09.2023 | 8000 |
| 23.09.2023 | 8000 |
| 30.09.2023 | 8326 |

*NR-Not reported

### Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs. 9500 per quintal and closed at Rs. 11000 per quintal with a net gain of Rs. 1500 per quintal.

| Weekly price of Dry Coconut at Kozhikode market (Rs/Quintal) | |
|---|---|
| 01.09.2023 | 9500 |
| 09.09.2023 | 9500 |
| 16.09.2023 | 9500 |
| 23.09.2023 | 11000 |
| 30.09.2023 | 11000 |

### Coconut

At Nedumangad market in Kerala, the price of coconut opened at Rs. 13000 per thousand nuts and closed at the same price during the month.

At Pollachi market in Tamilnadu, the price of coconut opened Rs. 21500 per ton and closed at Rs. 23000 per ton with a net gain of Rs.1500 during the month.

At Bangalore market in Karnataka, the price of coconut opened at Rs. 20000 per thousand nuts and the price was almost steady during the month.

At Mangalore market in Karnataka, the price of coconut opened Rs. 28000 per ton and the price was almost steady during the month.

| Weekly price of coconut at major markets | | | | |
|---|---|---|---|---|
| | Nedumangad (Rs./1000 coconuts)# | Pollachi (Rs./MT) ## | Bangalore Grade-1 coconut,(Rs./ 1000 coconuts) ## | Mangalore Black coconut (1 tonne) ## |
| 01.09.2023 | 13000 | 21500 | 20000 | 28000 |
| 09.09.2023 | 13000 | 21500 | 20000 | 28000 |
| 16.09.2023 | 13000 | 21500 | 20000 | 28000 |
| 23.09.2023 | 13000 | 21500 | 20000 | 28000 |
| 30.09.2023 | 13000 | 23000 | 20000 | 28000 |

## International price

### Coconut

The price of coconut quoted at different domestic markets in Philippines, Indonesia, Srilanka and India are given below.

| Weekly price of dehusked coconut with water | | | | |
|---|---|---|---|---|
| Date | Domestic Price (US$/MT) | | | |
| | Philippines | Indonesia | Srilanka | India* |
| 02.09.2023 | 122 | 144 | 185 | 259 |
| 09.09.2023 | 121 | 144 | 184 | 259 |
| 16.09.2023 | 121 | 150 | 189 | 259 |
| 23.09.2023 | 122 | 156 | 198 | 259 |
| 30.09.2023 | 122 | 155 | 197 | 277 |
| | | | | *Pollachi market |

### Coconut Oil

International price and domestic price of coconut oil at different international/ domestic markets are given below.

| Weekly price of coconut oil in major coconut oil producing countries | | | | | |
|---|---|---|---|---|---|
| | International Price(US$/MT) | Domestic Price(US$/MT) | | | |
| | Philippines/ Indonesia (CIF Europe) | Philippines | Indonesia | Sri lanka | India* |
| 02.09.2023 | 1129 | 1107 | NR | 1707 | 1341 |
| 09.09.2023 | 1096 | 1077 | NR | 1691 | 1341 |
| 16.09.2023 | 1055 | 1064 | NR | 1685 | 1308 |
| 23.09.2023 | 1059 | 1059 | NR | 1680 | 1300 |
| 30.09.2023 | 1080 | 1078 | NR | 1746 | 1325 |
| | | | | | *Kangayam |

### Copra

The price of copra quoted at different domestic markets in Philippines, Srilanka, Indonesia, and India are given below.

| Weekly International price of copra in major copra producing countries | | | | |
|---|---|---|---|---|
| Date | Domestic Price (US$/MT) | | | |
| | Philippines | Indonesia | Srilanka | India* * Kangayam |
| 02.09.2023 | 627 | 635 | 830 | 933 |
| 09.09.2023 | 616 | 606 | 900 | 939 |
| 16.09.2023 | 599 | 607 | 881 | 927 |
| 23.09.2023 | 599 | 612 | 909 | 915 |
| 30.09.2023 | 601 | 609 | 925 | 939 |
| | | | | * Kangayam |

#(Source: Epaper,Kerala Kaumudi),
##(Source: Star market bulletin)

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