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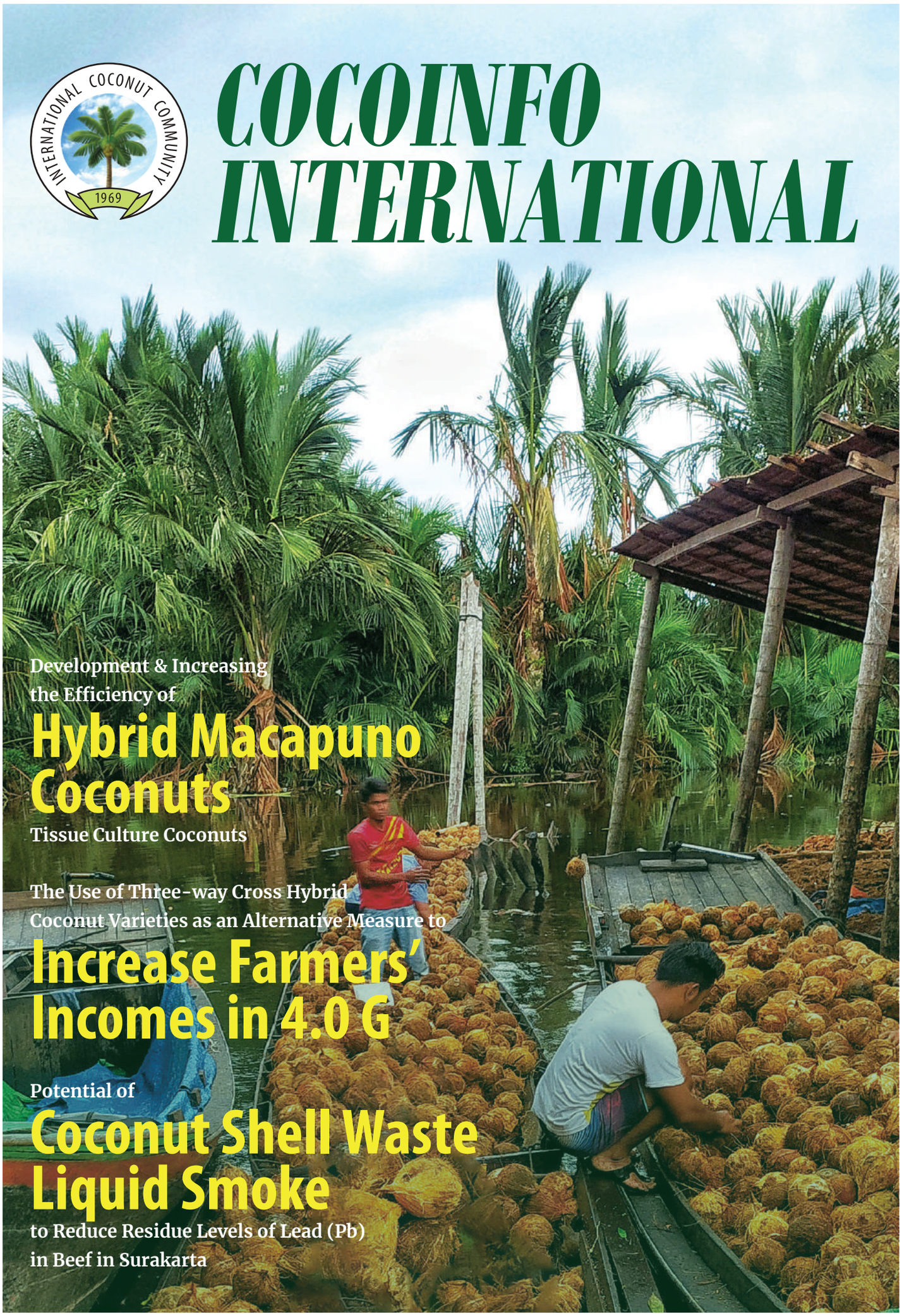

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Hybrid Macapuno Coconuts

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Increase Farmers' Incomes in 4.0 G

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Coconut Shell Waste Liquid Smoke

to Reduce Residue Levels of Lead (Pb) in Beef in Surakarta

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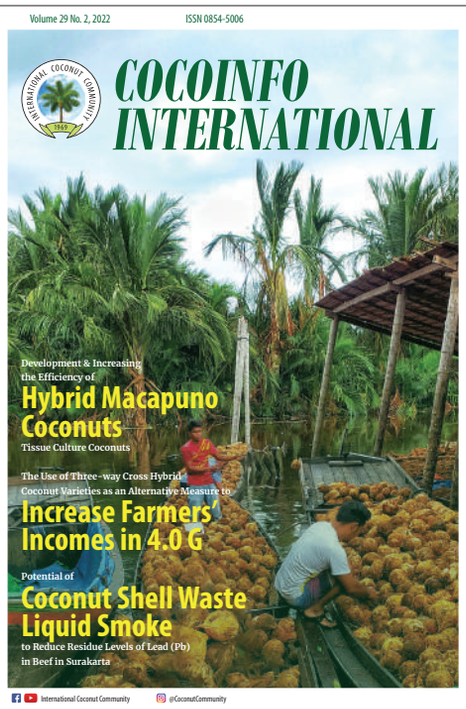

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From Research and Innovation to Enhanced Product Usability and Application

I sincerely welcome all our readers to the second issue of the Volume 29, *COCOINFO International*, a popular semi-annual and semi-technical magazine published by the International Coconut Community (ICC). In this Edition, we are proud to present to coconut stakeholders six various articles and several information about some of the ICC's major programs and product market trends.

The global demand for coconut and its high value-added product is increasing, driven by population and income growth as well as awareness of health and quality environmental aspects. The importance of coconut as the tree of life has shifted over time as continued studies and technological innovation generated innovative products and new uses or applications in addition to the current products available in the local and global market. About 100 food and non-food products have been traded and marketed. New products and applications have grown like coconut aminos, coconut husk-based fabric, biofuel, coconut fibreboard, and dried leave-based coconut straw. Increased revenue, market share, customer satisfaction, increased contribution to poverty reduction, food security, and climate change mitigation and adaptation due to novelty, increased usability and creativity could sustain this sector amid current global economic situation.

In this issue, the potential use of coconut shell-based liquid smoke is discussed in reducing the lead level in beef. Many other scientific research have been published on new products and applications of coconut-based products. Coconut oil-cocoa butter-beeswax mixture has been reported as an excellent long-lasting low friction lubricating solution for the frontline medical staff using personal protective equipment (PPE) amid the COVID-19 pandemic. This product has helped the healthcare workers around the world experiencing skin injury because of the long use of PPE.

Coconut also contributes to reducing the negative impacts of toxic compounds such as Congo Red, a toxic dye used in various pulp, paint and plastic industries and many more industries that cause cancer, cellular mutation and allergies. Scientific research results conducted by researchers from universities in Colombia, published in 2022 showed that coconut cellulose from coconut shell modified with CTAC (Cetyl trimethyl ammonium chloride) was a good adsorbent of Congo red in an aqueous solution, so to remove this harmful pollutant from water. This is the first report on the use of this biomass modified with CTAC for dye removal; therefore, the contribution of the present study is considered essential. The researchers suggested using coconut cellulose from coconut shell modified with CTAC to clean this pollutant from sewage before being discharged into water bodies to protect humans and the environment.

The coconut products market is an integral part, and understanding what drives market development is essential to assist the country in designing a policy framework that facilitates the fulfillment of all that is required. Increasing relevant research and development investment and developing innovative products is the key to being competitive in the market. The quality, quantity, and time available for the required quality of coconut planting material must be continuously pursued and the sophistication of breeding technology, macro, and micro-propagation, agronomic and post-harvest handling and processing that supports the development of innovative products and new applications must be increased and supported multilaterally.

DR. JELFINA C. ALOUW
Executive Director
Editor-in-Chief

Potential of Coconut Shell Waste Liquid Smoke to Reduce Residue Levels of Lead (Pb) in Beef in Surakarta

Muhammad Safrudin[1]

Food safety is the main prerequisite for food quality. According to Law No. 7 1996 it is stated that consumers have the right to safe food; which is characterized by the freedom of society from types of food that are harmful to human health and are not in accordance with public beliefs. Food safety means that food is free from factors that cause disease, as well as things that are dangerous and safe for consumption.

One of the current food safety issues stems from meat sources, including the large number of cattle grazing at the Final Disposal Site (TPA) which is suspected of having meat contaminated with heavy metals from the feed ingredients, namely waste at the TPA location. The beginning of cattle grazing in the TPA was caused by the absence of land to graze cattle (Wahono, 2010). Based on Law no. 7 of 1996 concerning Food, among others regulates food safety, states that the necessary conditions and efforts to prevent food from possible biological, chemical and other contaminants that can interfere, harm and endanger human health. This effort was realized by the Ministry of Agriculture in the form of PP No. 22 of 1983 concerning veterinary public health which stipulates that meat suitable for consumption must meet ASUH requirements (Safe, Healthy, Whole, and Halal), as a concrete manifestation of one of the development goals related to security. food (Masduqi, et al. 2015).

TPA Putri Cempo is one of the landfills in Surakarta which is used for cattle grazing. Based on research results from the Department of Agriculture, Food Security and Livestock of Surakarta, the cows grazing at the TPA were positive for lead (Pb). Moreover, meat consumption in Surakarta City has increased every year according to the Ministry of Trade of the Republic of Indonesia (2018). Whereas the effect of eating beef containing heavy metals is quite dangerous because it cannot be degraded and will accumulate in the body so that it can cause various diseases and damage (Hartati, 2015).

One of the efforts to prevent heavy metals from entering the body's cells is by chelating with trapping organic acids in the apoplastic environment by binding them to the released organic acids or to anionic groups from the cell wall. Based on Hartati's research (2015) organic acids such as citric acid and carboxyl acid are able to form complex compounds with Pb so that they can function as metal chelators.

Liquid smoke is a liquid vapor condensate of smoke through the pyrolysis process. Liquid smoke is widely used as a bioflavor, color-forming in smoked products, food preservatives, wood preservatives, and latex coagulation. Apart from being a food additive, liquid smoke can also function as a chelating agent. The functional properties of liquid smoke as a chelating agent are due to the content of phenolic compounds, carbonyl compounds, and acids. Coconut shell liquid smoke can reduce lead residue levels in soybeans by 63.41%. The Pb chelation process was carried out by soaking soybeans in a liquid smoke solution with a certain concentration. Apart from being a metal chelating agent, liquid smoke can be used as a natural preservative which increases the shelf life of the material.

In this article, the author wants to discuss the potential of liquid smoke from coconut shell waste as a heavy metal chelating agent in beef in Surakarta City. It is hoped that this idea can be a solution to food safety issues in the Surakarta City area. In addition, it can increase the utilization of coconut shell waste, which so far its use has not been maximized

Utilization of Coconut Shell Waste as Liquid Smoke

Coconut production in Central Java Province in 2017 reached 158,749 tons (Directorate General of Plantations, 2017). This high coconut production produces coconut shell waste which is quite high as well. Coconut shell contains chemical components, such as: cellulose 26.6%, hemicellulose 27.7%, lignin 29.4%, ash 0.6%, extractive components 4.2%, anhydrous uronic acid 3.5%, nitrogen 0.1%, and water 8.0%. as the main ingredient of liquid smoke (Hardianto et al. 2016).

Figure 2. Coconut shell waste

Pyrolysis of lignin will produce phenol which functions as a preservative in liquid smoke. Carbonyl is obtained from the degradation of cellulose, phenol which functions as an antioxidant and the presence of acidic compounds that work together with carbonyl which functions as an antimicrobial. Based on the research of Hardianto el al. (2016) identified components of liquid smoke from shells with a pyrolysis temperature of 300°C using GC-MS analysis obtained 26 compounds with dominant compounds of phenol (34.45%), 2,6-dimethoxy phenol (12.58%) and 2 -methoxy phenol (9.81%). The results of the analysis of coconut shell liquid smoke using GCMS contained 40 components with 7 dominant components, namely 2-Methoxyphenol (guaiacol), 3,4-Dimethoxyphenol, Phenol, 2-methoxy-4 methylphenol, 4-Ethyl-2-methoxyphenol, 3- Methylphenol, and 5-Methyl-1,2,3-trimethoxybenzene. In addition, carcinogenic Polycyclic Aromatic Hydrocarbon (PAH) compounds, including benzo[a]pyrene, were not found in coconut shell liquid smoke (Budjianto et al., 2008). Coconut shell contains phenol by 6.70%; carbonyl by 3.35%; and total acetic acid 2.52%. Its antioxidant components act as antimicrobial, antioxidant, color-forming, and taste. Antioxidants from liquid smoke which are phenol components act as hydrogen donors and are effective in small amounts to prevent oxidation reactions. Liquid smoke as an antioxidant can prevent oxidation of fat and prevent off flavor.

The components of liquid smoke that function as chelating agents are phenols, carbonyl groups and organic acids. Lead has a very strong affinity for the sulfhydryl group of cysteine, the amino group of lysine, the carboxyl group of aspartic and glutamic acids, and the hydroxyl group of tyrosine (Suksmerri, 2008 in Masduqi and Ngabekti, 2015). Phenol is a compound that has only one hydroxyl group (-OH) in its constituent. This hydroxyl group is capable of bonding with lead to form complex compounds. Other components such as carbonyl groups and acids are strong absorbents that react with metals (Buhani, 2006). The mechanism of Pb chelation by phenolic compounds is shown in Figure 4.

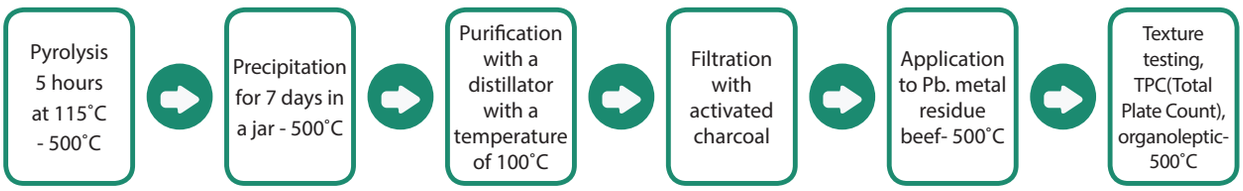

Figure 3. Flowchart of Utilization of Coconut Shell as a Chelating Agent

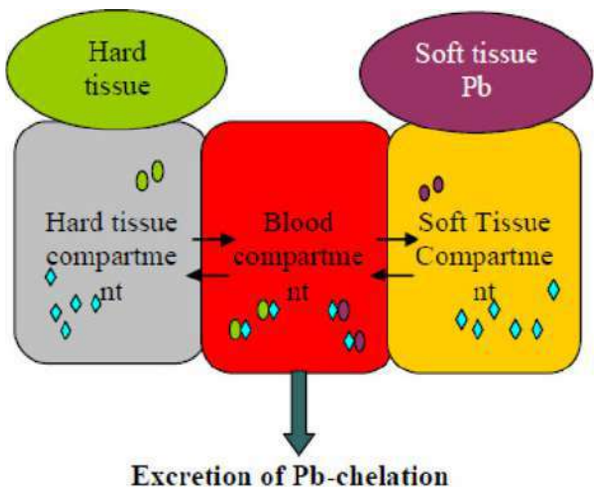

Figure 4. Mechanism of Pb Chelation by Phenolic Compounds (Flora and Fachauri, 2010)

Based on Figure 4, the process of chelating Pb by phenolic compounds can not only form complex compounds with metals but can inhibit fat oxidation, and can even function as carcinogenic compounds. Application of coconut shell liquid smoke on meat, can be done by soaking it with liquid smoke at the desired concentration. Based on research by Mu'tamar, et al (2009) regarding the application of liquid smoke to gourami using a concentration of 3% with immersion for 20 minutes. Besides being able to reduce Pb levels, liquid smoke can increase the shelf life of meat because of its antioxidant compounds that prevent oxidation and act as antibacterial.

CONCLUSION

Based on the explanation above, it can be concluded that coconut shell liquid smoke has the potential to be developed as a chelating agent and natural preservative due to its phenolic, carbonyl and acid content. Utilization of coconut shell waste as liquid smoke can be a solution for animal food safety issues, especially beef in the Surakarta City area and its surroundings. Through proper handling, it is hoped that the liquid smoke of coconut shell waste can be developed and further research is carried out on the right concentration to reduce heavy metal residues in other foodstuffs.

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Development & Increasing the Efficiency of Hybrid Macapuno Coconuts Tissue Culture in Thailand

Supaporn Sachati[1], Yokthip Sudaree[2], Orathai Tananchai[3], Siriluck Kaewsuralikhit[4], Parinda Hrunheem[5], Lawan Junamporn[6], Supattra Lertwatanakiat[7] and Wilaiwan Twishsri[8]

The embryo culture of hybrid macapuno coconuts takes 12-16 months from raising the embryo until developing into a plantlet and the production efficiency of seedlings is still low. The Department of Agriculture has therefore developed and increased the efficiency of hybrid macapuno tissue culture. The objective is to obtain propagation technology by developing embryo culture techniques to increase the number of coconut plantlets to meet the needs of farmers. The operation was conducted from 2018-2021 at the Horticulture Research Institute, Bangkok and Chumphon Horticultural Research Center. The result showed that medium and embryo placement characteristics affected embryo germination in the dark, and appropriate formulations for seedling development in 5 varieties, NamHom x Kathi (NHK), Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), West African Tall x Kathi (WAK) and Malayan Yellow Dwarf x Kathi (YDK). And, to study the effect of coconut aging and culture medium with was cut in half of the shoot to plant Chumphon 84-2 hybrid macapuno coconut. To study the effect of medium and embryo placement characteristics on germination percentage in the dark. The research found that 5 varieties of hybrid Kathi coconut embryo germination in the solid medium were better than in liquid mediums.

After culturing for 8 weeks in the dark, when they were sub-cultured in a modified Y3 solid medium and transferred to the light, it was found that the percentage of embryos development cultured in both solid and medium were better than those taken from embryos cultured in liquid medium.

For suitable formulations for the development of seedlings of 5 cultivars of hybrid macapuno coconut, from an 11-month-old embryo, it was found that the formula developed by the embryo was the most complete seedling of varieties of Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), and NamHom x Kathi (NHK), These are MS solid medium with 2,4-D 1 mg L^{-1} or B2 in the dark and B2 or Y3 modified liquid food in the light. West African Tall x Kathi (WAK) and Malayan Yellow Dwarf x Kathi (YDK), is solid and liquid medium B2 in dark and bright places.

Observing the effect of coconut aging and culture medium cut in half of the shoot to the plant of Chumphon 84-2 hybrid macapuno coconut, it was found that the number of shoot halves of the embryo can develop to shoot formation within 2 months. The piece of shoot halves of every fruiting age that were cultured on MS medium with 0.4 mg L^{-1} IBA and 3.2 mg L^{-1} kinetin had a higher percentage of seedling development than those cultured on modified Y3 medium. The piece of shoot halves of the fruiting age of 10 and 11 months cultured on both culture mediums had a higher percentage of seedling development than at 9 months. The piece of shoot halves of fruiting aged 10 months that cultured on MS medium with 0.4 mg L^{-1} IBA and 3.2 mg L^{-1} kinetin resulted in the highest seedling development.

INTRODUCTION

Coconut (*Cocos nucifera* L.) is a major Thai economic crop. At present, the major growing areas are only in the south, especially in Prachuap Khiri Khan, Chumphon, and Surat Thani provinces. in 2008–2013, productive area and yield decreased with age and plant conditions, because most of the area is the old coconut plantation. In 2010 an outbreak of coconut pests and the drought during the relatively dry weather to suitable for the infestation of such insects. As a result, the coconut yield is less. Conduce to a shortage of raw materials, high price per fruit. As a result, farmers have increased demand for good coconut varieties. But the government has insufficient production capacity.

Embryo culture is a technique that has been practiced by breeders for a long time. The key benefit is Helping the embryos of plants that cross-species or cross-genus and become sterile to grow into a complete plant. Kathi coconut cannot germinate in nature, so the embryo rescue technique was used. But the efficiency of seedling production is still low. Using the Kathi coconut embryo rescue technique, the zygotic embryos were successfully cultured in several laboratories. (Ashburner, 1991, Assy-Bah, 1989, Karunaratne et al., 2009, Rillo and Paloma, 1990) In Thailand, Somchai et al. (2008) successfully made Kathi coconut embryo culture and this technique is currently used as a good Kathi coconut production system by the Department of Agriculture. The result showed that medium and embryo placement characteristics affected 5 varieties, NamHom x Kathi (NHK), Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), West African Tall x Kathi (WAK), and Malayan Yellow Dwarf x Kathi (YDK), of hybrid Kathi coconut embryo germination.

In addition to trying to increase the number of seedlings produced from a single zygotic coconut embryo by somatic embryogenesis, propagation efficiency can also be increased by developing higher embryo culture techniques, this percentage can be increased up to 95%. Including the development of techniques at each stage of embryo culture, Germination, suitable recipes for each stage of development, and increasing the number of new shoots from a single embryo, etc., which is the purpose of this activity.

MATERIALS & METHODS

Medium and Embryo Placement Characteristics Affected 5 varieties of Hybrid Kathi Coconut Embryo Germination

Embryos of 5 varieties of hybrid Kathi coconut: NamHom x Kathi (NHK), Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), West African Tall x Kathi (WAK) and Malayan Yellow Dwarf x Kathi (YDK), 11 months old fruit, were isolated in Suratthani Seed Research and Development Center Tha Chana District, Suratthani 88170. They were shaken in 70% alcohol for 5 min. followed by 15 and 10% Clorox solution for 15 and 10 min. and then washed with sterile distilled water 3 times in a laminar airflow station.

The experiment used a completely randomized design with 3 treatments, consisting of hybrid Kathi coconut 5 varieties' embryo with 11 months fruiting age and culture medium with Embryo Placement Characteristics; modified Y3 liquid medium (Parinda, 2018) (Figure 1A), modified Y3 solid medium with placed upward (Figure 1B) and Murashige and Skoog (MS) solid medium with the addition of 2,4-Dichlorophenoxyacetic acid (2,4-D) 1 mg L^{-1} (Orathai, 2019) placed upward. Each embryo was cultured in the dark and taken after 8 weeks. The number of embryo's germination and development were observed and recorded every 2 weeks, 2 months after culturing.

Eight weeks later when shoots started growing, they were sub-cultured in a modified Y3 solid medium and transferred to the light under the illumination of cool-white, fluorescent tubes of about 37 µmol m^{-2} s^{-1} for 16 h/day photoperiods, 25+2 °C about for 8 weeks. The number of shoots and plantlet development were observed and recorded every 2 weeks for 2 months.

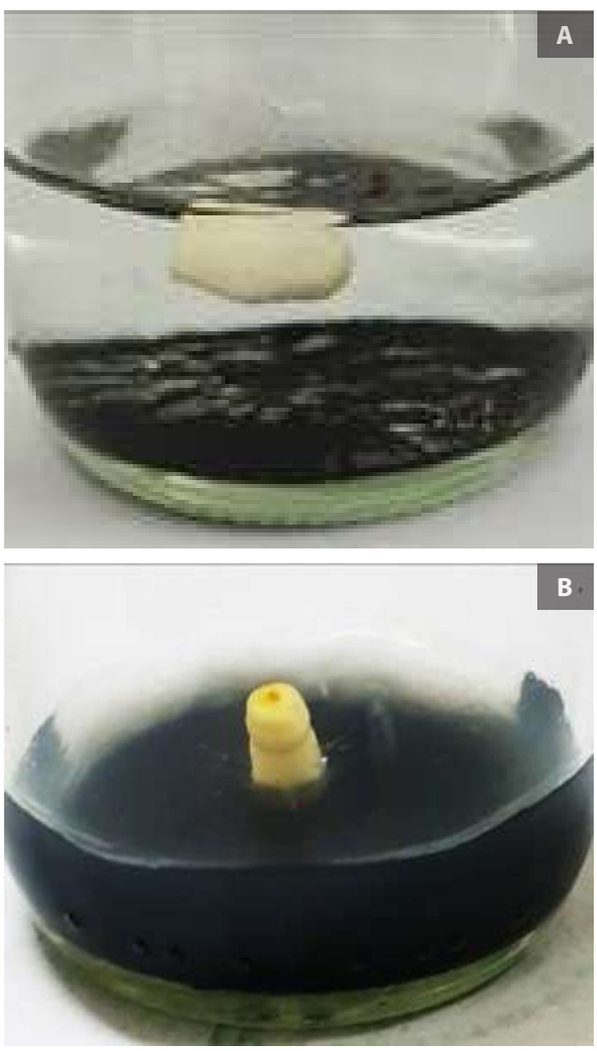

Figure 1. Embryo in liquid medium (A) and solid medium placed upward (B)

Effect of Appropriate Medium on Propagation of 5 Varieties Macapuno Using Plant Tissue Culture Technique

Completely randomized design (CRD) experiments were planned with 5 iterations, the size of the experimental unit. (experimental unit) 10 vials (embryos) per experimental procedure 5 varieties of macapuno were selected and the embryos contained in the varieties were cultured under sterile conditions starting from.

Step 1: Induction of embryo germination to form roots and shoots. (Figure 2)

Figure 2. Sterilization of endosperm, dissection, and inoculation on the media

Peel the coconut. Use a knife to open the coconut shell and divide it in half. Use the device to cut the coconut flesh around the embryo into a square shape. After that, the embryo is bleached and disinfected. And washed three times with distilled water. Use a dark slice to remove the embryo from the macapuno. In the meantime, it is carried out in a sterile cabinet. The prepared coconut embryos were cultured with a synthetic medium in bottles that were sterilized. The 3 mediums are Y3 media, MS with 2,4-D, and B2 media. The macapuno embryo culture bottles were placed in a dark room with a temperature of 25-27 °C.

Step 2: Embryo development in the bright room

The seedlings with shoots and roots were taken from the dark room and transferred to solid media Y3 and B2 media. Placed in a room with light 14 hours a day, temperature 25-30 °C. Embryos were cultured for 12 weeks, the pulp was removed, and sub-cultured by placing in the original solid media and placed in a bright room. Embryos were cultured for 16 weeks, sub-cultured solid medium to liquid medium. using the original recipe and sub-cultured every month. Seedling survival rate and plant height were recorded.

The effect of coconut aging and culture medium with cut in half of shoot to plant of Chumphon 84-2 hybrid macapuno coconut

The experiment design has a completely randomized design (CRD) with 6 treatments, consisting of the age of fruit being 9, 10, and 11 months (Figure 3A – C) and culture medium namely modified Eeuwens medium (Y3) (Parinda, 2018) and Murashige and Skoog (MS) medium supplemented with 0.4 mg L^{-1} Indole-3-butyric acid (IBA) and 3.2 mg L^{-1} kinetin (referred from Sisunandar et al., 2015). The fruiting aged 9, 10, and 11 months were selected. The embryo was cultured on a modified Y3 solid medium in the dark condition for 2 months to develop into the germination stage (Figure 4A). Cut in half of shoot (Figure 4B) were cultured on modified Y3 and MS medium supplemented with 0.4 mg L^{-1} IBA and 3.2 mg L^{-1} kinetin in the light condition, light Intensity 4,000-5,000 Lux and photoperiod 12 hours per day, for 2 months. The

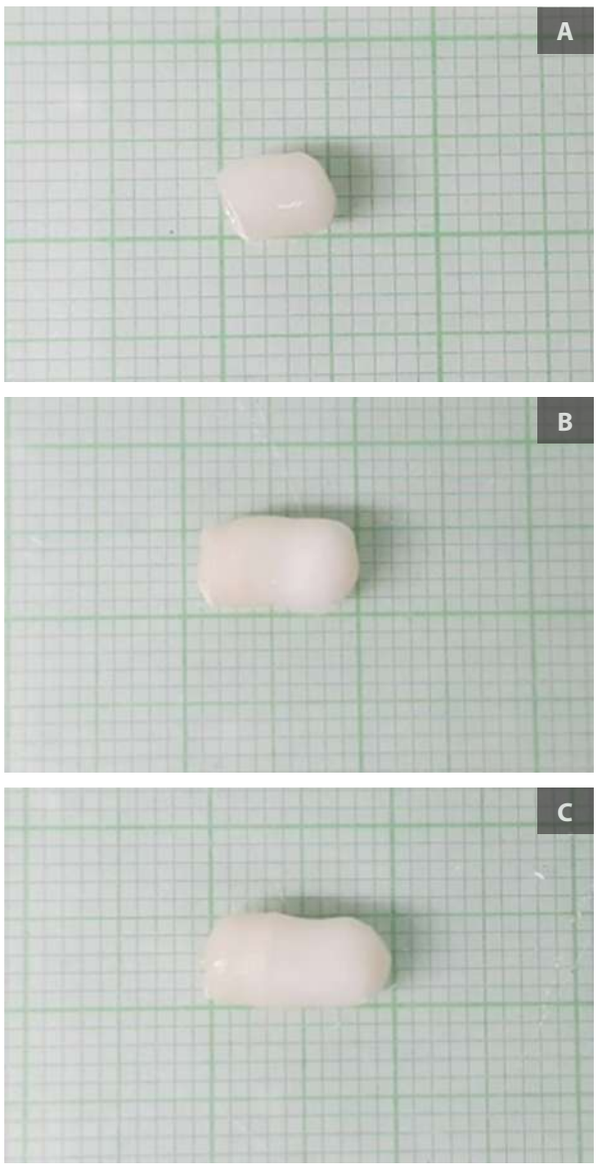

Figure 3. Chumphon 84-2 Hybrid Macapuno Coconut embryo, fruit age 9 months (A), 10 months (B) and 11 months (C)

Figure 4. The embryo begins to germinate after 2 months and is ready to be halved (A) The pieces of halves (B) 2 halves of the embryo after 2 months of culture (C)

percentage of embryo development in the light was recorded.

RESULTS AND DISCUSSION

Medium and Embryo Placement Characteristics Affected 5 varieties of Hybrid Kathi Coconut Embryo Germination

Effect of medium and Embryo orientation on germination. To study the effect of Medium and Embryo Placement Characteristics on the germination percentage, in the dark that the germination rate of solid medium ranged from 69.0 to 99.7 percent. While the liquid culture was 50.7 - 72.3 percent, embryo germination in a solid medium was better than in liquid mediums. The hybrid coconuts of TKK cultivars grown in both solid mediums, were significantly had greater germination than in the modified Y3 liquid medium (Table 1). And found that the hybrid coconuts of RDK, TKK, WAK, and YDK cultivars where were grown in Murashige and Skoog (MS) solid medium with the addition of 2,4-Dichlorophenoxyacetic acid (2,4-D) 1 mgl^{-1}, showed that the germination percentage (86.7, 99.7, 93.3 and 82.3%) was better than in the modified Y3 solid medium (74, 86.4, 69 and 74%). Also, MS solid medium with the addition of 2,4-D 1 mgl^{-1} was found longer shoots than the modified Y3 solid medium (Figure 5).

Eight weeks later when shoots started growing, they were sub-cultured in a modified Y3 solid medium and transferred to the light. It was found that embryos from the modified Y3 liquid medium had only 28.7 - 53.3 percent of

Table 1. Embryo germination percentage of five varieties of hybrid Kathi coconut after 8 weeks of culturing in medium with embryo placement characteristics in the dark

Treatment	Embryo germination in the dark (percent)				
	NHK	RDK[1/]	TKK[1/]	WAK	YDK
modified Y3 liquid medium	51.0	53.3 b	50.7 b	60.0	72.3
modified Y3 solid medium with placed upward	86.7	74.0 ab	86.7 a	69.0	74.0
MS solid medium with 2,4-D 1 mgl^{-1} with placed upward	80.0	86.7 a	99.7 a	93.3	82.3
C.V. (%)	44.8	20.0	18.5	29.5	22.7

[1/] The averages in the same column that follow with the same letter were not statistical difference at 95% confidence level by DMRT

Figure 5. Embryo germination of hybrid Kathi coconut after 8 weeks of culturing in medium with embryo placement characteristics in the dark

Figure 6. Embryo development percent of five varieties of hybrid Kathi coconut after 8 weeks of sub-culturing in modified Y3 solid medium and transferring to the light

developed plantlets. while embryos from solid medium culture modified Y3 and MS added 2,4-D 1 mgl^{-1} place upward had 62.7 - 99.7 percent to developed plantlets (Figure 6).

In the hybrid coconuts of NHK and TKK cultivars from the solid mediums, there was significantly greater plantlet development than in the modified Y3 liquid medium (Table 2).

Table 2. Embryo development percentage of five varieties hybrid Kathi coconut, from a cultured medium with embryo placement characteristics in the dark, after 8 weeks of sub-culturing in modified Y3 solid medium and transferring to the light

Treatment	Embryo development in the light (percent)				
	NHK[1/]	RDK	TKK[1/]	WAK[1/]	YDK
modified Y3 liquid medium	28.7 b	45.0	35.7 b	53.3 b	45.3
modified Y3 solid medium with placed upward	80.0 a	62.7	86.7 a	69.0 ab	62.7
MS solid medium with 2,4-D 1 mgl^{-1} with placed upward	73.3 a	86.7	99.7 a	93.3 a	82.3
C.V. (%)	35.5	34.8	27.8	27.5	30.6

[1/] The averages in the same column that follow with the same letter were not statistical difference at 95% confidence level by DMRT

To study the effect of Medium and Embryo Placement Characteristics on the percent germination in the dark, found that 5 varieties of hybrid Kathi coconut embryo germination in the solid medium was better than in liquid mediums (Table 1). After culturing for 8 weeks in the dark, when they were sub-cultured in a modified Y3 solid medium and transferred to the light, it was found that the percentage of embryos development from were cultured in both solid mediums are better than from were cultured in liquid medium (Table 2). In accordance with Pech Y Ake et al. (2004) studied enhanced aerobic respiration improves In Vitro coconut embryo germination and culture. Germination of Malayan Green Dwarf (MGD) coconut embryos was tested in liquid and solid medium. It was found that the percentage of germination increased when the embryo was fed on a solid medium, especially when the embryo with the micropyle side is placed upward. Causing exposure to the air inside the bottle and embryo proliferation is inhibited when the ambient atmosphere is replaced by N_2 or when anaerobic respiration inhibitors are added to the medium. The result showed that embryo proliferation requires aerobic respiration and germination in an upward position will result in better seedling development. In conclusion that medium and embryo placement characteristics affected 5 varieties of hybrid Kathi coconut embryo Germination, it was found that the embryos cultured in solid medium in the dark showed the best embryo germination and development to plantlet.

Effect of Appropriate Medium on Propagation of 5 Varieties Macapuno Using Plant Tissue Culture Technique

After culturing the embryos of 5 macapuno strains for 19 weeks, it was found that the sprouts had an elongation of shoots and increased development of the main root and branch roots. NHK macapuno hybrids grown on MS (dark)/Y3 (light) (Treatment 3) and B2 (dark)/ Y3 (light) (Treatment 5) mediums were able to develop into seedlings. However, from the embryo culture of RDK macapuno varieties, it was found that MS (dark)/B2 (light) (Treatment 4) and B2 (dark)/Y3 (light) diets (Treatment 5) were able to develop the most mature seedlings at 70 percent. The embryo culture of TKK macapuno varieties showed that MS (dark)/Y3 (light) medium, Treatment 3 and B2 (dark) medium/B2 (Bright) (Treatment 6) was able to develop into mature seedlings at 70 percent. WAK and YDK hybrid macapuno were found that the B2 (dark)/B2 (light) (Treatment 6) were able to develop into seedlings. The most complete, 70 and 80 percent, respectively (Table 3).

The NHK macapuno embryo hybrid varieties were cultured for 32 weeks in dark and light conditions. There were no statistically significant differences. The mean plant height was 7.6-14.5 cm (Table 4), RDK species had an average plant height of 5.8-11.0 cm (Table 4), but TKK species showed that the mean plant height was significantly different. Method 2 and Method 4 had the highest mean plant height

Table 3. Effects of culture media and conditions on embryo development of 5 varieties of macapuno at 19 weeks of culture under dark condition and transferred to light condition

Media and conditions	Embryo development (%)				
	NHK	RDK	TKK	WAK	YDK
Treatment 1 Y3 (dark room)/ Y3 (light room) (control)	70	30	40	30	70
Treatment 2 Y3 (dark room)/ B2 (light room)	40	60	60	20	50
Treatment 3 MS (dark room)/ Y3 (light room)	80	50	70	30	40
Treatment 4 MS (dark room)/ B2 (light room)	40	70	60	30	50
Treatment 5 B2 (dark room)/ Y3 (light room)	80	70	60	40	60
Treatment 6 B2 (dark room)/ B2 (light room)	60	60	70	70	80

Table 4. Effects of culture media and conditions on shoot length of five macapuno hybrid lines at 32 weeks of culture

Treatment	Shoot length (cm)				
	NHK[1/]	RDK	TKK[1/]	WAK[1/]	YDK[1/]
Treatment 1 Y3 (dark room)/ Y3 (light room) (control)	8.7 [b]	11	7.0 [b]	10.0 [ab]	6.0 [ab]
Treatment 2 Y3 (dark room)/ B2 (light room)	14.5 [a]	9.3	13.3 [a]	17.0 [a]	5.3 [b]
Treatment 3 MS (dark room)/ Y3 (light room)	11.0 [ab]	8.9	5.8 [b]	3.0 [c]	13.3 [ab]
Treatment 4 MS (dark room)/ B2 (light room)	9.8 [ab]	9.8	13.2 [a]	9.7 [b]	0
Treatment 5 B2 (dark room)/ Y3 (light room)	11.7 [ab]	5.8	8.7 [b]	12.5 [ab]	7.2 [ab]
Treatment 6 B2 (dark room)/ B2 (light room)	7.6 [b]	8.4	8.3 [b]	6.5 [bc]	13.5 [ab]
C.V. (%)	22.66	32.84	23.41	22.26	46.66

[1/] The averages in the same column that follow with the same letter were not statistical difference at 95% confidence level by DMRT

at 13.3 cm and 13.2 cm, respectively, and Treatment 3 had the lowest mean plant height at 5.8 cm (Table 4), while in the WAK and YDK strains, it was found that the plant height in each treatment was not significantly different. The average plant height is 4.5-17.0 centimeters and 5.3-13.5 centimeters, respectively (Table 4).

The culture study of 5 varieties of hybrid macapuno embryos was carried out in a single embryo culture. It will be a variety that is harvested at the same time. But each set received different environmental factors, each time of mating, which affects the integrity of the variety due to inbreeding between different parents or some bunches obtained from the same father and mother, not simultaneous maturation according to physiological characteristics, coconut is a plant with gradual blooming of female flowers takes about 7-15 days until they are completely bloomed. (Tippaya et al., 2021). The experiment showed that the formula affected shoot formation in the dark and the development of roots in the light. Embryos fed on the B2 formula showed better growth prospects. Due to the micronutrient elements concentration and growth factor, the B2 formula was 10 times higher than that of the Y3 formula and from embryo culture development in the dark, the development in the bright room, and the complete seedling development in each batch. The reduction in development percentage may depend on the management of the parent plot. Fertility and management within the laboratory and from experimental modification of methods and recipes, shoot emergence, and seedling development until the seedlings complete with leaves and roots take 8 months, which can reduce

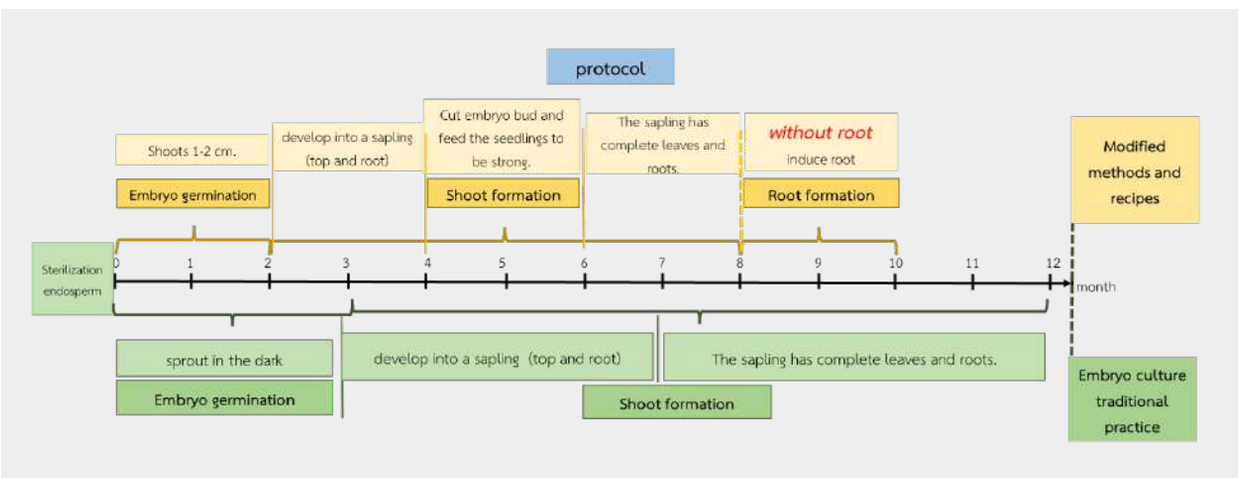

Figure 7. Comparison of the time period of the traditional practice of macapuno embryo culture and modified methods

the embryo culture duration from 12 months in traditional culture (Figure 7).

The effect of coconut aging and culture medium with cut in half of shoot to plant of Chumphon 84-2 hybrid macapuno coconut

Feasibility study of double shoots from a single zygotic embryo of Chumphon 84-2 Hybrid Macapuno Coconut (1 embryo can be cut in half to make two pieces. If it can develop into a whole shoot (Figure 4C), it will give two plants or 200%/ embryo. Observation of the development of new shoots from embryo halves with fruit maturity at 9, 10, and 11 months in a modified Y3 solid medium (Parinda, 2018) and Murashige and Skoog (MS) medium supplemented with 0.4 mg L^{-1} Indole-3-butyric acid (IBA) and 3.2 mg L^{-1} kinetin (referred from Sisunandar et al., 2015), it is found that using shoots from embryos with fruit maturity at 10 and 11 months in Murashige and Skoog (MS) medium supplemented with 0.4 mg L^{-1} Indole-3-butyric acid (IBA) and 3.2 mg L^{-1} kinetin, makes the percentage of development of a new shoot higher than the Y3 medium. The use of shoots from 9-month-old embryos showed the lowest percentage of new shoot development in both mediums (123.3 and 133.3%) compared to 10 and 11 months of fruiting (Table 5). Somchai (2003) mentioned that coconut embryo culture would be successful depending on the important component that the embryo aging must be between 10-11 months. And Sisunandar et al.' report used dwarf kopyor-type coconuts isolated from 11-month-old fruit.

And the effect of the medium on the development of the embryo is a new shoot by culturing in comparison with both mediums, it found that the percentage of embryo development at 9-11 months of age fruit on MS medium added 0.4 mg/L IBA plus 3.2 mg/L Kinetin higher when raised on a modified Y3 medium. In accordance with Sisunandar et al. (2015), the best protocol is to first incise the germinated embryos at the meristem site, followed by splitting the embryo into two after 4 weeks of culture and then recovering the embryos in Murashige and Skoog (MS) medium supplemented with 2 µM IBA and 15 µM kinetin. Results from the addition of growth regulators IBA and Kinetin, which are substances in the auxin and cytokinin group. Assists cell division and budding/new shoots in multi-vegetative culture. Shou et al. (2008) reported that the maximum number of shoots was induced from lotus bud explants on MS medium containing agar, sucrose, and BA added with NAA similar to Noraini et al. (2014). In addition, Jala (2012) reported shoot tips of *Curcuma longa* L. were given the highest average number of new shoots when cultured on MS medium supplemented with NAA and BA. The Y3 medium is a specific formula for coconut tissue culture (Somchai, 2003) without the addition of growth regulators. Therefore, the study induced new shoots in the modified Y3 formula with growth regulators. In the embryo halves, the shoot must be cut in half lengthwise into two equal parts. And multiple halves that resulted in the need to cut off the root part (Figure 8A). And when cultured in a Y3 liquid medium, the sapling develops into a mature plant and has 2-3 leaves, but is unable to take root (Figure 8B). Therefore,

Table 5. Embryo development percent of shoot halves of coconut fruiting age at 9, 10, and 11 months after 2 months culturing in medium in the light

Fruiting age	Medium	% Embryo development in the light[1/]
9 months	modified Y3	123.3 b
9 months	MS with 0.4 mg L^{-1} IBA and 3.2 mg L^{-1} Kinetin	133.3 ab
10 months	modified Y3	144.3 ab
10 months	MS with 0.4 mg L^{-1} IBA and 3.2 mg L^{-1} Kinetin	161.5 a
11 months	modified Y3	138.3 ab
11 months	MS with 0.4 mg L^{-1} IBA and 3.2 mg L^{-1} Kinetin	150.0 ab
C.V. (%)		15.7

[1/] The averages in the same column that follow with the same letter were not statistical difference at 95% confidence level by DMRT

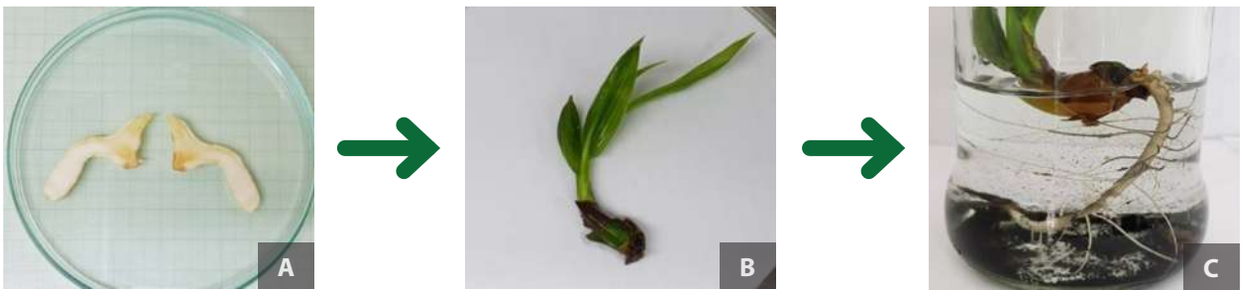

Figure 8. Characteristics of halved fragments (A) embryo halves No root development (B) and root emergence of embryo halves when cultured in Root medium (C)

it is necessary to study the root-inducing formula (Figure 8C), which is another experiment in the research project on the development and efficiency of coconut tissue culture (It is not mentioned in this report).

CONCLUSION

1. Medium and embryo placement characteristics affected 5 varieties of hybrid Kathi coconut embryo germination. It was found that the embryos cultured in a solid medium in the dark showed the best embryo germination and development to plantlet.
2. Different varieties of macapuno hybrids affect the response to different recipes. The suitable medium for propagating NHK macapuno hybrids were MS formula with 2,4-D or B2 formula in the dark and Y3 formula in the lightroom. RDK is MS formulation in the dark and B2 liquid medium in the lightroom. The embryo develops at most 70 percent of the seedling maturity, and the TKK, WAK, and YDK strains are B2 formula in the dark and B2 liquid medium in the lightroom.
3. Embryo incision can be applied to produce double seedlings of Hybrid Macapuno Coconuts. The best protocol is to first incise the germinated embryos at the meristem site, followed by cutting half the embryo into two and then recovering the embryos in Murashige and Skoog (MS) medium supplemented with 2 µM IBA and 15 µM kinetin.

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

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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 a 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, 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 in 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 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. 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,(MYD x TAT 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 at 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) 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, (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).

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 ie (MYDxWAT)xTT, (MYDxTAT)xTT and (MRDxRNT)xTT.

The average number of total leaves from three-way cross hybrids were shown in Table 3. It was of interest that at the juvenile phase (4-5 years old).

There were no significant differences among the three-way cross hybrids.

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

The average leaf length of the three-way cross hybrids were shown in Table 5. The results showed that leaf length began significantly differences at 3 years 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 this hybrid were not differences from (MYDxWAT)xTT and (MYDxTAT)xTT. When the palms

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	Up keep 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 1. Flow chart of Three-way cross-hybrid production

Table 1. Average height of hybrid coconut derived from the three-way cross in 1991 – 1995

Treatments	Coconut Height (cm)					Average
	1991	1992	1993 [1/]	1994	1995	
1 (RNT x WAT) x TT	208.84	568.67	624.16 a	745.33	870.66	603.53
2 (MYD x WAT) x TT	188.01	528.33	591.66 ab	687.50	819.92	563.08
3 (MYD x TAT) x TT	199.60	533.33	585.66 ab	694.16	700.75	542.70
4 (MRD x RNT) x TT	198.50	523.96	559.16 b	680.13	807.93	553.94
CV (%)	7.70	7.30	6.80	6.80	19.50	

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

Table 2. Average girth stem of hybrid coconut derived from the three-way cross in 1991 – 1995

Treatments	Girth (cm)					Average
	1991	1992	1993	1994 [1/]	1995 [2/]	
1 (RNT x WAT) x TT	50.48	124.67	134.41	147.33 a	169.16 a	125.21
2 (MYD x WAT) x TT	43.64	117.25	126.66	130.83 b	145.92 b	112.86
3 (MYD x TAT) x TT	46.98	125.91	126.16	131.42 b	146.25 b	115.34
4 (MRD x RNT) x TT	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	

[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

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

Treatments	Number of leaf (leaf)					Average
	1991	1992	1993	1994	1995	
1 (RNT x WAT) x TT	8.43	14.41	14.16	18.06	25.56	16.12
2 (MYD x WAT) x TT	7.76	15.60	15.52	18.90	26.41	16.84
3 (MYD x TAT) x TT	9.05	15.90	16.20	20.08	27.40	17.73
4 (MRD x RNT) x TT	8.70	14.80	15.22	18.14	25.56	16.48
CV (%)	14.67	6.10	9.20	11.00	8.30	

became 4 years 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, 553.43, 557.59 cm respectively. The comparison of the average yield of three-way cross hybrids from 2014 to 2017 was 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/pl/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/pl/yr, (MYDxTAT)xTT produced 108.60 nut/pl/yr and (MRDxRNT)xTT produced 90.20 nut/pl/yr and no significant differences between (MYDxTAT)xTT and (MRDxRNT)xTT produced 77.30 nut/pl/yr, 90.20 nut/

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

Treatments	Number of leaf increase (leaf)					Average
	1991	1992	1993	1994	1995	
1 (RNT x WAT) x TT	6.31	7.18	4.86	8.21	13.84	8.08
2 (MYD x WAT) x TT	7.00	7.86	5.08	8.16	14.28	8.48
3 (MYD x TAT) x TT	7.07	8.14	4.98	8.68	14.90	8.75
4 (MRD x RNT) x TT	6.73	7.43	4.93	7.80	13.88	8.15
CV (%)	6.90	7.50	9.40	9.60	4.30	

Table 5. Average leaf length for hybrid coconut derived from the three-way cross in 1991 – 1995

Treatments	Leaf Length (cm)					Average
	1991	1992	1993 2/	1994	1995 2/	
1 (RNT x WAT) x TT	115.43	474.50	522.56 a	560.50	576.43 a	449.88
2 (MYD x WAT) x TT	101.62	456.70	517.00 ab	546.33	556.60 b	435.65
3 (MYD x TAT) x TT	111.83	454.60	491.46 ab	531.66	553.43 b	428.60
4 (MRD x RNT) x TT	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	

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

pl/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 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, was shown in Table 7. It showed that they 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)

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

Treatments	Yield (nuts/palm/year)				Average
	2014 1/	2015	2016 1/	2017	
1 (RNT x WAT) x TT	105.20 a	103.40	105.00 a	95.82	102
2 (MYD x WAT) x TT	108.60 a	96.67	108.20 a	117.74	108
3 (MYD x TAT) x TT	77.30 b	99.07	77.20 b	91.63	86
4 (MRD x RNT) x TT	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 7. Comparison of the average yield of TWC hybrids nut/ha/yr. in 2014-2017

Treatments	Yield (nut/palm/ha)				Average
	2014[2/]	2015[2/]	2016[2/]	2017[1/]	
1 (RNT x WAT) x TT	14,460a	14,218b	14,438a	13,175b	14,075
2 (MYD x WAT) x TT	14,932a	13,287b	14,877a	16,870a	14,825
3 (MYD x TAT) x TT	10,628b	13,618b	10,615b	12,598b	11,868
4 (MRD x RNT) x TT	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

[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

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

Treatments	Copra Yield (kg/ha /year)				Average
	2014	2015	2016	2017	
1 (RNT x WAT) x TT	4,411a	4,749	5,089	4,890	4,787
2 (MYD x WAT) x TT	3,518ab	3,708	3,551	3,819	3,650
3 (MYD x TAT) x TT	3,133b	4,181	3,194	4,447	3,737
4 (MRD x RNT) x TT	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

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

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.

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.

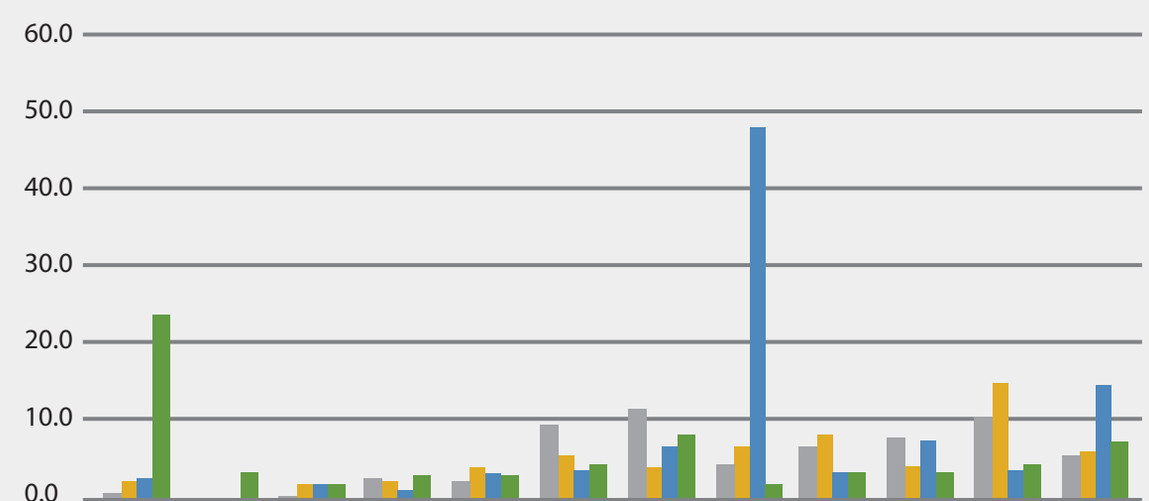
Table 8 Comparison of the average yield of 4 TWC hybrid between 2014 and 2017. The copra yield of three-way cross hybrids were shown in Table 8. In 2014 there were significant differences among 4 TWC hybrids in yields of copra/ha/yr (MRDxRNT) xTT produced the highest yield of copra,4,425 kg/ha/yr, and 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 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 this can be explained, because there was a five-month continuous drought from January up to May, which rain distribution was less than 10 mm/month this caused the abortion of initiated inflorescence bud (Figure 2).

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 the average rainfall of the year 2015, 2016, and 2017, where the rainfall distribution was good since 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.

A comparison of the average oil content of copra from TWC hybrids, between 2014 to 2017 was 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 ie (RNTxWAT)xTT, 21 kg/pl/yr, (MYDxWAT)xTT, 17 kg/pl/yr, (MYDxTAT)xTT, 16 kg/pl/yr and (MRDxRNT)xTT, 20 kg/ha/yr. Interestingly, if compared with the F1 hybrid, TWC hybrids 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 which was a shower in Table 10. It showed that were damaged by the coconut hispine beetle, and also there was no damage to the palms by black head 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 reserve diseases have been found such as nut fall, but rot which is caused by *Phythopthora palmivara* in conclusion there no revere pest or disease problem has been found. (Table 10-12).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	0.8	0.0	0.5	2.9	2.6	9.4	11.8	4.8	6.8	8.2	10.7	5.7
2015	2.4	0.2	2.2	2.3	4.2	5.8	4.4	6.8	8.3	4.4	15.1	6.2
2016	2.7	0.3	2.0	1.4	3.7	4.1	6.8	48.0	3.5	7.6	4.1	15.0
2017	23.7	3.5	2.1	3.2	3.2	4.6	8.5	2.1	3.6	3.4	4.6	7.8

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

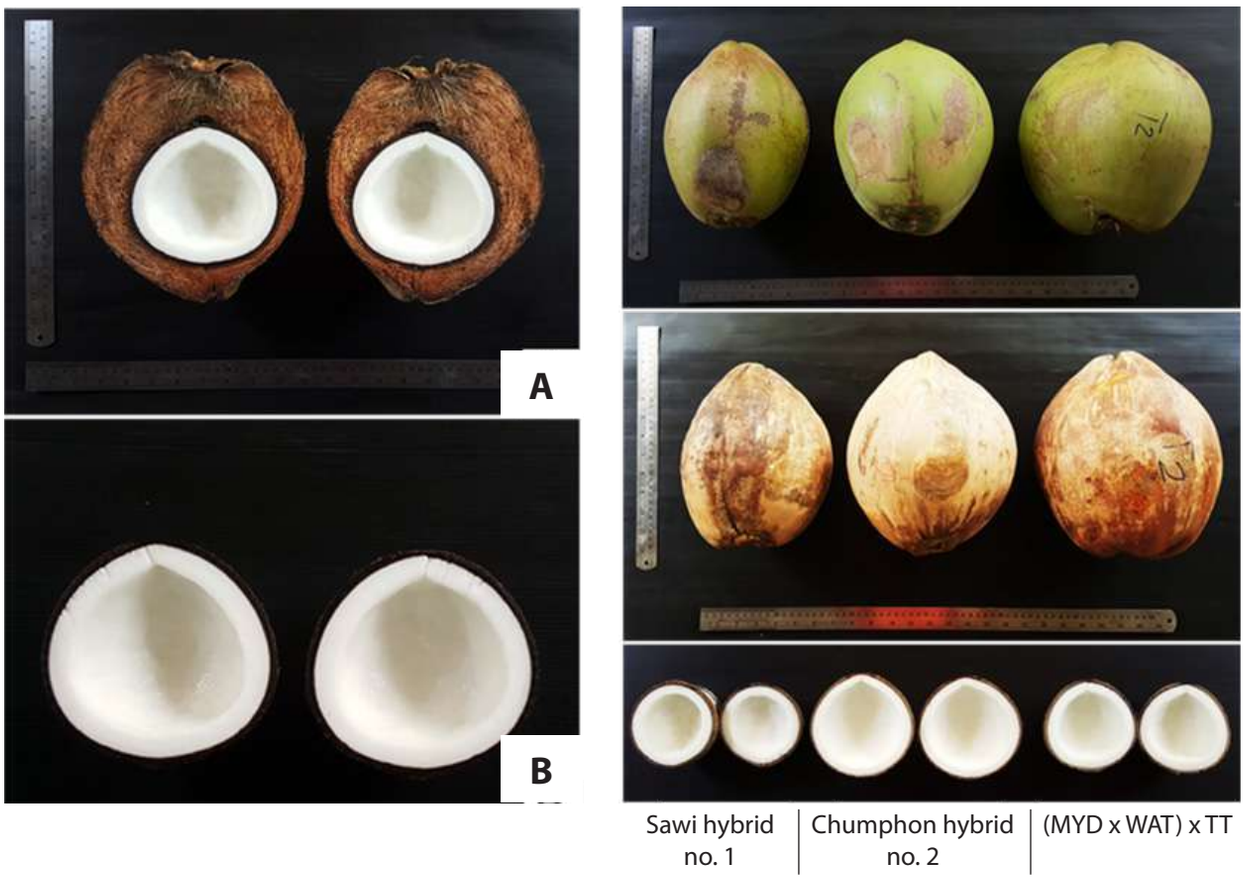


Figure 3. Characteristic of (RNT x WAT) x TT compare with coconut hybrid

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

Treatments	Oil Content (%)				Average	Oil Yield (kg./palm/yr)
	2014	2015 [1/]	2016 [2/]	2017 [2/]		
1 (RNT x WAT) x TT	60.44	59.16 a	61.56 ab	62.00 a	61	21
2 (MYD x WAT) x TT	61.64	59.17 a	62.65 a	63.00 a	62	17
3 (MYD x TAT) x TT	60.12	52.22 b	60.34 b	58.39 b	58	16
4 (MRD x RNT) x TT	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

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

CONCLUSION

Three-way cross hybrids (RNTxWAT)xTT and (MYDxWAT)xTT. Both hybrid varieties possess superior characteristics that match the breeding criteria ie yield, copra production, fruit size, and % oil content. If we compare the production 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 is lower than (RNTxWAT)xTT by approx. 20%. In the comparison of copra production per hectare per year, (RNTxWAT)xTT produces copra

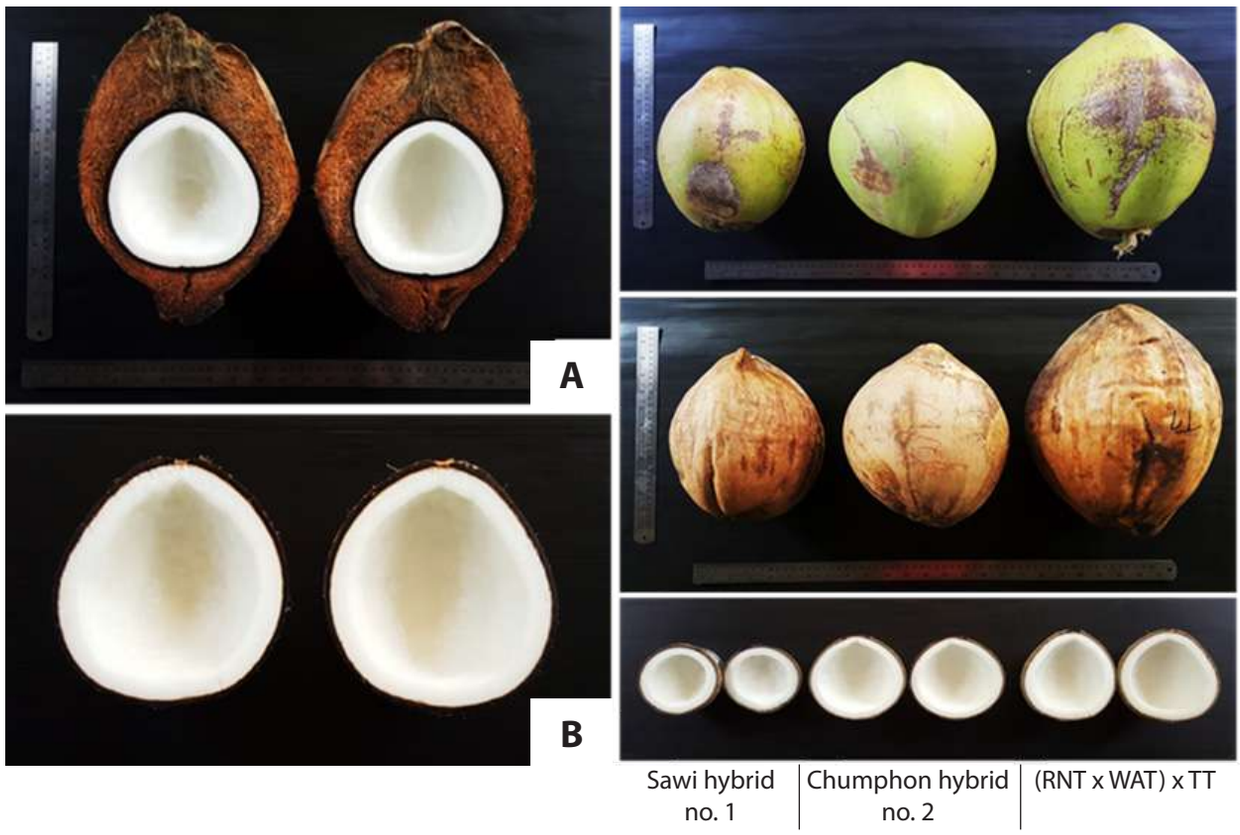


Figure 4. Characteristic of (RNT x WAT) x TT compare with coconut hybrid

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

Treatments	Number of coconuts palm	Level of damage [1/]	Number of coconut palm damage				Average
			2014	2015	2016	2017	
1 (RNT x WAT) x TT	60	0	60.0	60.0	60.0	60.0	60.0
2 (MYD x WAT) x TT	60	0	60.0	60.0	60.0	60.0	60.0
3 (MYD x TAT) x TT	60	0	60.0	60.0	60.0	60.0	60.0
4 (MRD x RNT) x TT	60	0	60.0	60.0	60.0	60.0	60.0

Source: Amporn *et. al* (2017) [1/] 0 = not detected (0 leaf)

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

Treatments	Number of coconuts palm	Level of damage [1/]	Number of coconut palm damage				Average
			2014	2015	2016	2017	
1 (RNT x WAT) x TT	60	0	60.0	60.0	60.0	60.0	60.0
2 (MYD x WAT) x TT	60	0	60.0	60.0	60.0	60.0	60.0
3 (MYD x TAT) x TT	60	0	60.0	60.0	60.0	60.0	60.0
4 (MRD x RNT) x TT	60	0	60.0	60.0	60.0	60.0	60.0

Source: Amporn *et. al* (2017) [1/] 0 = not detected (0 leaf)

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

Treatments	Number of coconuts palm	Level of damage [1/]	Number of coconut palm damage				Average
			2014	2015	2016	2017	
1 (RNT x WAT) x TT	60	0	58.0	59.0	59.0	60.0	59.0
		1	2.0	1.0	1.0	0	1.0
2 (MYD x WAT) x TT	60	0	60.0	59.0	56.0	60.0	59.0
		1	0	1.0	4.0	0	1.0
3 (MYD x TAT) x TT	60	0	57.0	60.0	58.0	59.0	58.0
		1	3.0	0	2.0	1.0	2.0
4 (MRD x RNT) x TT	60	0	59.0	58.0	60.0	58.0	59.0
		1	1.0	2.0	0	2.0	1.0

Source: Amporn *et. al* (2017) [1/] 1 = less than 6 leaf 0 = not detected (0 leaf)

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 ie (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 oil content is 66%

The Three-way cross hybrids are more adaptable to adverse environments than that single cross hybrids, The yield of nut per palm per year will be good evidence to show which hybrid varieties were more tolerance 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) 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.

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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 be produced 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 it will be able to produce seedlings, 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 had already been planted and will be able to produce seedlings in 2020-2021 around 14,400 seedlings which could be planted in 106.4 ha, and from 2022-2027, seedlings could be producing 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, 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/pl/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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Pink Husked Coconut Types and its Biochemical Properties

Regi J. Thomas, M. Shareefa, Harsha H. and J. S. Sreelekshmi

Coconut palm, botanically known as Cocos nucifera, belongs to family Arecaceae, an important member of monocotyledons. India is the third largest producer of coconut and has a rich diversity of coconut types. ICAR-CPCRI has a total of 455 germplasm holdings in its genebanks maintained at Kasaragod and Kidu. Coconuts with different traits are available in the germplasm collections available at ICAR-CPCRI.

Characterization of genetic resources in coconut is a prerequisite for crop improvement initiatives in coconut as the breeding efforts are cumbersome in coconut owing to its perennial nature, long juvenile phase, large area requirement, lack of clonal propagation technique, height of palm and longer time duration for any evaluation trials. Germplasm characterization has resulted in identification and utilization of varieties with different traits and economic uses. However, unexplored diversity still exists in the coconut gene pool.

Scientific studies are lacking on certain specific traits which have already been reported in coconut. Though wide variability and diversity for many traits have been reported in coconut, characterization of individual accessions at different localities is important to utilize them for further improvement programmes. Therefore independently maintained populations at various localities are to be tested before going in for germplasm multiplication and utilization.

Pink husk is one such trait which has already been reported in coconut by workers from different countries. Sparse occurrence of pink husked types was reported from the West Coast Tall (WCT) population cultivated in the root (wilt) disease affected tracts of Kerala, India (Thomas et al., 2016). Such types were also observed in Malayan Green Dwarf (MGD) population cultivated at CDB Farm, Ernakulam (Kerala) and also from ICAR-CPCRI Regional Station, Kayamkulam (Kerala). Rarely such trait specific palms are observed

and hence systemic studies using large samples become a constraint. A coconut palm bearing fruits with pink coloured mesocarp was identified in San Ramon Tall population from ICARCPCRI, Kasaragod. Flowers and fruits from all bunches exhibited pink colour below the tepals and the husk fibred of tender fruits also exhibit pink colour (Jerard et al, 2016).

Coconut palms with pink husked nuts are rarely reported in farmers' fields also. Morphologically the palms are similar to normal genotype except for the conspicuous pinkish colouration observed on parts of nut between the calyx and the husk portion. The pinkish colouration is also observed in plumular region of germinating nuts and in inflorescence immediately after its opening which will fade in the subsequent days. In few palms roots and root tips also exhibited pinkish colour.

Farmers claim that this mutant coconut type with pink husked nuts has some medicinal properties. It is being used in traditional system of medicines for curing jaundice, for preparing a medicine known as 'Elaneer kuzhambu' and also for treating many eye infections including cataract. Because of these medicinal properties, the tender nut of 'pink husked' genotype is being sold at premium price in the market. In Kareelakulangara (near Kayamkulam), Mr. Soman, a vendor sells the tendernuts of Pink husked coconut types at Rs.60/- to Rs. 65/- compared to Rs. 30/- to Rs. 35/- for normal tendernut. Systematic study was conducted for biochemical characterization of tendernut water from pink husked types identified from Guam Tall population planted at ICAR-CPCRI, Regional Station, Kayamkulam for validating its nutraceutical properties.

Biochemical characterization: The studies revealed that a significantly higher total phenol content in the tender nut water of pink husked types as compared to control (Table 1). Higher phenol content is clearly an indication of its ability to scavenge free radicals. Antioxidative properties of the coconut water could be attributed to the presence of phenolic compounds. There was no significant difference with regard to free amino acid content in both pink husked and normal husked types. Significantly higher protein content of 86 mg/100 ml was noted in pink husked type as compared to normal husked type with 58.7 mg/100ml indicating nutritional superiority.

Figure 1. Inflorescence of pink husked type - variety: MGD

Figure 2. Plumule pink husked type variety: MGD

Figure 3. Pink husked types - WCT variety from farmers' field near Kayamkulam

Free radicals are unstable molecules that are made during normal cell metabolism (chemical changes that take place in a cell). They accumulate in cells and cause damage to other molecules. This damage may increase the risk of cancer and other diseases. In humans, many diseases are associated with the accumulation of free radicals. Antioxidants can protect cells from the damage caused by free radicals and thereby minimize their impact (Rahman et al., 2016). Therefore, the search for naturally occurring antioxidants of plant origin is imperative. The antioxidant activity of tendernut water from pink husked type was evaluated by DPPH assay. Radical scavenging activity of DPPH was expressed as

Figure 4. Tendernut of pink husked type variety: West Coast Tall

IC50, which represents the concentration of the extract required to inhibit 50% of the free radical scavenging activity. Higher IC50 value indicates lower radical scavenging activity. Present studies revealed higher scavenging activity based on DPPH assay with pink husked recording IC50 value of 266.67 as compared to normal type with IC50 value of 358.27. Similarly the Phosphomolybdate assay also revealed higher free radical scavenging activity of pink husked type based on IC50 value of 415.17 s compared to 637.9 observed in normal husked type. Tender nut water can act as electron donors due to the presence of phenolic compounds present in it. This may justify its free radical scavenging activity. Significantly higher content of anthocyanin (25.97mg/100 g) was noted in the exocarp of pink husked types and it was negligible in normal husked type (1.464 mg/100g). The presence of higher anthocyanin content also can be correlated to higher antioxidant activity.

ICAR-CPCRI, Regional Station, Kayamkulam, Kerala - India.

** This article is through the courtesy of Indian Coconut Journal of Coconut Development Board, India.*

Photo by: Reoco

Fighting Deforestation with Waste

Tina S. Mehnpaine[1]

It is less about the money but more about the intent — the fight against deforestation.

This fight, for Morris Dougba, a climate entrepreneur in Liberia, requires the swapping of wood-based charcoal for briquettes charcoal, which are sometimes made from leftover bits of wood and sawdust mixed or agricultural waste – an energy source that requires no chopping of trees.

His enterprise, Green Gold Liberia, which has been in existence since 2018, produces tons of charcoal briquettes yearly, which studies have shown smolder twice as long as wood charcoal — saving extra cash in the process and benefiting the environment. A ton of charcoal look-alikes created from natural waste was equivalent to conserving up to 88 trees, according to a study commissioned by the Food and Agriculture Organization in the Philippines on the use of charcoal briquettes.

"The more people use briquettes to charcoal, the more we can conserve our trees," Dougba said while conversing between coconut trash collection stations on a humid afternoon in Brewerville City, on the northern fringes of Monrovia. "The good thing is everyone enjoys charcoal but this alternative is not just safer and helpful for the planet, but a cheap energy source."

"The day the last tree dies, so does the last man. So this is why we are buying coconut shells and other agricultural waste products to turn them into an alternative source of energy that is healthier for the environment. And we expect that as time passes, we will be able to reduce the demand for wood charcoal, which continues to have a disastrous influence on deforestation."

337,000 metric tones of wood charcoal

Dougba's quest comes as charcoal remains the top cooking fuel in Liberia since electricity is

often unreliable and not widely accessible to all. It is expected to be the mainstay energy source for years. With the current model of charcoal production, which is based on indiscriminate felling of trees, the situation worries Dougba as it poses a danger to the environment — regarding widespread forest degradation and deforestation.

The World Bank, in a 2019 report, says "under the Liberia Forest Sector Project, the use of charcoal, which is a significant source of greenhouse gas emission, has seen its demand growing rapidly to an estimated 337,000 metric tons worth US$46 million in 2018, due to ready availability, desirable performance characteristics and a lack of affordable alternatives."

And the industry is thought to employ up to 28,000 people on a 'full-time equivalent' basis, though many more are in practice due to seasonal or part-time involvement, according to the Bank.

While charcoal rules the urban energy market, firewood is the most popular fuel in rural regions. According to the most recent national census (2008), 5 percent of rural families used charcoal as their principal cooking fuel, compared to 70 percent of urban households (increasing to 85 percent in Monrovia). Because charcoal is often used as a secondary fuel, the actual consumption rates are probably significantly higher.

Montserrado County, which includes Monrovia, dominates the market and accounts for over 65 percent of total demand, more than ten times greater than any other county, the World Bank 2019 report said. The next largest centers of demand are Margibi (6.5%) and Bong (6%),

Morris Dougba holding one of the ecostove made from clay and metal (Photo by Tina S. Mehnpaine)

both adjacent to Montserrado, with Nimba, Grand Bassa, and Bomi ranked next, meaning that 90% of Liberia's charcoal is consumed through the country's central belt.

It is this high usage that scares Dougba since charcoal is a significant source of greenhouse gas emissions in Liberia, citing the Environmental Protection Agency in a report submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2020.

"As you burn charcoal you have CO2 going into the atmosphere, which causes the earth to get warmer. We are trying to keep the temperature at 1.5 degrees census, said Dr. Eugene Shannon, former Minister of Lands, Mines, and Energy, now President of the Natural Resources Development Corporation.

"Charcoal goes along with deforestation. People cut down trees to make charcoal and sell them to make some money to take care of themselves, send their children to school, and live a viable life without considering the environmental effect."

In fact, the United Nations last year estimated that more than 950 million people rely on wood and charcoal for cooking in Sub-Saharan Africa alone; that number will rise to 1.67 billion by 2050.

And as charcoal remains king in Africa — Liberia being no exception — accounting for nearly 65 percent of global charcoal production, it will continue to accelerate the country's biodiversity loss since traditional charcoal is produced by cutting down trees and burning them in kilns. This is because the manufacture of charcoal degrades arable land, and when trees are cut down for charcoal production, the lands become vulnerable to wind and water erosion since the deforestation caused by charcoal production alone emits millions of tons of carbon dioxide every year.

Electricity

The environmental worry in the near future is certain. So Dougba, despite his fears, continues to be obsessed with finding ways to stop deforestation. As a result of this obsession, his company, Green Gold Liberia, now produces briquettes that are specifically designed to meet the needs of both commercial and domestic customers.

However, fixing a single charcoal briquette requires a lot of waste. So Dougba buys his waste product including coconut shells from juice vendors who see the extra cash as an incentive not just to uncontrollably dispose of their waste but to sell and earn some cash.

One ton of charcoal briquettes takes forty 25kg bags of rubbish — yet trash is something Dougba never runs out of since he receives a lot of it regularly. However, due to the lack of energy, he is unable to create as many charcoal briquettes as expected, as demand climbs.

"We are steadfastly committed to completing this task, which is to halt deforestation in Liberia, but we are wishing for support for this project," he said. Sadly, electricity is the company's biggest challenge to produce more products. "We have to rely on solar panels. We spend more money when we use our generator and sometimes, on average, to run a twelve-hour shift, we spend US$42 for seven gallons of diesel.

"The boys selling coconut are major trash suppliers. They sell the coconut, we drink the water, and they bring that trash to us at Green Gold Liberia to buy."

Unlike the manufacturing of ordinary charcoal, which requires a lot of physical labor, such as

cutting trees and gathering, slicing them into pieces, piling them together to create a fire, and burning for weeks or months before collecting the coal, the process of producing briquettes is straightforward.

The garbage is collected and carbonized before being fed into a grinder machine that pulverizes it finely before being fed into a mixer and then into briquettes producing equipment that generates the finished product.

However, before the briquettes charcoal is sold, it must be dried in the sun, after which Dougba and his staff pack it in a 25kg bag containing 60 pieces. It is then sold at L$750 (US$5). Briquette charcoal burns slower and retains more heat than wood charcoal. When compared to carbonized briquettes, they have a higher heating value, fewer contaminants, and less moisture.

Dougba remarked that one ton of charcoal briquettes saves roughly 11 trees and that they smoke less, resulting in exceptionally good cooking conditions at all locations of usage.

"Very soon charcoal briquettes will replace wood charcoal and firewood. Once we get stable electricity, we are capable of producing a lot more for the population in Montserrado and subsequently the entire country. It is impossible. Deforestation is rampant and a lot of the country's forest is being lost each year."

"It is against this nightmare that Green Gold was founded to preserve the remaining trees. At Green Gold, we are contributing to household income through people saving on daily costs rather than on cooking because charcoal briquettes stay longer and heat more compared to wood charcoal. We are also creating jobs for young people who work with the factory or as sales agents."

The future

Dougba's interest in briquette manufacturing evolved during his time in the US, arguing that he is not deterred by challenges as he envisions a future where the country will transition to sustainable energy, with no tree cutting in the name of firewood harvesting. This vision has led to the manufacturing of an ecostove made from clay that can be used along with charcoal briquettes for domestic purposes.

"The charcoal briquettes and eco stoves, when produced in large quantities, would help reduce the country's reliance on charcoal, which is one of the primary causes of deforestation. We have also introduced sell-pay for our distributor network. We tell them when someone wants the ecostove and you sell it in the community just tell them to bring me L$100 every day and in fifteen days you come for your ecostove and that is resonating with our people," he said.

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[1] *Climate Change and Environmental Journalist, Liberian Daily Observer Newspaper*

What is the Significance of Coconut Farming?

Haika Kimaro[1]

Many people think of cashewnuts and sesame when they think of agriculture in the Mtwara and Lindi regions, Tanzania, but many people are unaware that coconut farming is a major undertaking by many people in the two regions, and that in some places, coconut farming used to outperform cashewnuts and sesame farming in terms of income to farmers.

Coconuts are considered a sustainable crop since they can be picked three or even four times a year from a single tree, and the tree can live for decades.

Coconut farming is thriving in the Mtwara and Mtwara Mikindani municipals, with annual production ranging from 600 to 800 tonnes, bringing in between Sh600,000 and Sh1 million per month in levies.

Coconut is mostly grown in the Lindi Region's Kilwa, Lindi, and Liwale districts, with 95,000 tonnes taken from 10,860 hectares in the 2018/19 season, but 59,429 tonnes harvested from 10,098 hectares in 2019/20.

According to locals in Lindi District's Ng'apa, they pay Sh20 per coconut sold, implying that the region earned an average of Sh954 million in 2018/19, whereas the tax from coconuts should have been Sh594 million in 2019/20.

Coconut is mostly used to make cooking oil, although its shells can be used as firewood and ornaments, and its husks can be used to make ropes and baskets. Unripe coconut is a popular snack and drink in coastal locations.

Abdulrahman Ally, a coconut farmer from Ng'apa Village, which leads the Lindi Region in coconut production, claims that coconut farming is his sole source of income.

He added that in the past, they used to earn a lot of money from the crop, but that since the 2021 season, the crop's price has fallen; he said that a

coconut used to be worth up to Sh600, but now they can barely get Sh200 for one.

"Prior to the wet season, prices would drop, but today even in the dry season, prices are not promising; we have a lot of coconuts in our residences, even though it is now a dry season," he says.

Issa Laulau, another village farmer, says he can harvest 10 tonnes of coconuts every three months, but the biggest challenge is finding a market for the produce, which he says is primarily in Dar es Salaam, Mbeya, and Songea. He is backed up by Hadija Hassan, who says she is also looking for buyers for her produce.

"The local council has imposed a Sh20 levy on every coconut we sell, but they don't help us access markets for the crop," says Laulau. "Worse still, if you decide to take your produce to the market, you will be charged twice: once here and again at the market."

Another major difficulty they encounter, he says, is a lack of expert support in coconut farming; he claims that many trees are dying for no apparent reason, and that extension staff have not checked on them in a long time.

"We would also welcome the construction of a coconut processing factory in our area, as this would provide a reliable market for our crop," he adds.

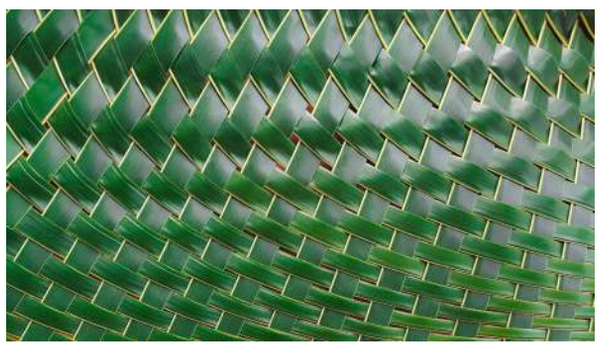
Another villager, Omari Abdallah, observes that in order to improve production, a farmer invests heavily in tendering for the crop, and it is the farmer who surfs when the price falls.

"If you do not properly till your coconut farm, production will go down; because we earn less and less, most of us find it difficult to take proper care of our farms; as a result, we will start to experience a drop in production soon," he recalls, pleading with the government to find investors who can guarantee them a steady market.

Benefits

Hadija Bakiri, Lind Regional Agricultural Officer, lists the benefits of the crop, saying that coconuts grown in the region are used to make cooking oil, and that in the past, farmers would dry the coconut and sell it abroad. She also mentioned that the coconut tree is used to make expensive timber.

"Coconut leaves are also used as roofing and fencing materials, as well as baskets and traditional hats," she adds.



Webbing of coconut leaf, which can be used as a basket

Challenges

Ms Bakiri said of late the crop has been experiencing a variety of issues including advent of illnesses which assaults the coconut trees such as devastating yellow disease, lack of reliable markets, price fluctuations and absence of programmes to replace elderly plants and those which die of diseases.

"However, our research institutes have yet to produce coconut kinds that can live in the current conditions, and we also lack factories to process the crop and extension personnel, leaving many farmers without aid in their activities," she says.

Strategies

According to Amani Rusake of the Mtwara Regional Commissioner Office's Economy and Production Department, crop growth suffers from a lack of coordination, which has resulted in a lack of trustworthy data needed to plan a course forward.

"Coconut differs from other crops in that each farmer harvests at his or her own time; there is no common harvest season like other crops, making it difficult to coordinate the crop's development."

He claims that efforts to engage farmers to see what can be done to improve the crop have failed, and that at one point they called the Malaysian envoy in the nation, who stated his country could buy coconuts from Mtwara, but that nothing else came out of the meeting.

"We were waiting for the Foreign Affairs and East African Cooperation ministry to guide us on what to do next," Rusake adds. "We were ready to mobilize

farmers to serve this enormous market, but we are still waiting," he says.

Significance

Coconut is one of the most important crops in Tanzania, according to Furahini Hiza of Tanzania Agricultural Research Institute (TARI) in Mikocheni, Dar es Salaam, because it is the mainstay of many small farmers, particularly in coastal areas.

According to data, the country's annual production is 546,302 tonnes, and research conducted by their center in charge of overseeing the crop's development shows that on average, a tree can produce 45 nuts per year.

According to Hiza, coconut farming covers 265,000 hectares across the country, including Zanzibar.

Coconut farming is also practiced in KigomaRegion and Kyela District in Mbeya Region, as well as on the shores of Lake Victoria.

Coconut is one of the most important crops in the country and abroad, according to Hiza, and it has the potential to improve the economy of individual farmers as well as the national economy through investments in processing facilities that would boost coconut exports.

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[1] *Journalist of The Citizen, Tanzania*

Highlights of The 50th International COCOTECH Conference & Exhibition 2022

Mridula Kottekate[1]

International COCOTECH Conference and Exhibition is the largest technical conference conducted once in every two years and dedicated solely to showcasing the different development activities in the coconut sector. This conference is organized by the International Coconut Community (ICC) together with the ICC member country that offers hosting facilities. The 50th International Cocotech Conference and Exhibition is organized by ICC in association with the Government of Malaysia through the Ministry of Agriculture and Food Industries from 7-11 November at Kuala Lumpur Convention Centre, Malaysia with the theme ***"Climate Change Adaptation and Mitigation Strategy for a Resilient and Sustainable Coconut Agroindustry"***.

It was officially inaugurated by **YB. DATUK SERI HAJI AHMAD BIN HAMZAH**, Deputy Minister I, Ministry of Agriculture and Food Industries Government of Malaysia. In his inaugural remarks, the honorable minister expressed his happiness to be part of this big event and Malaysian Government is developing a suitable policy for the sustainable development of the coconut sector. He added that it is good to see the representatives from different countries gathered here with one objective and working together for the economic growth and development of the sector. He appreciated the activities of ICC and informed that these four days of conference conclude with suitable recommendations for the implementation by the countries.

(A) YB. Datuk Seri Haji Ahmad Bin Hamzah, inaugurated the event; (B) Dato' Haslina Binti Abdul Hamid, delivered her welcome address; (C) Dr. Viliami Toalei Manu, delivered his conderence address; (D) Dr. Jelfina C. Alouw, introduced the conference; (E) Head of Country Delegates

Welcome addressed was delivered by **DATO' HASLINA BINTI ABDUL HAMID**, Secretary General, Ministry of Agriculture and Food Industries Government of Malaysia. She mentioned that it gives an immense pleasure for her, to extend a very warm welcome to all to the 50th International Cocotech Conference and Exhibition 2022, the world's largest technical forum on coconut development. It is delighted to have the presence of a diverse group of institutions and companies from many countries, united by the same aspiration, towards exchanging knowledge and discovery of the latest technology in the coconut industry. She continued that Malaysia envisions under the policy to develop a sustainable, resilient, and technology-based agro-food sector in driving economic growth, improving people's well-being, as well as prioritizing food security and nutrition. It is set with a thrust to embrace modernization, strengthening the value chain for domestic and international markets, developing talent and skilled workforce, advancing towards sustainable agricultural practices, and creating a conducive business ecosystem. The exhibition arranged on this occasion will give a platform for networking opportunities where all can meet and mingle with potential customers and business partners. She requested all to enjoy their stay in Kuala Lumpur and wish all to have a productive conference.

DR. VILIAMI TOALEI MANU, Chairman of the International Coconut Community, in his conference address expressed his happiness to meet all physically after the pandemic and requested all to take as much advantage of this conference and exhibition and take back home the knowledge and technologies from the speakers of this conference and also share skill and experience with all.

Some views of the conference

DR. JELFINA C. ALOUW, Executive Director, ICC delivered the conference introduction. She mentioned that 39 eminent speakers are going to share their knowledge and experience at this biggest technical conference. The expected output from this conference are causes of vulnerability and points of resilience identified; Adaptation & mitigation management interventions identified and promoted; Comprehensive standards & policy tools that may accelerate resilience to climate change determined; Decarbonization of key sectors including shifting to renewable energy sources & Degradable products promoted. She added that in the present scenario of Global challenges we have to break down the barriers and work together for a sustainable & resilient coconut industry. Dr. Jelfina acknowledges the contributions of all the former Executive Directors of ICC on this occasion of the 50th International Cocotech conference and appreciated the support of all the member countries.

The 50th International COCOTECH Conference was well attended by over 900 participants including the daily visitors to the exhibition from 52 countries who joined physically. This was one of the biggest events organized by ICC after two years of the pandemic.

The conference was for 5-days in which four-day classroom session was arranged and on the fifth day delegate tour was organized to two locations Linaco Manufacturing Unit Batu Pahat, Johor, and Jorak Agriculture Centre-Smart Irrigation System with IoT Pagoh, Johor .

The conference covered eight technical sessions by 39 eminent resource speakers, where they shared their ideas, knowledge, and experiences with the latest technologies and development. The subjects covered during the Conference assisted in preparing farming communities to counter the challenges and maximize benefits

Some views of the exhibition

from the opportunities that are presented. One session was exclusively arranged as a parallel session wherein call for papers were invited from the researchers of universities and research institutes who are involved in the research on the coconut sector. Ten such presenters presented their work at the conference.

The Sessions were on: Policy Coherence to Climate Change Solutions for a Resilient and Sustainable Coconut Agroindustry and Farmer's Livelihood; Promoting the Development of Green Exports of Coconut Products; Agronomic Adaptations Strategies to Climate Change; The New Integrated Pest Management Paradigm for Emerging Threats of Pests and Diseases of Coconut; Genetic Adaptations Strategies to Climate Change; Development of Innovative Products to Address Climate Change, Non-Renewable Energy, and Non-Degradable Products; Sustainable Conservation and Utilization of Coconut Genetic Resources and Their Impact to Climate Change Mitigation and Adaptation for the Economic Development of the Countries and Role of Coconut Products in Enhancing Public Health and Diseases Prevention. Each Session was followed by an Open Forum and Discussion coordinated by Session Chairs. The queries raised by the participants were well attended by the resource speakers.

A physical exhibition was also arranged in which the development departments, farmer organizations and industry stakeholders showcased the latest technology development of food and non-food products, services, and machinery, and build brand proximity. A daily business matching to connect (match) companies and people with common business interests, create valuable business relationships and strengthen business networks was also provided. 40 exhibitors from 7 countries participated in the exhibition, which includes India, Indonesia, Malaysia, Philippines, Thailand, Vietnam, and Papua New Guinea.

The recommendations emanating from COCOTECH were endorsed by the plenipotentiary delegates; session chairs and resource speakers from the countries

Field trip to Linaco Manufacturing Sdn Bhd and Jorak Agriculture Centre, Smart Irrigation System

for implementation by the member countries, Amongst the emergence of new knowledge and the development of innovative technologies shared at the Conference are the introduction of mobile apps technology under Internet of Things (IoT) for smart irrigation systems for coconut plantations sustainable development; innovative micropropagation method as an alternative to the clonal propagation method that relies on somatic embryogenesis; low-cost value-added products from coconut.

Many International partner organisations, research institutes and commodity boards of the member countries participated in the Conference, they were United Nations Economic and Social Commision Asia and The Pacific (UN-ESCAP), Non-Aligned Movement-Center for South-South Technical Cooperation (NAM-CSSTC), Coalition of Coconut Producing Districts (KOPEK), The Pacific Community (SPC), Centre de Coopération Internationale en Recherche Agronomique Pour le Dévelopment (CIRAD), Coconut Development Board (CDB) of India, Indonesian Palm Crops Research Institute (IPCRI), Philippine Coconut Authority (PCA),Coconut Development Authority (CDA) of Sri Lanka, Coconut Research Institute (CRI) of Sri Lanka, Coconut Cultivation Board (CCB) of Sri Lanka, Coconut Industry Board(CIB) of Jamaica,Centre de Investigaci'on Cienti'fica de yucat'an (CICY) of Mexico, Conservation and Development of Coconut Oil Forum of Thailand (CDCOT), International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA-FAO),International Trade Center (ITC), Commonwealth Scientific and Industrial Research Organization (CSIRO), Caribbean Agricultural Research and Development Institute (CARDI), ICAR-Central Plantation Crop Research Institute, BRIN, and Australian Centre for International Agricultural Research (ACIAR).

The four days Conference concluded with the adoption of the policy recommendations crafted from the presentations and discussions for the implementations by the member countries. In the closing session **Hon. Maiava Fuimaono Tito Asafo**, Deputy Minister of Agriculture and Fisheries, Government of Samoa mentioned that this conference was very much beneficial and that the expertise and knowledge shared by the speakers and the interactive session were very useful. He appreciated ICC and Government of Malaysia for arranging this big event and thanked the host country of Malaysia for their excellent hospitality. Awards were distributed to the winners of the World Coconut Day 2022 competitions organized by ICC. The conference adjourned with the closing remarks of Dr. Jelfina C. Alouw, Executive Director.

[1] *Assistant Director, International Coconut Community*

Highlights of The 58th ICC Session and Ministerial Meeting

Mridula Kottekate[1]

ICC Session & Ministerial Meeting is the highest decision-making body of the Community and is held annually to discuss, deliberate and take policy decisions on the activities to be undertaken by the Community for the sustained development of the global coconut sector. The countries are represented at the Session by the Honourable Ministers of Agriculture/Trade/Commerce, Plenipotentiary Delegates authorized by the National Governments and Senior Officials from the concerned Ministries.

The three-day-long 58th ICC Session and Ministerial Meeting was conducted virtually from 28th-30th November 2022. The Government of Kingdom of Tonga held the Chair of the International Coconut Community (ICC) for the CY 2021-2022 and was the host for the 58th ICC Session & Ministerial Meeting. For the third time consecutively, Session & Ministerial Meeting convened virtually.

The inauguration is an official opening ceremony organized by the host Government of Kingdom of Tonga. Dr. Viliami T. Manu, Chief Executive Officer, Ministry of Agriculture, Food and Forests delivered the greeting remarks followed by the National Anthem of Kingdom of Tonga, and Prayer of Thanksgiving by Father Lutoviko Finau Parsh Priest, Nuku'alofa.

H. E. Hon. Hu'akavameiliku, Prime Minister, Government of Kingdom of Tonga, delivered his opening speech

Dr. Viliami T. Manu, CEO, Ministry of Agriculture, Food and Forest, chaired the meeting

Dr. Jelfina C. Alouw, Executive Director, ICC, delivered her introductory remark

In absence of Hon. Mr. Lord Fohe, ICC Chair & Minister of Agriculture, Food and Forests Government of Kingdom of Tonga, Dr. Manu read his welcome address. The official opening of the session was done by H. E. Hon. Hu'akavameiliku, Prime Minister Government of Kingdom of Tonga as Chief Guest. Introductory Remarks delivered by Dr. Jelfina C. Alouw, Executive Director, ICC with the soft launching of the Cocopest portal.

The 58th ICC Session & Ministerial Meeting was attended by Delegates and participants included Senior Government Officials of ICC member countries and Official Observers from the Centre for Agriculture and Bioscience International (CABI), The Pacific Community (SPC), Australian Centre for International Agricultural Research (ACIAR), French Agricultural Research Centre for International Development (CIRAD), International Treaty on Plant Genetic Resources for Food & Agriculture (ITPGRFA), Bioversity International, Non-Alligned Movement Centre for South-South Technical Cooperation (NAM CSSTC) and International Trade Centre (ITC), Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (DOST-PCAARRD), Department of Science and Technology, Philippines and Caribbean Agriculture Research and Development Institute (CARDI). The Governments of Guyana, Kiribati, and Vanuatu were not represented.

Some delegates presented their country reports

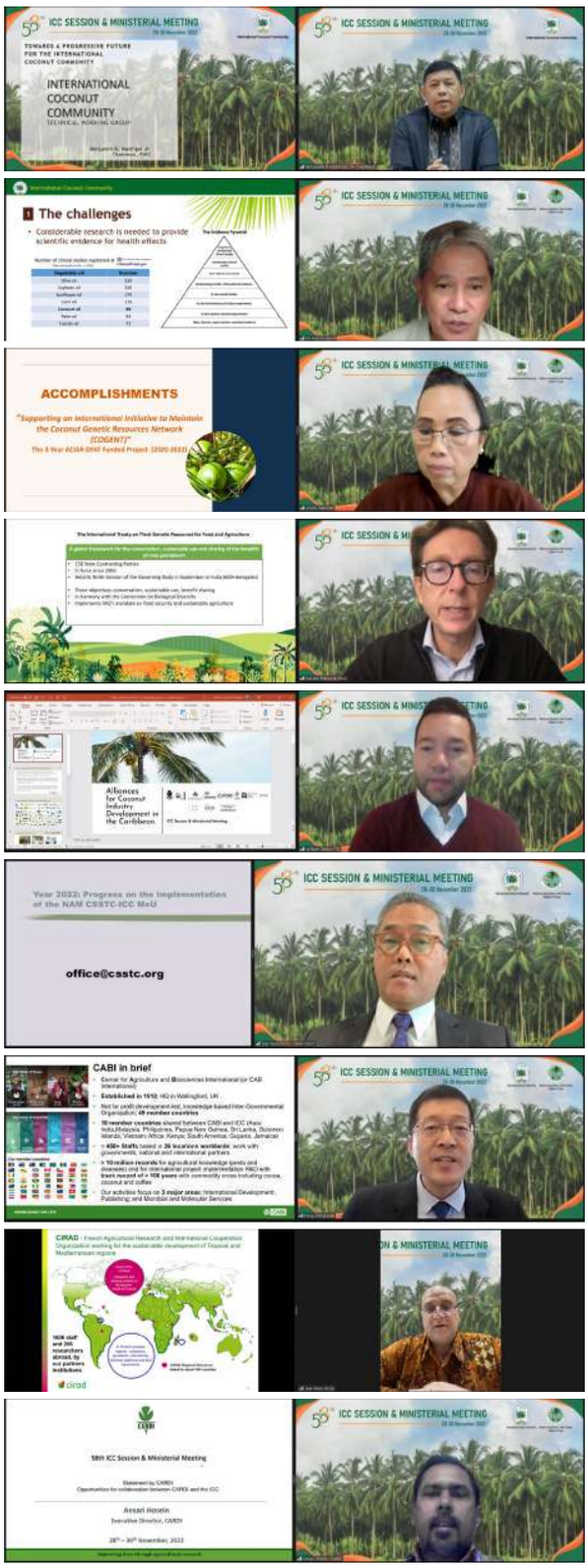
COUNTRY PAPERS–GATEWAY FOR EXCHANGING IDEAS AND PROGRAMS

The session meeting started with the country paper presentation by member countries to give a brief update on the policies and programs for coconut development undertaken by National Governments including the legislation to promote the development of the sector. The delegates presented the status of coconut production, processing and export in their countries. Presented the updates on the coconut replanting, new planting and rehabilitation programs. The status of the research and development activities, policies, and programs implemented in the country to enhance farm productivity and increase the farmers' income were also shared by the member country delegates. The constraints faced by the sector and suggested road map for the way forward for the coconut sector were briefed by the delegates besides the impact of Covid-19 on the coconut industry by some of the countries. The country papers helped in understanding the developmental activities undertaken by the countries and helps to identify the replicable models for customized implementation in other countries. It also helped in the exchange of ideas and technology and paved the way for possible collaborations between member countries, ICC and international partner organizations.

OBSERVER ORGANIZATIONS

The International partner organizations were attended and presented the nature and extent of their involvement in the coconut sector with reference to collaboration with the community are French Agricultural Research Centre for International Development (CIRAD); CAB International (CABI); The Pacific Community (SPC), Australian Centre for International Agricultural Research (ACIAR), International Treaty on Plant Genetic Resources for Food & Agriculture (ITPGRFA), Non-Alligned Movement Centre for South-South Technical Cooperation (NAM CSSTC), International Trade Centre (ITC) Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (DOST-PCAARRD), Department of Science and Technology, Philippines and Caribbean Agriculture Research and Development Institute (CARDI).

The other agendas discussed were the ICC Annual Report which included the global scenario of a



Reports presented by ICC TWG, ICC SACH, ICC Cogent and some observer organizations

sustainable and resilient coconut sector, highlights of 2021, update of activities of 2022 The report was presented by Dr. Jelfina C. Alouw, Executive Director. The Session also discussed the various programs and projects proposed to be undertaken by ICC during CY 2023.

During the year 2022, amid the COVID-19 pandemic, ICC's activities as planned were implemented both virtually and physically. The major ICC program, which was organized physically was the 50th International COCOTECH Conference & Exhibition in association with the Government of Malaysia,. The physical program organized during the year was the International Workshop on Good Agriculture Practices (GAP) in coconut and Tissue Culture Workshop both in India. The first International IPM Symposium was conducted virtually in association with the Philippines Coconut Authority. International Certificate Course for Coconut Development Officers could not conduct in 2022 and have postponed to the year 2023, to conduct physically in association with the Coconut Research Institute (CRI), Sri Lanka.

INTERNATIONAL COCOTECH CONFERENCE & OTHER EVENT MATTERS

The 50th International COCOTECH Conference was conducted successfully with the theme "Climate Change Adaptation and Mitigation Strategy for a Resilient and Sustainable Coconut Agroindustry" and the policy recommendations of the Conference and other recommendations crafted from the International Workshop on GAP in coconut 1st International symposium on IPM in coconut was adopted by the session for implementation by the ICC member countries.

The 58th ICC Session & Ministerial meeting adjourned with the acceptance of the Chair of ICC for 2023 by Government of Thailand hosting the 59th ICC Session & Ministerial meeting in 2023 in Bangkok, Thailand.

[1] *Assistant Director, International Coconut Community*

Experts' Finding on the Health Benefits of Coconut

Dr. Fabian M. Dayrit
Chairman of ICC Scientific Advisory Committee on Health and Professor, Department of Chemistry, Ateneo de Manila University, Academician, National Academy of Science and Technology and President, Integrated Chemists of the Philippines

Virgin coconut oil is effective in lowering C-Reactive Protein levels among suspect and probable cases of COVID-19. There were two main indicators used: recovery from COVID-19 symptoms and level of C-Reactive Protein (CRP) in the blood. These two indicators showed that VCO can be used to treat mild COVID-19 cases.

CRP is a protein that is analyzed in the blood as a quantitative measure of inflammation or infection. CRP level less than 5 mg/L indicates recovery from inflammation or infection. The recovery from COVID-19 symptoms was more rapid in the VCO group compared with the Control group: 17% in the VCO group showed improvement compared to only 4% in the Control group. Full relief from COVID-19 was attained by day 18 in the VCO group compared to day 23 in the Control group.

The level of CRP in the VCO group dropped much more rapidly and completely compared to the Control group. By day 14, the CRP level in the VCO group had fallen below the 5 mg/L, and this continued to show a decreasing trend at day 28. In comparison, the CRP level in the Control group fell slowly to 5 mg/L at day 14 and stayed at this level until day 28.

Other beneficial effects of VCO were noted from the blood assay:

- HDL-cholesterol ("good cholesterol") increased
- LDL and triglycerides remain within normal range
- Fasting blood sugar (FBS) decreased

These results show that VCO, indeed, is a healthy oil.

Source: Proceedings of the XLIX Cocotech Conference, 30 August-2 Sept 2021, Jakarta, Indonesia.

Dr. Damodaran Vasudevan, MBBS, MD.
Associate Dean, PG & Doctoral Programs, Faculty of Medical Sciences
Amrita Vishwa Vidyapeetham, Kochi, India

Increased risk for coronary artery diseases is attributed to elevated levels of serum cholesterol, which in turn is due to increased intake of saturated fats. However, a fear complex has been created among the general public that consumption of coconut oil results in elevated cholesterol levels. This "myth" is primarily due to equating coconut oil with saturated fat; without knowing that saturated fat in coconut oil are of the short chain and medium chain fatty acids. It is to be emphasized that the fats that cause heart disease are saturated fats with long chain fatty acids. Nearly 50 % of the fat in coconut oil is Lauric acid (medium chain fatty acid). These medium chain fatty acids directly enter into the cells and are metabolized immediately (Vasudevan et al, 2010). On the other hand, long-chain fatty acids (of other oils) require the help of lipoproteins, which are eventually deposited into various organs, including heart vessels.

Source: Cocoinfo International, Vol. 18, No. 1, 2011.

Experts' Finding on the Health Benefits of Coconut

Dr. Bruce Fife

Certified Nutritionist and Doctor of Naturopathic Medicine, and Director, Coconut Research Center, based in USA

If any food could be labeled as brain food it would be coconut oil. According to Fife, coconut oil, converted into ketones, acts as a superfuel to the brain and normalizes brain function, stops the erratic signal transmissions that leads to seizures, and improves cognition and memory. The medium chain triglycerides (MCTs) in coconut oil are converted into ketones, which act as high-potency fuel for the brain. The ketone MCTs provide energy to the brain and stimulate healing and repair. The chemical structure of the MCTs and fatty acids in coconut oil enable them to pass through the blood-brain barrier, which ordinary food or oil cannot break into.

Source: Cocoinfo International, Vol. 19, No. 1, 2012

Prof. Dr. Rabindarjeet Singh

Lifestyle Science Cluster, Advance Medical and Dental Institute, Universiti Sains Malaysia, Bertam 13200 Kepala Batas, Penang, Selangor, Malaysia

Coconut water (*Cocos nucifera* L.) is an ancient tropical beverage whose popularity has been increasing in recent years. This 'naturally canned' beverage is a sweet refreshing drink obtained directly from the inner part of the fruit. It is a beverage that has drawn the attention as a natural functional drink. Coconut water is sterile at source, and is very rich in potassium, and contains sodium, chloride, magnesium and carbohydrates. Therein, making it a healthier alternative to carbonated drinks including isotonic sports drinks. Apart from the lower calories due to lower sugar content, the non-carbonated coconut water is also a great source for replacing the electrolytes lost during sweating when compared to carbonated drinks. Ingestion of carbonated drinksis known to be associated with gastrointestinal discomfort in certain individuals. This "Mother Nature's" gift of coconut water, could be prized as the beverage above all other beverages for its health renewing properties.

Source: Proceedings of the XLVI Cocotech Conference 7-11 July 2014, Bandaranaike Memorial International Conference Hall Colombo, Sri Lanka.

Experts' Finding on the Health Benefits of Coconut

Dr. M. Vijayakumar
Amrita Institute of Medical Sciences and Research Center, Kochi, India

Coronary artery disease resulting from atherosclerosis is closely linked with lipids which is influenced by dietary fat and oil. Being rich in saturated fatty acids coconut oil has been pointed out as one of the many reasons for high incidence of coronary artery diseases (CAD). There is already recommendations by major organization to avoid coconut oil in order to reduce the CAD risk. In this context we decided to look the impact of coconut oil a cooking medium on the cardiovascular events and risk factors in patients with stable coronary heart disease receiving standard medical care.

Using anthropometric indicators of cardiovascular risk, like body mass index, waist/hip ratio and percentage body fat were statistically comparable between the two groups of using coconut oil and sunflower oil as cooking media over a period of 2 years, the result findings showed that there is no change in the major anthropometric, biochemical, vascular function and in cardiovascular events in patients with coronary artery diseases while using coconut oil. Therefore, as a cooking media, even though rich in saturated fatty acids coconut oil seems to be safe in those receiving standard medical care including statins.

Source: Proceedings of the XLVI Cocotech Conference, 7-11 July 2014, Bandaranaike Memorial International Conference Hall, Colombo, Sir Lanka

Dr. Faizal C. Peedikayil
Professor & Head Department of Pedodontics & Preventive Dentistry, Kannur Dental College, India

Coconut oil rinsing reduces gingival inflammation. Oil rinsing is a type of traditional procedure that involves swishing edible oil in the mouth and then spitting it out. Virgin and regular coconut oil can be used to reduce plaque related gingivitis. However, the study shows that virgin coconut oil has better taste, odor, and texture in the mouth than regular cooking coconut oil. The advantage of coconut oil or virgin coconut oil as natural oils is that they neither cause any staining as seen in the use of mouthwashes nor there is any after taste or allergic reactions. and are readily available. Such practices cure about 30 systemic diseases and have an effect on the overall well-being of the individuals practicing it.

Source: CORD Journal, Vol. 37 2021

Bullish Market of Coconut Oil in the First Half of 2023

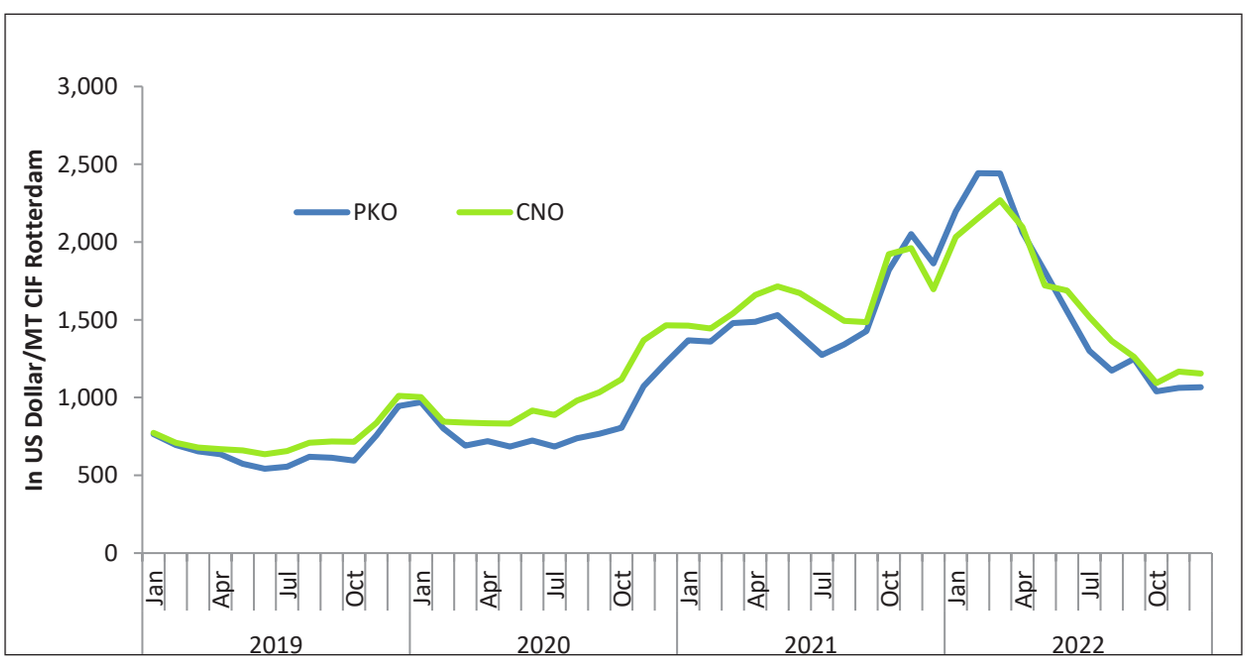
Alit Pirmansah[1]

Global production of lauric oils is projected to marginal decrease to 11.32 million tons in 2023 as opposed to 11,38 tons in 2022. The expected decline of lauric oil is mainly driven by the estimated drop in coconut oil production. World Production of coconut oil is forecast to slowdown as exhausted coconut trees after high yield in last two years especially in Philippines and Indonesia amid expected ample rainfall. Global production of coconut oil is estimated to decrease by more than 200 thousand tons. Production of the oil in two main producing countries, Philippines and Indonesia, is estimated to dwindle. Philippines is expected to produce 1,060 tons of coconut oil in 2023 meaning a decline by more than 220 thousand tons as opposed to previous year's production. Similarly, Indonesia is also expected to experience a decrease in

Table 1. Coconut Oil Production, 2021-2023 (000MT)

Countries	2021	2022	2023e
Philippines	997	1,283	1,060
Indonesia	777	871	865
India	366	366	373
Mexico	132	132	132
Sri Lanka	58	67	65
Malaysia	53	55	56
Vietnam	40	41	41
Papua New Guinea	39	41	40
Thailand	29	29	29
Other countries			
World	2,754	3,153	2,907

Source: Oil World and ICC estimates



Source: Oil World

Figure 1. Price Trend of Lauric Oils, January 2019-December 2022 (USD/MT)

Bullish Market of Coconut Oil

Table 2. Palm Kernel Oil Production, 2021-2023 (000MT)

Countries	2021	2022	2023e
Indonesia	4,653	4,826	4,933
Malaysia	2,049	2,073	2,122
Thailand	282	286	291
Nigeria	151	162	166
Other countries	**841**	**876**	**902**
World	7,976	8,223	8,414

Source: Oil World and ICC estimates

Table 4. Palm Kernel Oil Imports, 2021-2023 (000MT)

Countries	2021	2022	2023e
EU-27	713	634	682
USA	382	348	380
China	628	535	600
Malaysia	286	260	278
Brazil	248	245	250
Other countries	**1,083**	**910**	**1,140**
World	3,340	2,939	3,330

Source: Oil World, USDA, and ICC estimates

production of the oil from 871 thousand tons in 2022 to 865 thousand tons in 2023.

Meanwhile production of palm kernel oil is estimated to increase by 190 thousand tons in 2023. Indonesia and Malaysia as biggest producers for palm kernel oil are expected to level up their production. Indonesia is expected to produce 4.9 million tons of palm kernel oil during CY2023 and Malaysia is projected to rise up its production of the oil reaching 2.1 million tons.

Table 3. Coconut Oil Imports, 2021-2023 (000MT)

Countries	2021	2022	2023e
EU-27	616	686	610
USA	468	535	550
Malaysia	225	325	237
China	174	219	200
UK	27	26	26
Other countries	**492**	**506**	**427**
World	2,002	2,297	2,050

Source: Oil World, USDA, and ICC estimates

Expected lower production and high price premium of coconut oil over palm kernel oil is expected to bring about lower demands for the oil. World import demand of coconut oil is forecast to decrease by at least 150 thousand tons in 2023. Imports of coconut oil to European countries is forecast to dwindle by more than 80 thousand tons in 2023. Similarly import demand of coconut oil from China is expected to reduce in 2023 by more than 8%. However, USDA estimated shipments of the oil to US market will go up by at least 15 thousand tons in 2023.

High price premium of palm kernel oil will not only put a pressure on the price, but also brought about a shift in demand from coconut oil to palm kernel oil. In 2023, import demand for palm kernel oil by European Countries is estimated to increase by about 48 thousand tons. US market is also expected to level up its demand for palm kernel oil by 32 thousand tons in 2023. Similarly China is expected to boost its demand for the oil by at least 65 thousand tons in 2023. Therefore, global demand for palm kernel oil is estimated to go up by 391 thousand tons in 2023.

The expected decline of production may curb world consumption of coconut oil. Global exports and domestic consumprtion of coconut oil is estimated to decrease in 2023. Exports of coconut oil is expected to go down by around 250 thousand tons. Meanwhile, domestic consumption of the oil is estimated to weaken by 129 thousand tons. The decline in production will be mitigated by a reduction of stocks. Global stocks of coconut oil is expected to reduce by around 135 thousand tons following the decrease in production. Likewise, world stocks of palm kernel oil is estimated to decrease owing to high demand of the oil.

After recording a historical price hike in March 2022, prices of lauric oils steeply dropped to the

Bullish Market of Coconut Oil

lowest level in October 2022 recorded a decrease of more than 50% in 6 months. The price in October 2022 was the lowest since November 2020. Underlying expected lower production and higher import demand, lauric oils prices are set to appreciate noticeably in first half of 2023. It is forecast prices of palm kernel oil to be at US$1,155/MT and coconut oil at US$1,185/MT on average during January-June 2023.

In conclusion, the global production of lauric oils, particularly coconut oil, is expected to decline in 2023 due to exhaustion of coconut trees and lower yields in major producing countries such as the Philippines and Indonesia. In contrast, the production of palm kernel oil is expected to increase, mainly in Indonesia and Malaysia. As a result of the expected lower production and the high price premium of coconut oil, demand for coconut oil is forecast to decrease, and there may be a shift in demand towards palm kernel oil. The decline in production may curb world consumption of coconut oil, and global exports and domestic consumption of coconut oil are estimated to decrease in 2023. Despite the steep drop in prices in October 2022, prices of lauric oils are expected to appreciate significantly in the first half of 2023 due to the underlying expected lower production and higher import demand. The projected increase in prices of palm kernel oil and coconut oil during January-June 2023 is estimated to be US$1,255/MT and US$1,385/MT, respectively. These projections suggest that there may be some challenges for producers and consumers of lauric oils in the coming year, particularly for those who rely heavily on coconut oil.

[1] *Market and Statistics Officer, International Coconut Community*

Table 5. World Balance of Lauric Oils (000MT), 2022-2023

Countries	Coconut Oil		Palm Kernel Oil		Lauric Oils	
	2022	2023	2022	2023	2022	2023
Beginning Stocks	360	473	1,212	1,390	1,572	1,863
Production	3,155	2,907	8,223	8,414	11,378	11,321
Imports	2,373	1,994	2,939	3,330	5,312	5,324
Total Supply	5,888	5,374	12,374	13,134	18,262	18,508
Exports	2,287	2,036	3,096	3,350	5,383	5,386
Domestic Consumption	3,129	3,000	7,889	8,404	11,018	11,404
Ending Stocks	473	338	1,390	1,380	1,863	1,718
Total Distribution	5,889	5,374	12,375	13,134	18,264	18,508

Source: Oil World, USDA, and ICC estimates

Coco Events

WORLD COCONUT DAY 2022 CELEBRATION

World Coconut Day is observed every year 2 September, to Commemorate the establishment of ICC by all coconut-producing country.

The 2022 World Coconut Day theme was ***"Growing Coconut for Better Future and Life"***. To accommodate the participant's enthusiasm, this year ICC invited nominations for awards in different catagories which included Best Innovative Farmer, Best Micro Small and Medium Enterprise, Best Coconut Farmer Organization, and Best Coconut Scientist and invited nominations from all the ICC member countries. ICC also invited a Coconut Song Writer Competition which was open to all globally. ICC secretariat being part of the celebration of World Coconut Day organised by Government of India through Coconut Development Board in Kochi, Kerala.

The event was conducted in a hybrid mode, both physically and virtually along with the distribution of National Award & Export Excellence conducted by the Coconut Development Board, India. The inauguration was commenced with the lamp lighting ceremony by Honorable Union Minister of Agriculture, Govt of India Mr. Narendra Singh Tomar, who joined virtually from the Junagarh district of Gujarat state of India. He also inaugurated the state centre of Coconut Development Board in Junagarh. The event was attended physically by Dr. N Vijayalakshmi, Chairperson, CDB and Dr. Jelfina C. Alouw, Executive Director, ICC with other dignatories in Kochi.

During the function ICC announced the nominations received from the member countries in different four catagories and distributed the certificate of participation to the nominees received from India. The winner for each category were announced during the 50th International COCOTECH Conference, in Kuala Lumpur, Malaysia, 7-11 November 2022. An exhibition was also organized in which depicting the different coconut value added products, research developments and schemes implemented by CDB showcased. ICC also participated in the exhbitions and displayed the different publications.

The program was concluded with the vote of thanks proposed by Mr. Rajeev Bhushan Prasad, Chief Coconut Development Officer, CDB. *(ICC News)*.

1ST INTERNATIONAL IPM SYMPOSIUM IN COCONUT

International Coconut Community and the Philippines Coconut Authority organized the 1st International Integrated Pest and Disease Management Symposium on Coconut virtually from 23-26 August 2022. The theme was: ***"Implementing IPM to Sustainably Protect Coconut, Producers and Industry"***. The general objective of organizing the symposium is to establish an international IPM network system and synergy to protect the coconut producers & industries, conserve the coconut genetic resources and diversity from the adverse impact of pests and diseases through expertise and experience sharing.

The pest and disease experts from the different ICC member countries, universities, research institutes, and international organizations participated in the symposium and presented their most recent research and development in this sector. There were 193 participants from 34 countries attended the event. This symposium served as a venue for knowledge sharing amongst entomologists, pathologists and breeders for a concrete and innovative action toward protecting our crop and managing pests with minimal or no use of harmful chemicals.

During the four-day virtual symposium, subject matter experts from UPLB, CABI, CSIRO, FAO, and DPP&Q-MAFW presented the state of the art of Integrated Pest and Disease Management (IPM) in three sessions as follows: Modelling and Decision Support System for IPM; Strengthening IPM to Increase Global Market Acceptability of Coconut Products; Biosecurity for Germplasm and Biocontrol Agent Movement.

The fourth session was Country Presentation-Related to Pest and Disease Challenges (New Emerging Pests) and Control Strategies, Policy Support, Economic, Sociological and Cultural Barriers/Boosters to the Adoption of the IPM Principles in which countries like India, Indonesia,

Sri Lanka, Philippines, Pacific Country, Caribbean, and African countries status were presented.

On the last day of the symposium the Establishing of IPM Networks were presented by Dr. Jelfina C. Alouw, Executive Director.

Ms. Mridula Kottekate, Assistant Director, ICC, presented the soliciting recommendations crafted from the four days symposium which will be submitted to the ICC Session & Ministerial meeting for approval and for implementations. The Symposium concluded with the closing remarks by Mr. Ramon L. Rivera, Deputy Administrator, PCA, Philippines. Dr. Chyrelyn Pace was the moderator for the Symposium. *(ICC News)*

INTERNATIONAL WORKSHOP ON GOOD AGRICULTURE PRACTICES (GAP) IN COCONUT

International Coconut Community in association with the Government of India through Coconut Development Board organized a three-day International Workshop on Good Agriculture Practices (GAP) in coconut, at Le Meridian Kochi, Kerala, India from 2-4 September 2022 in a hybrid mode. The theme of the workshop was: Good Agricultural Practices for Coconut in Enhancing Production Efficiency, Product Quality and Resilience to Climate Change.

The general objective of organizing the workshop is to disseminate the knowledge on GAP for 'Enhancing the level of management practices adopted in coconut gardens for higher quantity of quality nuts for better remuneration, in the wake of biotic & abiotic stresses amid climate change'.

The agronomists and related experts in the field of major coconut growing countries from India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam and international organization participated in the workshop and presented their most recent research and development in this sector. There were more than 125 participants joined physically as well as virtually. This workshop served as a venue for knowledge sharing amongst agronomists, soil science and related experts for establishing an international platform/network among ICC member countries to catalyse local/national innovation and action for scaling up climate smart agriculture for coconut and to Identify data and technology gaps, area for future research activities to develop improved GAP recommendation based on up to date research results.

The workshop was inaugurated on 2nd September by Dr. Jelfina C. Alouw, Executive Director, ICC by lightning the traditional Lamp with Dr. N. Vijaya Lakshmi, IAS, Chairman CDB. The other dignatories present were Mr. Rajendra Kumar Kataria, Principal Secretary Horticulture, Government of Karnataka, India.

Dr. Jelfina C. Alouw, Executive Director, ICC, delivered the inaugural address and presented the rationales and objectives of the workshop.

The three day workshop covered in three sessions. Session 1 Good Agricultural Practices in Coconut for Sustainable Development and Innovative Extension Approaches for Promotion of GAP was mainly focused on the country presentations. The second session was Moving Towards Sustainable Agriculture - GAP and its Relevance in the Context of Climate Change in which experts from FAO and Quality Council of India presented the different programs and GAP certification procedures to be followed by the stakeholders and farmers. The last and third session on Successful Models Practiced by Progressive Coconut Farmers for Enhancing Productivity & Nut Quality was mainly on the experience sharing by the progressive farmers.

The physical session was conluded on 3rd September with the valedictory session addressed by Dr. N. Vijaya Lakshmi, IAS, Chairman CDB and Dr. Jelfina C. Alouw, Executive Director, ICC.

A field visit was arranged on 4th September to the field of Mr. Raam Mohan and Mr. OVR Somasundaram, Tirupur District of Tamil Nadu state. The participants could see the hybridization techniques followed in the Umapathy hybrid centre in which he adopted an integrated farming system with poultry farming.

The workshop was an integrated package covering both physical, field visit and exhibitions which give the participants a combined feelings of seeing in believing. *(ICC News)*

EXPLORING RELATIONSHIP BETWEEN SRI LANKAN AND INDONESIAN COCONUT INDUSTRIES

To strengthen and exploring relationship between Sri lankan and Indonesian coconut industry, H.E. Yasoja Gunasekera, Ambassador of Sri Lanka to Indonesia and ASEAN has visited the ICC Secretariat, on 9 June 2022. One of the agendas for the meeting was also to discuss the potential partnership and investment between the major coconut industry of Sri Lanka and Indonesia.

Join with Her Excellency Ambassador, was Heshani Kaushalya, Third Secretary Embassy of Sri Lanka (Commercial). The ICC Secretariat team was led by Dr. Jelfina C. Alouw, Executive Director and joined by Mr. Alit Pirmansah Market & Statistics Officer, Mr. Klaudio D. Hosang, Administrative & Finance Officer, and Mr. Otniel Sintoro Publication Officer, of ICC.

In her welcome address, Dr. Jelfina expressed her appreciation towards the initiative of the embassy of Sri Lanka in Jakarta to visit the ICC for a discussion about the coconut sector and she also expressed her appreciation to the Government of Sri Lanka for organizing the International Training Course for Coconut Development Officers in 2021, the ICC's regular program for member countries in collaboration with CRI Sri Lanka (CRISL). She also thanked the Government of Sri Lanka for supporting the Tissue Culture Symposium and Workshop in 2022 as part of ICC-COGENT program funded by ACIAR and DFAT, by appointing a TC expert as one of the resource speakers at the events.

Dr. Jelfina also shared ICC's programs that could be of benefit to promoting the coconut industry in Sri Lanka, one of which is the 50th COCOTECH in November 2022, where the Sri Lankan coconut producers can participate and promote their products and keep up with the latest technology in the coconut industry.

H.E. Ambassador Yasoja Gunasekera showed her interest in trade fairs like COCOTECH where the Sri Lankan coconut industries could promote their products. She also shared her gratitude that amid the pandemic the coconut sector in Sri Lanka is still increasing, especially VCO and coconut milk, and, during the economic restructuring, several Sri Lanka's companies want to expand their market and production, therefore they showed interest in investing and seek for B2B partnerships in Indonesia.

Dr. Jelfina C. Alouw mentioned that ICC could facilitate both parties, to see what opportunities are available in Indonesia or other member countries. She also invited coconut industries in Sri Lanka to visit the leading Indonesian coconut manufacturer to explore best practices in coconut processing and develop partnerships. Sri Lanka as a member country also eligible to utilize all of ICC's statistics and market information available on the ICC's website, publications, and database.

There were in-depth and productive discussions on the potential collaboration and strategic implementation between both countries. The meeting concluded with thanks to the Ambassador and her team. *(ICC News)*

EXPOSURE VISIT TO MACHINE MANUFACTURERS AND COCONUT INDUSTRIES OF INDIA

India is one of the leading country in coconut with highest production and productivity. Many industries are established in India for the coconut processing and for machine manufacturers for coconut based industry. To know more about the strengths and challenges of the coconut industries during and beyond the COVID-19 pandemic, and to know strategies for addressing problemss as well as to share ideas and knowledge, Dr. Jelfina C. Alouw, Executive Director, ICC along with Ms. Mridula Kottekate , Assistant Director, Mr. Alit Pirmansah, Market & Statistics Officer and Mr. Klaudio Hosang, Admn and Finance Officer visited some of the machine manufacturing companies and processing industries in Coimbatore, India on 24th and 25th May 2022.

The first company visited was of Essar Engineers, promoted in the year 2001 as a company to manufacture the machineries required for coir pith product manufacturing industries to meet out the international Quality Standards. The promoter K.Rajarathinam is an experienced designer with more than 27 years in the field of machine tool designing and manufacturing

equipment for coconut husk, coconut shell and coconut food processing etc. The company installed equipment's for processing coconut husk, coconut peat, coconut shell, coconut kernel and coconut water, virgin coconut oil, desiccated coconut powder processing machines. They have done around 700 installation in coconut growing countries like India, Indonesia, Philippines, Sri Lanka, Brazil, Dominican Republic, Ghana, Mozambique, Ivory Coast, Thailand and Vanuatu. Though the company started as manufacturing of machines but later on to coir processing and other products of coconut. He exports the processed coir fibre products in the form of cocopeat to many countries which includes China, Korea, Brazil, Mexico, Colombia, African and Caribbean Countries. He is a regular participant of ICC 's International Cocotech Conference and could establish a wide range relationship between the coconut growing country representatives and able to share his knowledge and experience with other country members. This helped him a lot in expanding his business as well as knowledge in the sector. He has gained a wide knowledge in coconut based products by constantly travelling, presenting papers and installing machines in almost all the coconut growing countries.

Essar Engineering also encouraging precision farming in the name of "Farmagain" which is a smart agriculture using IoT & Artificial Intelligence. In this technology taking care of irrigation, productivity and fertigation.

He mentioned that the major challenges he experienced in this sector is lack of proper research and development. There is a gap between the research done reaching to the actual beneficiaries. Besides short of sufficient fund to take up the research activities. He further added that the policy makers and beaurocrats needs exposure to coconut industry for better understanding of the challenges faced by the farmers and the entrepreneurs.

He expressed his future planning of establishing a training institute for the budding engineers and industrialist who can practice and do their initial training on the processing of various coconut products and learn the things before they go for establishing their own processing units.

The second industry visited is of Food Protech, manufacturer of machines for the Desiccated Coconut Powder and Virgin Coconut Oil Processing Solutions. The team met with Mr. Rakesh, the manager of the company. He explained the functioning of the company and informed that they mainly exporting the machines to Indonesia, Sri Lanka, Ivory Coast and Brazil.

It was a very thrilling experience for the team to visit one of the biggest coconut oil processing unit Marico under the brand "Parachute", located in Perundurai, Coimbatore, India established in the year 1990 occupying 63% of the market share in the coconut oil category. One out of 10 coconuts grown in India are used by Marico. More than 1.5 Billion packs sold every year. During the visit ICC team could able to meet a team of management of Marico led by Mr. Arun V. Head-Copra Buying and Mr. P.J.Subin, Buying Manager, who shared the activities and functioning of Marico. The ICC team could see all the processing including quality analysis of copra, crushing, processing and filtering of the coconut oil. The oil is mainly processed by making white copra collected from the farmers. The final product before going to the customers is passing through different quality check so that the customer can have the best quality coconut oil for their daily use.

Marico having products in the category of value added hair oils, skin care and related products. Marico aspires to be a leading emerging market MNC with a leadership position in the categories of leave in hair nourishment, Foods, skin care and male grooming in a few chosen markets in Asia and Africa. The company also exports its products to markets in the India-sub continent such as Nepal, Bhutan & Sri Lanka as well as Indian Diaspora markets across the globe.

To make a positive difference to the coconut farmers, Parachute Kalpavriksha Foundation was launched in September 2, 2017 on World Coconut Day for improving yield, imparting scientific knowledge and implementing precision farming. Under this program learning, enabling, transforming and train the farmers to be self-capacitated in handling their farms. Introduced digital channels to reach farmers and thru kalpavriksha Mobile application so that the farmers can share their problems and discuss

various issues related to coconut cultivation, by means of scientific based farm management, market trends, and integration of other stakeholders in value chain.

By doing this Marico directly linked with famers through sustainable development and social upliftment of farming community. This is one of the unique example of linkage between farmers and a private sector company.

The last company visited was of T&I Global Ltd, manufacturing integrated coconut processing solutions. The company supplying machines mainly to the southern part of India. Mr. Karthik J. GM Marketing briefed the activities of the company. The coconut processing machines are also exporting to countries like Philippines, Indonesia, Vietnam and Papua New Guinea.

During the visit to all the four units, Dr. Jelfina C. Alouw, Executive Director presented ICC plaque of appreciation and publications.

The visit was quite learning experience for ICC team and was very productive and useful. *(ICC News)*

COCONUT PROCESSORS PUSH VCO AGAINST COVID-19 IN A BATTLE

Virgin coconut oil (VCO) proponents and processors have encouraged the government to promote VCO and other non-vaccine techniques to increase immunity and disease resilience among Filipinos in light of the rising instances of COVID-19, dengue fever, and at least one confirmed case of monkeypox.

The Department of Science and Technology (DOST) has already conducted clinical trials proving the efficacy of VCO as a cure for mild to moderate COVID cases, according to the VCO Producers and Traders Association of the Philippines (VCO Philippines).

"VCO should be effective against Omicron variants based on two clinical studies that were conducted against two variants of the SARS-CoV-2 virus (the original Wuhan variant and the Delta variant). This is due to the fact that all SARS viruses share a viral membrane, which is what VCO is thought to attack, according to VCO Philippines.

Since the dengue and monkeypox viruses are lipid-coated, VCO may potentially be effective in theory. However, all of these need to be validated in clinical investigations. VCO is reasonably priced and safe to take. The government, perhaps, will pay for these studies, according to VCO Philippines.

VCO should be included in the nation's arsenal of weapons against emerging diseases, according to Dr. Ed Lalusis, patented inventor of a capsulized VCO and president and chief executive officer of Growrich Manufacturing Inc. This is especially true in light of the DOST-funded clinical trials on VCO that demonstrated its curative properties against COVID-19.

Well, Lalusis said, "My recommendation there really is that we should take the prevention strategy — mass vaccination with boosters especially, and promote VCO intake.

Dr. Sterling Tiu, a patented inventor of a VCO with menthol spray and who had recently filed an application for patent to a lagundi and VCO mix mouth spray, said coconut oil should be seriously considered as an adjunct treatment for COVID-19.

Numerous studies have demonstrated the ability of virgin coconut oil to inactivate viruses like HIV, RSV, influenza, and many others. In light of this, VCO could theoretically be used as a supplemental therapy for both established and emerging infectious diseases, according to Tiu.

Although there are no foolproof methods to prevent infections, daily VCO intake can aid the body in getting ready and aiding in its defense if it is exposed to these pathogens, the expert said.

Meanwhile, lagundi is also believed to have anti-viral properties in addition to being able to relieve respiratory symptoms.

"The nicest thing about VCO and lagundi is that they are made from Philippine plants and crops, which means that using them has fewer side effects than using other supplements and medications. Therefore, as we move towards an inevitable future

of novel infections, VCO and lagundi hold a great deal of promise," Tiu said.

The results of the DOST Food and Nutrition Research Institute (FNRI) enlarged clinical trials on VCO, which revealed the outcomes of the 2020 clinical tests in Sta. Ana, were given by the former science secretary Fortunato dela Pea in Valenzuela City last January. La Laguna, Rosa

"Both VCO clinical trials by DOST-FNRI confirmed that VCO hastens the resolution of COVID- 19 signs and symptoms," Dela Peña added. *(Phil Star Global)*

"THE ROLE OF TECHNOLOGY AND GOVERNMENT POLICY IN SUSTAINABLE COCONUT DEVELOPMENT"

Dr. Jelfina C. Alouw, Executive Director, ICC, delivered a scientific oration on the topic: "The Role of Technology and Government Policy in Sustainable Coconut Development" in the 62nd Anniversary of Sam Ratulangi University, Manado. The occasion held on May 30th 2022, at the Auditorium of Sam Ratulangi University. She shared the challenges faced by the coconut sector globally, where there is an imbalance between the availability of raw materials for the coconut processing industry and the global market demand for coconut products. Global market demand for coconut products increases from year to year, while coconut production tends to decrease every year.

In Indonesia, low productivity is the result of ageing plants and not being followed by a structured rejuvenation program. Other causes are pest and disease attacks, where lack of maintenance and the varieties used are not liable and susceptible to biotic and abiotic stresses. Another challenge is to maintain reasonable price stability for farmers as producers of raw materials, and for the industry itself.

Another challenge is logistics problems which cause production costs to be higher, especially in isolated and difficult to reach areas. In addition, the global market demand for certified products is another obstacle in the Indonesian coconut sector. Several certifications like USDA Organic, Fair Trade, etc., make it difficult for MSMEs to be able to compete with large industries in the global market.

Dr. Jelfina mentioned that the sustainable development of coconut needs to be carried out with the support of technology, funds, mutualism synergy, and multilateral collaboration between stakeholders as well as policy support from the government by prioritizing the coconut sector as one of the national priority programs.

Dr. Jelfina added that the FAO One Country One Priority Product (OCOP) program might be implemented at the provincial level by mobilizing each district to identify potential main products (One District One Priority Product/SKSPP) so that in one provincial area there are one or more integrated coconut industries. and integrated.

Present at this event, Rector of Sam Ratulangi University, Head of North Sulawesi Police Department, Head of the Alumni Association of the Faculty of Agriculture, Regent of North Minahasa, Deputy Major of Tomohon, Deputy Regent of Minahasa, Deputy Regent of Mitra, Regional Leadership Coordination Forum of North Sulawesi, Chair of Manado Family Welfare Movement, Treasurer of the Association Alumni of the Faculty of Agriculture, Chair of the Sam Ratulangi University Senate and Chair of the Faculty of Agriculture Senate, Dean of Faculty of Agriculture Sam Ratulangi University, Professors of Unsrat as well as lecturers of the Faculty of Agriculture Sam Ratulangi University, Manado. *(ICC News)*

KARA WINS INDONESIA ORIGINAL BRAND AWARD AGAIN

At the end of 2022, KARA Indonesia won the Indonesia Original Brand award which was initiated by SWA Magazine in collaboration with Business Digest.

The Indonesia Original Brand Award is an award event dedicated to original Indonesian brands that have received positive feedback in terms of satisfaction, loyalty and level of brand advocacy, based on customer evaluations.

Receiving two prestigious awards at the same time on November 22, 2022, in the Coconut Cream and

Coconut Cooking Oil categories, being selected as one of the winners in the Indonesian Original Brand segmentation shows KARA's real commitment as a pioneer in the coconut derivative product industry in Indonesia, which continues to grow rapidly and improve performance so that it becomes a choice in Indonesian society.

Sambu Group Corporate Communication Manager Dwianto Arif expressed his gratitude for the awards received for KARA Indonesia in these two categories for the community, because they remain the first choice, as the original Indonesian brand and remain the choice of the Indonesian people to this day.

This achievement is also a benchmark for the success of Sambu Group, a KARA producer in managing the company's brand performance, to contribute to the Indonesian coconut ecosystem.

Both the Coconut Cream (Coconut Milk) and Coconut Cooking Oil (Coconut Cooking Oil) categories, KARA received the title as CHAMPION, aka the highest score in its category.

"This award will also continue to trigger us to maintain the quality of each of KARA's products. And of course it is a challenge for KARA to continue to be able to maintain this achievement going forward. And continue to present the best and quality coconut derivative products for loyal customers," said Dwianto Arif.

KARA also dedicated this award to all Indonesian coconut farmers. This is because KARA is produced from the best coconuts that come from coconut farmers.

The interdependence relationship between KARA and coconut farmers has created a positive synergy for the product. "Thank you Indonesian coconut farmers, thank you loyal KARA customers," concluded Dwianto Arif. *(Kontan)*

ICAR-CPCRI DEVELOPS HIGH-YIELDING VARIETY OF COCONUT

The Indian Council of Agricultural Research (ICAR) - Central Plantation Crops Research Institute (CPCRI), Regional Station, Kayamkulam, Kerala, India, has developed a high-yielding variety of coconut.

Named Kalpa Vajra (to commemorate the platinum jubilee of the regional station), the new variety, meant specifically for the root (wilt) disease prevalent tract, has an annual average yield of 80.1 nuts/palm. While the healthy palm produces on an average 158 nuts per palm a year, the diseased palms gives an average yield of 65 nuts.

Kalpa Vajra was recommended by the All India Coordinated Research Projects (Palms) for release in September. Officials of the ICAR-CPCRI, Regional Station, Kayamkulam, say the Central Variety Release Committee would soon notify the release of Kalpa Vajra.

It is after a gap of 10 years that the ICAR-CPCRI is recommending a variety for release specifically for the root (wilt) disease prevalent tract, says P. Anithakumari, head, ICAR-CPCRI, Regional Station, Kayamkulam.

The ICAR-CPCRI had earlier released three coconut varieties — Kalparaksha (2008), Kalpasree and Kalpa Sankara (both in 2012).

The Kalpa Vajra variety of coconut has been produced by crossing high-yielding and root (wilt) disease-free West Coast Tall (WCT) palms. The parental palms for crossing have been selected from farmer's plots located in 'hotspots' of root (wilt) disease after serological testing.

Regi Jacob Thomas, principal scientist, ICAR- CPCRI, Regional Station, says they hope to begin largescale distribution of Kalpa Vajra seedlings to farmers in 2025.

The regional station has collaborated with three grama panchayats — Pathiyoor and Devikulangara in Alappuzha and Oachira in Kollam — for mass production of the elite WCT and Kalpa Vajra seedlings through the modified ground pollination technique developed by the ICAR-CPCRI.

"Advantages of the modified ground pollination technique include gender neutrality and reduction in the cost of hybrid seed nut production to the tune of 50%. Using this technique means dependence on skilled climbers is limited for emasculation, bagging

and bag removal since the pollen application (for modified ground pollination) is managed from the ground itself. Modified ground pollination resulted in an average fruit setting of 25%, which is comparable to the setting observed upon normal assisted pollination in coconut," Mr. Thomas says. *(The Hindu)*

MALAYSIA TO BOOST COCONUT PRODUCTION BY 50 PERCENT NEXT YEAR

The Ministry of Agriculture and Food Industries (MAFI) aims to increase coconut production for the domestic market by 50 percent next year from 2020 level. Agriculture Department director-general Datuk Zahimi Hasaan said the target was in line with the increase in coconut-based products.

He said this to some 300 delegates of the 50th International Cocotech Conference and Exhibition who went on a field trip to the Jorak Agriculture Centre on November 11 which MAFI hosted. At the Center, the delegates were shown the methods of coconut breeding, seeding, planting and a mini exhibition of various coconut food and non-food products. The Center features a Smart irrigation system with Internet of Things (IoT).

Zahimi said in 2020, coconut plantation in Peninsular Malaysia was 55,573 hectares with production of 451,691 metric tons. Moreover, he noted that the current coconut market is only focused on the domestic market with 70 percent involving the production of coconut-based products, although there are plans in the future to market them in the international markets. *(UCAP Bulletin)*

AGRICULTURE MINISTRY ACQUIRES 10,000 BRAZILIAN DWARF COCONUT SEEDNUTS TO PROMOTE INDUSTRY

In an effort to stimulate the economy, the Belizean Ministry of Agriculture, Food Security, and Enterprise (MAFSE) has acquired 10,000 Brazilian dwarf coconut seednuts.

"We have begun our efforts to diversify agriculture in the North by planting 10,000 seednuts of the Brazilian dwarf coconut." We are collaborating with the Ministry of Agriculture and the SIRDI, as stated by MAFSE Minister Jose Abelardo Mai.

Mai stated that the seednuts were acquired from Sergio Marroquin's Blue Creek farm.

According to Breaking Belize News, the Brazilian dwarf coconut is in high demand due to its high yield and high-quality water production.

The Brazilian dwarf coconut seednuts were acquired earlier this week and are currently being planted at the SIRDI station in Buena Vista, Corozal, and the Yo Creek agriculture station in Orange Walk, Belize. The Ministry stated that the seedlings will be offered at a reasonable price to farmers interested in producing coconut water, especially in northern Belize, at the beginning of the following year. *(Breaking Belize News)*

INDONESIAN MINISTRY WILL CONSTRUCT A COCONUT PROCESSING PLANT IN THE MINAHASA DISTRICT

The Ministry of Cooperatives and SMEs will construct a production facility to process coconut goods in the South Minahasa District of North Sulawesi Province. Eventually, cooperatives will operate the production house to expedite the downstream distribution of coconut products owned by farmers.

Teten Masduki, the Minister of Cooperatives and Small and Medium-Sized Enterprises, stated that the establishment of a production house was a significant step towards the downstream processing of products, as farmers could not independently process products due to the high cost of the necessary technology. He noted that, if successful, the government will likely construct similar production facilities in other regions of the country, each adapted to the local products.

The minister stated that coconut production has not yet directly benefited small farmers. He gave the example of converting the entire nut, which sells for Rp2,000, into virgin coconut oil, which may then be sold for Rp12,000 per unit. Similarly, he underlined the necessity of

utilizing additional coconut pieces for added value, such as coconut husk processed into coir and coir fiber, coco peat, and coconut shells for charcoal briquettes. *(UCAP Bulletin)*

TAMIL NADU IS A LEADER IN COCONUT PRODUCT EXPORTATION

Tamil Nadu is a prominent supplier of coconut byproducts such as activated carbon, coconut oil, and coconut shell charcoal, Indian Agriculture Minister Narendra Singh Tomar said.

Speaking at a farmers' meeting held by the Coconut Development Board, he said 4.44 lakh hectares was under coconut cultivation in the State (2.11 million acre in the country), with productivity of 11,526 nuts per hectare, which was better than the national average of 9,123 nuts per hectare. Of this, 88,467 hectares was under coconut in Coimbatore district.

Tamil Nadu is leading in coconut processing operations with a significant number of units making activated carbon, virgin coconut oil, packaged tender coconut water, etc. Globally, India is positioned third in the overall area under coconut farming and has 31% of the annual world coconut production. Export of coconut products, excluding coir products, exceeded ₹3,236.83 crore last financial year, marking 41% rise over the previous year. Activated carbon, coconut oil, dried coconut, frozen grated coconut, dehydrated coconut, fresh coconut and virgin coconut oil are the key coconut goods exported from India, he said.

M.R.K. Paneerselvam, Minister for Agriculture and Farmers' Welfare, said the State had so far procured 25,000 tonnes of copra from farmers through the marketing committee at 41 places for ₹105.90 a kg.

The Central government has allowed buying of 50,000 tonnes. The State is willing to acquire copra throughout the year provided the Union government permits and it should boost the procurement price to ₹150 a kilogram, he said. The State government will research coconut growers' requests for coconut oil to be supplied to PDS stores. However, strategies to increase the shelf-life of coconut oil should be studied, he noted.

The Coconut Development Board, according to Horticulture Commissioner Prabhat Kumar, administers ten programs to promote value addition, quality seed sowing, etc. The country's 12 clusters, including the banana cluster at Theni, Tamil Nadu, are being developed by the Horticulture Department.

Mr. Tomar met farmers of the Velliangiri Uzhavan, a farmer producer organisation, during his visit to Isha Yoga, and later met farmers of FPOs in Pollachi. *(The Hindu)*

Statistics

Table 1. WORLD Exports of Coconut Oil, 2016–2022 (MT)

COUNTRY	2016	2017	2018	2019	2020	2021	2022[F]
A. APCC Countries	**1,530,193**	**1,584,413**	**1,805,750**	**2,046,920**	**1,687,810**	**1,730,115**	**1,986,163**
F.S. Micronesia	-	87	57	-	-	-	-
Fiji	1,779	1,957	3,261	2,487	2,533	1,460	2,160
India	28,816	11,726	6,831	7,828	11,096	14,445	28,145
Indonesia	602,318	510,441	675,138	610,812	577,645	611,452	695,248
Jamaica	4	6	5	6	9	0	5
Kenya	252	55	36	44	55	655	251
Kiribati	2,220	1,359	3,493	3,561	2,517	1,829	2,636
Malaysia	115,969	102,735	121,914	223,077	203,362	186,608	137,737
Marshall Islands	1,239	1,524	2,229	1,085	1,115	402	708
Papua New Guinea	17,081	15,740	12,566	20,975	17,732	10,099	16,269
Philippines	727,827	912,631	951,320	1,146,642	842,533	881,085	1,276,349
Samoa	491	116	141	424	8	116	183
Solomon Islands	1,487	5,515	5,432	4,561	5,272	5,225	5,019
Sri Lanka	7,094	6,310	4,606	4,056	5,180	3,825	4,805
Tonga	-	-	-	-	-	-	-
Thailand	21	1,331	1,268	1,337	1,745	1,686	1,016
Vanuatu	6,056	2,543	3,669	3,498	1,367	711	274
Vietnam	17,539	10,337	13,784	16,527	15,641	10,516	9,372
B. Other Countries	**362,947**	**369,896**	**317,881**	**317,408**	**341,233**	**330,306**	**329,649**
TOTAL	**1,893,140**	**1,954,309**	**2,123,631**	**2,364,328**	**2,029,043**	**2,060,421**	**2,315,812**

F: Forcasted figures; Source: ICC, ITC and Oil World

Table 2. Prices of Coconut Products and Selected Vegetable Oils, January-December 2022 (US $/MT)

	2022											
Products	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Copra	1,039	1,143	1,221	1,203	1,010	966	797	685	662	605	652	641
Coconut Oil	2,033	2,153	2,269	2,097	1,720	1,688	1,517	1,364	1,261	1,094	1,167	1,155
Copra Meal[2]	214	232	236	235	233	238	248	243	243	282	301	302
Desicc. Coconut[2]	2,557	2,721	2,704	2,690	2,631	2,408	2,307	2,021	1,984	1,984	1,957	1,947
Mattress Fiber[1]	124	131	106	78	70	64	62	62	60	49	39	48
Shell Charcoal[2]	407	407	406	397	393	385	364	365	371	364	373	369
Palm Kernel Oil	2,171	2,425	2,378	2,037	1790	1512	1265	1217	1219	1018	1,062	1,067
Palm Oil	1,358	1,522	1,813	1,719	1714	1573	1203	1095	1048	1043	946	940
Soybean Oil	608	669	720	723	720	675	618	633	643	623	1,652	1,409

1: Sri Lanka (FOB); 2: Philippines (FOB); r: revised; Source: ICC and Oil World

Statistics

Table 3. World Oil Balance 2020-2022 (million tons)

Oil/Year	Jan/Dec 2022[F]	Jan/Dec 2021	Jan/Dec 2020
Palm Oil			
Opening Stocks	12.61	12.35	13.63
Production	78.33	76.01	74.02
Imports	47.92	51.16	50.30
Exports	48.96	50.29	50.69
Disappear	75.27	76.61	75.92
Ending Stocks	14.63	12.61	12.35
Soybean Oil			
Opening Stocks	7.00	6.39	5.89
Production	60.20	60.15	58.69
Imports	12.61	13.61	12.97
Exports	12.81	13.72	12.91
Disappear	60.73	59.43	58.25
Ending Stocks	6.27	7.00	6.39
Groundnut Oil			
Opening Stocks	0.37	0.28	0.28
Production	4.66	4.41	4.20
Imports	0.30	0.41	0.38
Exports	0.32	0.35	0.43
Disappear	4.68	4.37	4.16
Ending Stocks	0.33	0.37	0.28
Sunflower Oil			
Opening Stocks	3.03	3.24	3.39
Production	19.48	18.97	21.31
Imports	11.34	11.07	13.62
Exports	11.25	11.10	13.62
Disappear	19.34	19.16	21.46
Ending Stocks	3.24	3.03	3.24
Rapeseed Oil			
Opening Stocks	3.43	3.23	3.06
Production	26.50	26.93	25.77
Imports	5.34	6.57	6.01
Exports	5.46	6.28	6.12
Disappear	26.68	27.01	25.49
Ending Stocks	3.13	3.43	3.23
Cotton Oil			
Opening Stocks	0.35	0.35	0.36
Production	4.38	4.44	4.62
Imports	0.14	0.13	0.15
Exports	0.15	0.13	0.16
Disappear	4.37	4.43	4.61
Ending Stocks	0.35	0.35	0.35

Oil/Year	Jan/Dec 2022[F]	Jan/Dec 2021	Jan/Dec 2020
Palm Kernel Oil			
Opening Stocks	1.21	1.24	1.35
Production	8.22	7.98	7.89
Imports	2.94	3.33	3.48
Exports	3.10	3.24	3.48
Disappear	7.89	8.10	8.00
Ending Stocks	1.39	1.21	1.24
Coconut Oil			
Opening Stocks	0.36	0.44	0.53
Production	3.16	2.75	2.63
Imports	2.37	2.00	1.91
Exports	2.29	1.92	1.90
Disappear	3.13	2.90	2.74
Ending Stocks	0.47	0.37	0.44

Source: ICC and Oil World *F: forecast figures*

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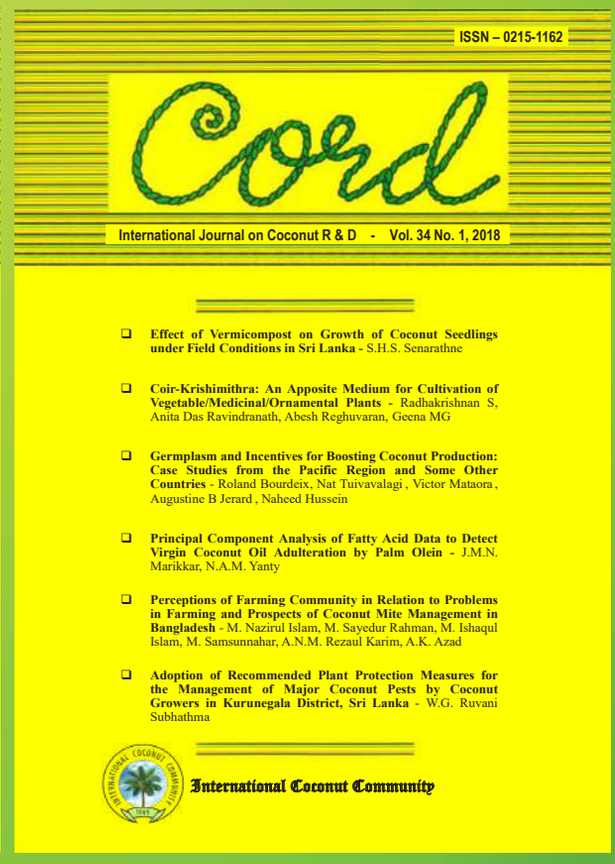

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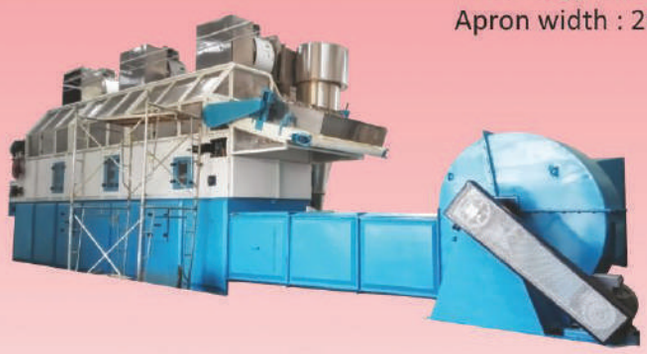

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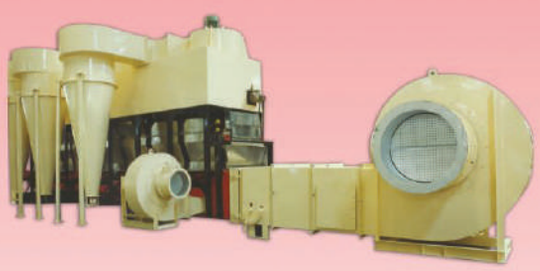

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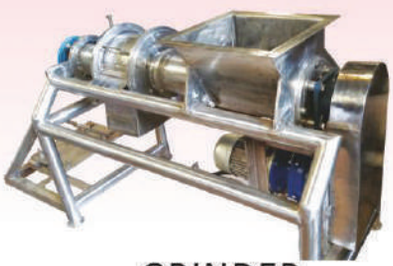

GRINDER

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BLANCHER

Output Capacity :
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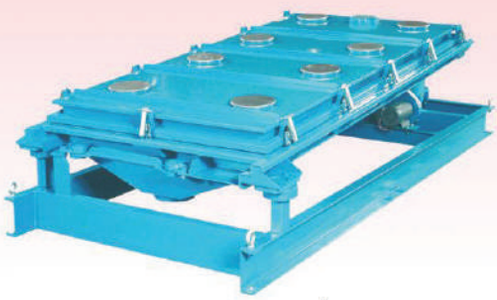

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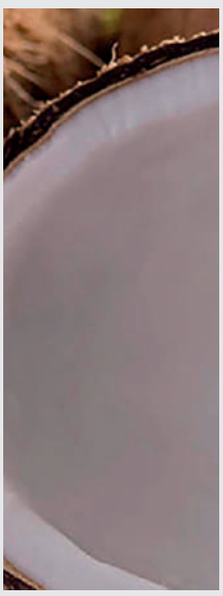

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