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From Tree to Tummy: Coconut for Optimal Gut Health

The ICC secretariat and its community across 21 member countries are supported by the Scientific Advisory Committee for Health (SACH), which includes medical doctors, biochemists, nutritionists, and relevant experts from various countries. They are a voluntary group that provides technical and policy assistance to the ICC on health and coconut product-related aspects. Scientific research has shed light on the increasing prevalence of gut health issues, which are affecting millions of people worldwide. These conditions not only disrupt digestion but also influence overall health, mood, and immune function. Maintaining a healthy gut is crucial for fostering a balanced microbiome, aiding digestion, enhancing immune response, and even impacting mental health through the gut-brain axis.

The gut microbiome, an intricate ecosystem of trillions of microorganisms, plays a vital role in our overall well-being, influencing everything from digestion to mood via the gut-brain connection. Coconuts, a delightful tropical fruit, have been scientifically recognized for their ability to significantly improve gut health as experienced by many individuals. USDA Food Data Central reported that the dry coconut meat is a complete natural food: proteins (7%), carbohydrates (22%), fiber (16%) and oil (56%). Research has found that coconuts are rich in both soluble and insoluble dietary fibers. Soluble fibers, like inulin and resistant starch, act as prebiotics, nurturing beneficial gut bacteria and promoting a thriving microbiome. Insoluble fibers help regulate bowel movements, facilitate efficient digestion, and promote overall gut health. Furthermore, these fibers slow sugar absorption, which aids in maintaining a sense of fullness and supports healthy blood sugar levels.

Beyond fiber, studies indicate that coconuts are a rich source of medium-chain triglycerides (MCTs), which selectively promote the growth of beneficial probiotic microbes such as Bifidobacterium and Lactobacillus. Along with potent antioxidants like polyphenols, coconuts help preserve a healthy gut lining and shield against oxidative stress. The anti-inflammatory effects of coconut's polyphenols and medium-chain fatty acids soothe the digestive tract, further supporting gut health by reducing excessive inflammation.

Incorporating coconut and its products into human diet has been suggested as a delicious way to enhance gut health. Scientific findings support using virgin coconut oil for its MCT benefits. Adding shredded coconut, desiccated coconut, coconut flour, or coconut meat to smoothies and baked goods can increase the intake of gut-nourishing fibers. Coconut-based yogurt could also provides a probiotic and prebiotic-rich snack, while coconut kefir combines the benefits of coconut and kefir cultures into a gut-friendly beverage. Overall, the diverse nutrients in coconuts, including prebiotics, antioxidants, and anti-inflammatory compounds, work synergistically to cultivate a balanced and thriving gut microbiome. By fostering beneficial bacteria, reducing inflammation, and supporting digestive functions, coconuts are scientifically validated as excellent products of optimal gut health.

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

Coconut Oil for Oral Health
A Discussion of Research Results

Faizal C. Peedikayil[1]

Saliva is one of the most important components in the oral environment and an integral component of oral health. It plays a critical role in oral homeostasis by modulating the ecosystem within the oral cavity. Its main functions are lubrication, protection, buffering action and clearance, maintenance of tooth integrity, taste perception, antibacterial activity, and digestion. Saliva also plays an important role in the development and maintenance of plaque biofilm which is attached to the tooth surface. Proteins from saliva enable the biofilm to attach to the tooth's surface which leads to harboring of microorganisms, paving the way for various oral diseases. Therefore, changes in the physicochemical properties of saliva can determine the health status of an individual. It is emerging as a biomarker for many oral and systemic diseases (Lai et al., 2019; Sreebny, 2000).

Even though mechanical methods of tooth cleaning are the most accepted and reliable method of oral health maintenance, chemotherapeutic agents are used as adjuvant to plaque control. Chlorhexidine is a gold standard among the various chemotherapeutic agents and is a main constituent in various oral hygiene aids such as mouthwashes. But chlorhexidine is known to have some side effects such as staining and altered taste sensation (James et al., 2017).

Coconut oil pulling or swishing is a procedure mentioned for various diseases by ancient Indian ayurvedic physicians such as Charaka and Sushrutha. In this procedure, a certain amount of oil is held in the mouth for some time and swished all over the oral cavity till it turns milky white and spitted out. This procedure in Ayurveda is termed as Kavala Graha or Gandoosha (Asokan et al., 2009). The Sanskrit textbook Charaka Samhita, in

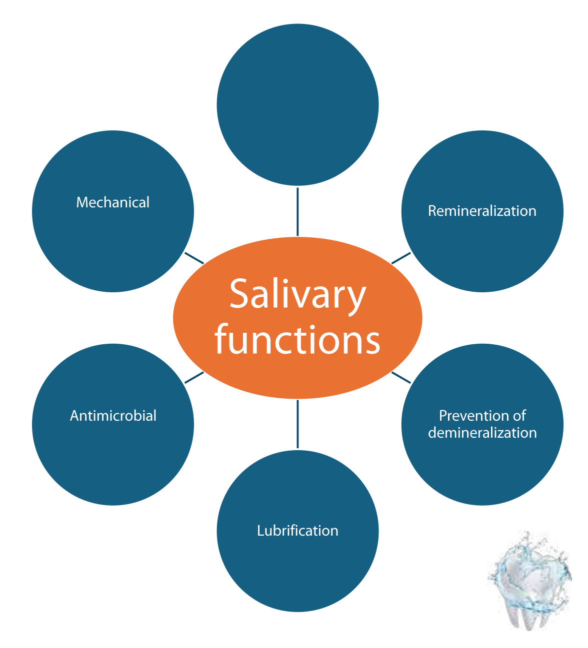

Figure 1. Salivary functions

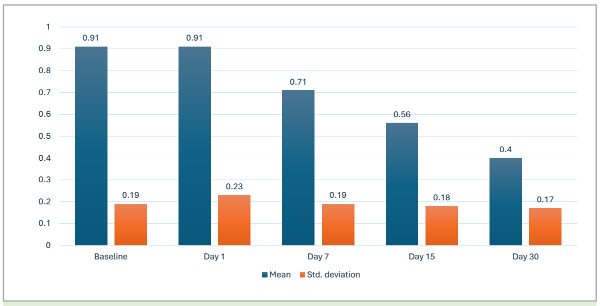

Figure 2. Plaque index scores (Peedikayil et al., 2015)

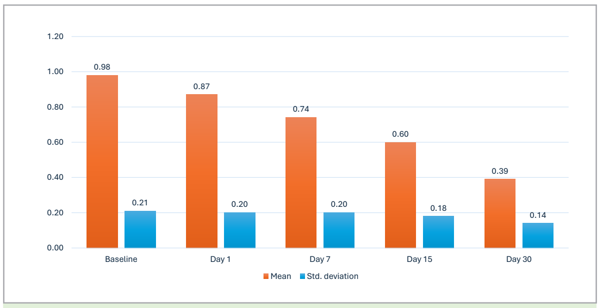

Figure 3. Gingival index scores (Peedikayil et al., 2015)

its 5th Chapter, quotes that oil pulling reduces the chances of oral diseases. Later in the 20th century Dr. F. Karach, a Russian scientist, popularized this procedure and described it as oil-pulling in modern literature (Peedikayil, 2019). Over a decade, studies have been conducted at our institution on coconut oil in aspects of improving oral health and also as treatment aids. Our studies focussed mainly on the oral anti-microbial property, oral anti-inflammatory property, and the effect of oil pulling/oil swishing on salivary buffering capacity, the effect of oil pulling/ oil swishing on the total antioxidant capacity of saliva.

LITERATURE REVIEW OF THE PUBLISHED ARTICLES

Ten research studies conducted at Kannur Dental College on coconut oil were published in various scientific journals. A review of literature of those articles shows the effects of coconut oil on oral health. In vitro studies were conducted to check its efficacy on gingivitis, anti-plaque effectiveness. anticariogenic potential, anti-oxidant capacity and buffering capacity.

Peedikayil et al. (2015) conducted a pilot study to evaluate the effect of coconut oil pulling/oil swishing on plaque formation and plaque-induced gingivitis. This prospective interventional study was done among 60 age-matched individuals with plaque-induced gingivitis. Oil pulling was included in their oral hygiene routine for a period of one month. Plaque and gingival indices of the subjects were assessed at baseline and 1, 7, 15 and 30 days statistically significant decrease in the plaque and gingival indices were noticed from day 7 and the scores continued to decrease during the period of study. The study concluded that oil pulling using coconut oil could be an effective adjuvant procedure in decreasing plaque formation and plaque-induced gingivitis. A similar study (Peedikayil et al., 2021) checked the effectiveness of virgin cooking oil and refined coconut oil (RCO) on plaque-induced gingivitis. The study also focussed on the taste perception of virgin coconut oil and regular cooking coconut oil when used for oil pulling. The study showed anti-inflammatory properties with significant differences in gingival index scores across all the study groups on the 15th day and 30th day in both groups. The study also checked for the perceptions of the subjects using the Hedonic Scale on the taste and odor. The Hedonic rating scale showed that virgin coconut oil (VCO) has better taste, odor, and texture in the mouth than refined cooking coconut oil (RCO).

A study (Peedikayil et al., 2016) was done to check the effectiveness of *Streptococcus mutans* count in saliva and plaque. *Streptococcus mutans* is one the common microorganism causing dental caries. Fifty participants were asked to routinely perform oil swishing with coconut oil and rinse every morning after brushing for 2–3 min for 30 days. *S. mutans* counts in plaque and saliva were determined using the Dentocult SM Strip Mutans test on day 1, day 15, and day 30. The results showed that there is a

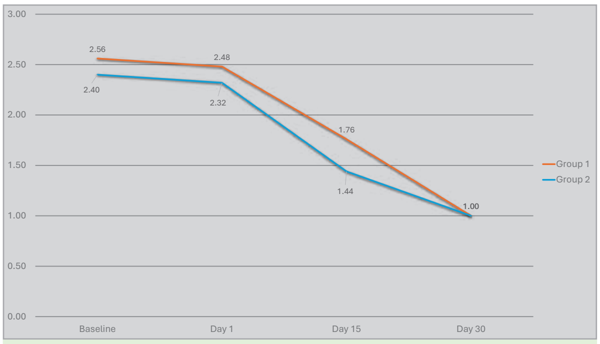

Figure 4. Plaque S. mutans *count (Peedikayil et al., 2022)*

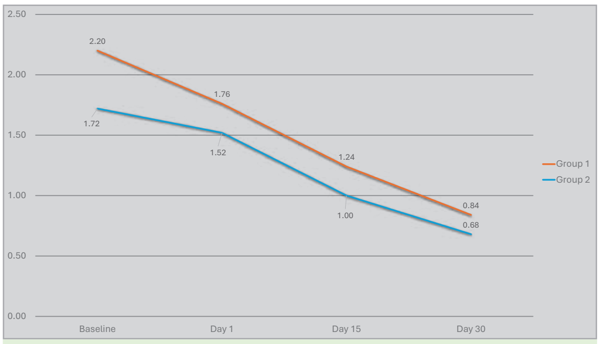

Figure 5. Salivary S. mutans *count (Peedikayil et al., 2022)*

statistically significant decrease in *S. mutans*. count in the coconut oil group from baseline to 30 days which denotes that coconut oil pulling has the same efficacy in reducing the *S. mutans* count.

Another study (Peedikayil et al., 2022) was conducted on the effect of oil pulling on salivary buffering capacity and total antioxidant capacity. The study period was one month and the subjects were advised to do oil pulling in adjuvant to tooth brushing. The unstimulated saliva was collected from the subjects and the samples were evaluated at time intervals of baseline, 15th day and 30th day for its buffering capacity and total antioxidant capacity. The buffering capacity was evaluated using Ericcsons method, which is considered as the gold standard in salivary buffering capacity evaluation. It measures salivary pH value after adding a certain amount of HCl to the collected saliva. The antioxidant capacity was measured using α, α-diphenyl-β-picrylhydrazyl (DPPH) scavenging assay. The DPPH free radical scavenging method offers the first approach for evaluating the antioxidant potential from biological sources. The results showed a statistically significant increase in salivary buffering capacity and total anti-oxidant capacity following coconut oil pulling.

Few invitro studies were conducted to check the antimicrobial efficacy of coconut oil. In a significant study, the anti-fungal effect of coconut oil against candida albicans (Shino et al., 2016) was evaluated.

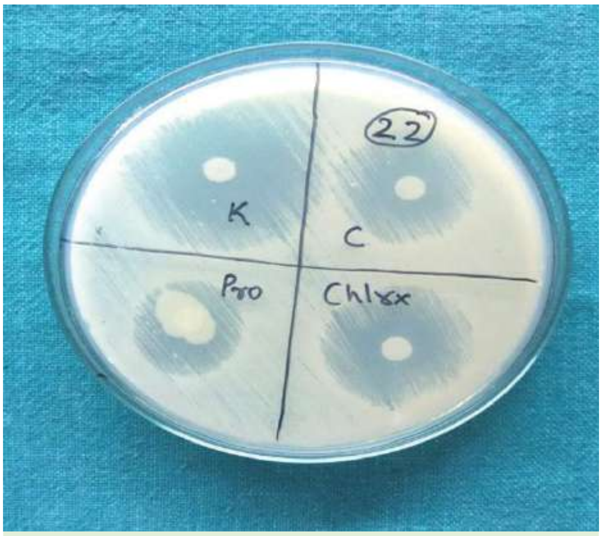

Figure 6. Zone of inhibition observed around the disc (Shino et al., 2016)

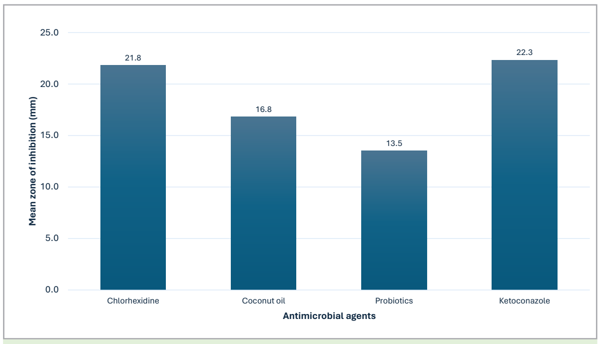

Figure 7. Mean of zone of inhibition of the antimicrobial agents against Candida albicans *(Shino et al., 2016)*

Candida was isolated from the samples collected from the tooth surface with early childhood caries. The zone of inhibition was measured by disc diffusion method and the study concluded that, coconut oil has significant antifungal activity which is comparable with ketoconazole, an antifungal agent.

Medium-chain fatty acids (MCFAs) form the major constituent of coconut oil. They are biologically inert sources of energy and is beneficial for health and immunity. The Antimicrobial efficacy of various Medium-chain fatty acids (MCFAs) was done (Devan et al., 2019). The study compared its effect against *E. faecalis*, which is the most common organism in root canals. The actionod MCFAs such as Lauric acid (LA), decanoic acid (DA), octanoic acid (OA), were tested in this study. These MCFAs were added as solution to the E. fecalis strains on Mueller - hinton agar. The antibacterial activity was assessed by the zone of inhibition. The study concluded that, lauric acid (LA), exhibited antimicrobial efficacy against *E. faecalis*. Lauric acid constitutes the MCFAs in coconut oil. Another study (Devan et al., 2019), was done to evaluate the antimicrobial efficacy of MCFAs when used as irrigants against *E. faecalis* and *C.*

Table 1. MIC values of test materials against Enterococcus faecalis *(Devan et al., 2019)*

Concentration (µg)	*Enterococcus faecalis*					
	OD_{630}			Percentage inhibition		
	LA	DA	OA	LA	DA	OA
Control	0.306	0.306	0.306	0	0	0
0.25	0.1706	0.1993	0.1543	44.61028192	35.09121	50.01658
0.5	0.1549	0.1795	0.1439	49.81757877	41.65837	53.466
1	0.1541	0.1586	0.1323	50.08291874	48.59038	57.31343
5	0.1459	0.1184	0.132	52.8026534	61.92371	57.41294
10	0.136	0.113	0.1068	56.08623549	63.71476	65.77114
MIC value (µg)				2.5794	3.27604	0.24

LA=Lauric acid, DA=Decanoic acid, OA=Octanoic acid, MIC=Minimum inhibitory concentration, OD=Optical density

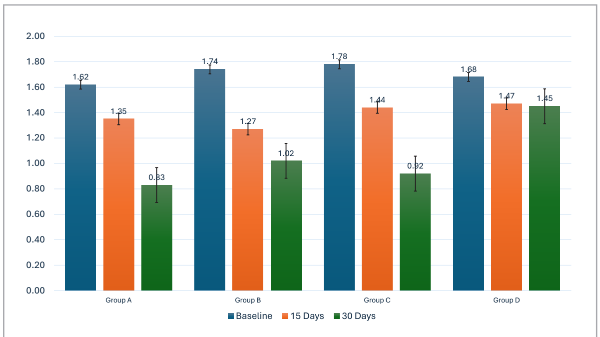

Figure 7. Modified Gingival Index at baseline, 15 and 30 days

albicans. Paper point samples were taken from root canal walls and transferred into Brain Heart Infusion broth and potato dextrose broth and placed in an incubator at 37°C. The appearance of turbidity was checked at 24, 48, 72, and 96 hours using direct contact test. The study concluded that MCFAs show promising antimicrobial efficacy against *E. faecalis* and *C. albicans*. The antifungal efficacy of coconut oil as a root canal medicament was evaluated in another study (Paul et al., 2020). The results on 7th day showed that coconut oil cream exhibited antifungal activity, but other materials used in the study such as calcium hydroxide, tri-antibiotic paste, Odontopaste, Ledermix® paste, Pulpdent® paste, showed better antimicrobial efficacy.

A surface accumulation of debris called a smear layer is formed in the root canal on the dentine during instrumentation. A study (Purakkal et al., 2020) was done to evaluate the smear layer removal efficacy of coconut water. Before and after irrigation of the root canal with irrigants, the teeth were evaluated and assessed for the amount of smear layer present under a field-emission scanning electron microscope. The study concluded that coconut water showed smear removal efficacy of the root canals.

Zinc oxide in combination with eugenol is commonly used as temporary filling material and also as a root canal filling material in primary teeth. An in vitro study (Peedikayil et al., 2021) was conducted to check the antimicrobial efficacy of Zinc oxide with various other oils against E. fecalis, which is the most prevalent root canal pathogen. The samples collected from infected root canals were subjected to microbiological analysis, and the efficacy of the medicaments were evaluated with the zones of inhibition. The study concluded that the coconut oil when mixed with zinc oxide was effective against *E. faecalis*.

DISCUSSION

As oil is swished in the mouth, the mechanical shear forces exerted on the oil lead to its emulsification and the surface area of the oil is greatly increased. The oil film thus formed on the surface of the teeth and the gingiva can reduce plaque adhesion and bacterial co-aggregation. The alkalis in the saliva can react with the oil leading to saponification and the formation of a soap-like substance which can reduce the adhesion of plaque. Lauric acid in medium-chain fatty acids can enhance its anti-inflammatory effect in the oral cavity (Lai et al., 2019). The anti-inflammatory action of coconut oil in the oral cavity may be attributed to the action of the lipase enzyme present in the saliva, which is responsible for the breakdown of triglycerides to release various medium-chain fatty acids. Lauric acid, which is a main MCT in coconut oil, in conjugation with salivary lipase produces monolaurin. Monolaurin has an antimicrobial action that indirectly helps with anti-inflammatory effect and reduces the plaque-related gingivitis (Kaliamoorthy et al., 2018; Peedikayil et al., 2015, 2016; Singla et al., 2014).

S. mutans is considered as the most cariogenic of the oral microflora. It colonizes the tooth surfaces and produces significant amounts of extra and intracellular polysaccharides and is responsible for the initial stage of oral biofilm formation and carious lesions. Chemotherapeutic agents can be used as an adjuvant in the reduction of *S. mutans* count. The antimicrobial effect of coconut oil was first reported by Hierholzer and Kabara. Coconut oil is a rich source of beneficial medium-chain fatty acids (MCFAs), particularly, lauric acid, capric acid, caprylic acid, and caproic acid (Dayrit et al., 2011; Deen et al., 2021). Electron microscopic image showed that 15 minutes of exposure to monolaurin, a monosaccharide present in coconut oil, caused cell shrinkage and cell disintegration of gram-positive cocci (Sezgin et al., 2019). The glycolipid compound sucrose monolaurate, which is produced by the saponification of coconut oil with saliva, has an anticaries effect due to reduced glycolysis and sucrose oxidation on *S. mutans*, and thus preventing the adhesion of plaque. Acids produced by cariogenic bacteria are neutralized by the natural buffers present in saliva like, phosphates, bicarbonates, proteins, mucins and the oxidative stress is balanced by the antioxidant systems in saliva, and also by antioxidant enzymes like salivary peroxidases, catalase, glutathione reductase and non-enzymatic antioxidants like uric acid, albumin, polyphenols, lactofferin (Dimzon et al., 2011).

The increase in salivary buffering capacity with coconut oil pulling may be due to, the plaque control effectiveness and antimicrobial activity, which reduces the bacterial load and thereby increasing the pH. The reason attributed could be due to the improvement in oral hygiene following plaque control (Ripari et al., 2020). Since there is a paucity of literature regarding the alteration in salivary buffering capacity following oil-pulling therapy, the reason behind the increase in buffering capacity cannot be explained precisely.

In our study, regarding anti-oxidant and free radical scavenging activity, the scavenging activity was increased with virgin coconut oil pulling from baseline to the 15^{th} and 30^{th} day. The reason may be due to the fact that virgin coconut oil could activate the exogenous antioxidants in saliva and has a topical effect in the oral cavity, thereby increasing the antioxidant activity of saliva. Another reason for antioxidant action may be due to the presence of phenolic compound like protocatechuic, vanillic, caffeic, syringic, ferulic and p-coumaric acids in coconut oil (Peedikayil et al., 2022; Williamson, 2017).

CONCLUSION

Our studies have shown that there is a definitive anti-inflammatory, antibacterial and anti-oxidant capacity for coconut oil gargling or pulling. Coconut oil or its constituents can be added to oral health products so that oral chemotherapeutic materials are replaced by greener alternatives in the future.

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Coconut Pests and Diseases Throughout the Pacific: Management of Outbreaks and Mitigation of New Incursions

Carmel A. Pilotti, Mark Ero, Fereti Atumurirava, Amit Sukal and Visoni Timote

The Pacific Island countries span a vast area of the Pacific Ocean covering approximately 30 million square kilometres of which 98% is ocean. Coconut (*Cocos nucifera*) is an indigenous species in the Pacific Islands growing optimally within the range of 23°N and 23°S of the equator and may have first reached many of the islands by natural dispersal thousands of years ago although coconuts may only survive up to 4 months on seawater (Chan & Elevitch, 2006). A strong case has been presented for long- distance movement of coconut seeds by flotation in the sea, although present wind and current patterns in the Pacific do not favor eastward movement from the likely center of origin in the Indonesia - New Guinea region (Levison et al., 1972). It is possible that these patterns were quite different in the past however, evidence suggests the pantropical dissemination of coconuts were assisted by humans through historical navigational routes from the West to the Eastern Pacific and subsequently to the Pacific coasts of Latin America (Gunn et al., 2011).

The most widespread crop in the Pacific islands is probably coconut, as the plant can grow in unfavorable atoll environments. Coconut palms were first cultivated on a 'plantation' scale in the mid- to late1800s following an upsurge in demand in Europe for oil suitable for soap-making. Since then, coconuts have continued to be important sources of food and income for Pacific Island communities, although production has somewhat declined since the end of WW2 when alternative vegetable oils began trading. It is estimated that over 600,000ha of coconut are planted in the Pacific region, with upwards of 70 million trees (based on average planting densities), probably in production, with the vast majority in smallholdings.

The majority of coconut pests and diseases in the Pacific region are similar to those found in Southeast Asia (SEA). For example, the coconut rhinoceros beetle (CRB, Oryctes rhinoceros), the coconut hispine beetle (Brontispa longissima), and bud rot, amongst others. A shortlist of minor and major pests and diseases of coconut in Pacific Island countries is provided in Table 1. Information for this list has been obtained from the SPC Pest List Database, CABI, PestNet, ICC and other references listed in the Bibliography. This list is not comprehensive, and other pests and pathogens may have been recorded in the different countries of the Pacific however, some records infer only association and clear pest status is not defined. Here, we present only those pests and pathogens that have had recent or past transient or ongoing outbreaks that may be of national or regional quarantine importance. It is also important to note that many of the minor pests listed in Table 1 (green shading) are well controlled by natural enemies and are usually of little or transient economic concern.

There are some diseases and pests that appear to be endemic or well established in some regions, such as the coconut stick insect Graeffea crouanii, Sexavae (multiple species of long-horned grasshoppers), coconut foliar decay virus (CFDV), Tinangaja disease and Bogia Coconut Syndrome (BCS) indicating that adaptation of local pests and diseases from other crops or plants is a reality and continued vigilance must be exercised. With increasing changes in environments due to deforestation, climate change effects such as droughts and El Nino events, it is anticipated that pest and disease problems in coconut and associated crops will be exacerbated, and novel techniques of management will be required to contain and control outbreaks in the future.

This paper highlights a selection of the pests of coconut that have had moderate to major impact in localized areas in the Pacific region, past and present, and the ongoing efforts to contain and manage threats and outbreaks in different countries and Territories.

PEST OF IMPORTANCE

Many of the pests recorded for Pacific Island countries have been associated with localized outbreaks and apart from the coconut rhinoceros beetle (CRB), knowledge on their history and present day distribution and spread is sketchy. Further advances in population genetics and studies of these pests may shed more light on the comparative importance of these pests.

The following narrative covers only those pests that have had significant impacts in the past in some countries and some that continue to have moderate impacts under management.

A. Coconut flat moth

Scientific name
Agonoxena argaula, *A. pyrogramma*.

Distribution
A. argaula is recorded from American Samoa, Cook Islands, Tokelau, Tonga, Tuvalu, Hawaii, Vanuatu, and Wallis and Futuna.

Another species, *A. pyrogramma* is found in the western Pacific islands of Guam, Federated States of Micronesia (FSM), Northern Mariana Islands, Papua New Guinea and Solomon Islands.

Alternative hosts
Other palm species, weeds.

Symptoms
The larvae of the flat moth eat mainly the lower surface of the frond leaflets. This results in eroded areas 1-2 mm wide and 2-3 cm long near the leaflet

*Figure 1. Coconut flat moth (*Agonoxena argaula*)*

Table 1. Some of the major and minor pests and diseases recorded on coconut in Pacific-island countries and Territories (Sources: ICC, CABI, SPC Pest List Database).

Pest/Disease	Kiribati	F. S. Micronesia	Fiji	PNG	Cook Islands	Guam	RMI	Samoa	Solomon Islands	Tonga	Tuvalu	Vanuatu	Niue	Tokelau	Wallis & Futuna	French Polynesia	American Samoa	New Caledonia	Nauru	Palau
Icerya seychellarum (Seychelles scale)		minor	minor		minor					minor		minor	minor					minor	minor	minor
Agonoxena argaula (coconut flat moth)	minor		minor		minor					minor					minor		minor	minor	minor	
Agonoxena pyrogramma		minor		minor		minor			minor											
Amblypelta cocophaga (coconut bug)				minor																
Amblypelta theobromae (coconut bug)				minor																
Amblypelta lutescens (banana spotting bug)				minor																
Aspidiotus destructor (coconut scale)		minor	minor			minor		minor	minor	minor	minor	minor		minor	minor	minor	minor		minor	minor
Axiagastus cambelli (Coconut spathe bug)*				minor					minor											
Brevipalpus phoenicis (false spider mite) *			minor	minor				minor	minor	minor										
Brontispa longissima (coconut hispine beetle)				?				major	major			major				minor	minor	minor	minor	
Graeffea crouanii (coconut stick insect)			minor		minor					minor					minor	minor	minor			
Heliothrips haemorrhoidalis (black tea thrips)	minor		minor	minor						minor		minor								
Oryctes rhinoceros (Coconut rhinoceros beetle CRB)			minor	major		major		major	major			minor								
Plesispa reichei (Coconut leaf beetle)																	minor			
Promecotheca caeruleipennis **(coconut leaf miner)			minor							minor										
Scapanes australis (rhinoceros beetle)				minor					minor											
Segestidae spp. (Sexava)***				minor																
Tirathaba rufivena (coconut spike moth)			minor					minor		minor								minor		
Diseases																				
Ca. Phytoplasma novaguinense (Bogia Coconut Syndrome, BCS)				major																
Cofodeviride (Coconut foliar decay virus, CFDV)												major								
Marasmiellus cocophilus (bole rot)									minor											
Tinangaja virus						major														
Phytophthora palmivora (coconut bud rot)		minor	minor	?	minor			minor	minor	minor		minor			minor			minor		

minor = Pest/disease of minor importance major = Pest/disease of major importance

* Not listed in SPC PLD? = not listed in SPC PLD for that country
** *P. papuana* – PNG; *P. opacicollis* – Vanuatu ***Only *Segestes unicolor* recorded for Palau and PNG in SPC PLD

mid-rib. The adult is 5-9 mm long; the female is yellowish brown, and the males have white stripes on the forewings. Eggs are laid on the underside of the leaflets, near the tips and along the midribs, singly or in rows. Larvae or caterpillars are green and up to 2 cm in length when mature. They spin a fine web and shelter under this, feeding on the top layers of the leaflets, parallel to the veins. Feeding areas turn light brown and are conspicuous. Pupae are formed above or below the leaflets or on undergrowth.

Impact

Occasionally, the flat moth is a serious pest of coconuts and other palms affecting up to 40% of the leaf surface during outbreaks. In trials in Fiji, a caged palm with 25% leaf damage recorded 20% reduction of nuts, although some researchers think this level of damage rarely occurs in the field. In general, it seems likely that heavy damage to coconut leaves reduces yields, but it is not clear what the effects are of low levels of damage over a long period. However, it is possible that the growth of seedlings may be slowed by heavy attack on the leaflets.

A. pyrogramma, is frequently parasitized by natural enemies and hence damage is much less than A. argauala. Both species are more abundant during periods of dry weather, possibly because of the impact of the weather on the natural enemies of the moths.

Detection
Characteristic long, thin, grey translucent patches appear on the leaflets where the larvae have fed. Larvae can usually be seen on the underside of leaflets under a thin web.

Management
Many insects have been introduced into countries of the region to control *A. argaula*; these are mostly wasp, braconids and chalcids (e.g. in Cook Islands, *Brachymeria* sp. and *Trichospilus diatraeae*) that attack larvae or pupae. Insect parasites have been sourced from Fiji, India, Indonesia, Papua New Guinea and Samoa. Ants are reported to destroy *A. argaula* pupae and may eat eggs. In Fiji, it is reported that an unidentified fungus destroyed a high proportion of the pupae, and also killed the larvae and adults. Although the natural enemies are not known in Solomon Islands, they are likely to be similar to those of *A. argaula*. A tachinid fly has been reared from *A. pyrogramma* in Solomon Islands, and Waterhouse and Norris 19) quotes others that "parasite introductions against *A. pyrogramma* have been successful", without giving details.

Studies in Cook Islands showed that on average, *Brachymeria* sp. parasitised about 50% whilst only 5% were attacked by *T. diatraeae*.

B. Coconut hispine beetle, coconut leaf hispa

Scientific name
Brontispa longissima.

Distribution
Asia, Southeast Asia, Oceania. It is recorded from American Samoa, Australia, French Polynesia, New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Vanuatu and Wallis and Futuna.

Note that another species, the Pohnpei coconut leaf beetle, *B. chalybeipennis*, is recorded from Marshall Islands; *B. mariana* from the Federated States of Micronesia and Northern Mariana Islands; and *B. palauensis* from Guam and Palau.

*Figure 2. Coconut hispine beetle (*Brontispa longissima*)*

Alternative hosts
Betel nut, sago palm, oil palm, and other palms

Management
Brontispa longissima is mostly under control by its natural enemies. *Tetrastichus Brontispae*, a wasp, was introduced successfully into the Russell Islands, Solomon Islands, in the 1930s and again in the 1960s. The wasp was subsequently introduced into Samoa in the 1980s from New Caledonia and was responsible for the initial decline of *Brontispa* at that time. Later, another wasp, *Chrysonotomyia* sp., was found attacking the larvae, which may be a native species. Both *T. brontispae* and *Chrysonotomyia* attack *Brontispa* larvae. Outbreaks of the pest in Asia have been brought under control by the introduction of *Secodes hispinarum*, also a larval parasitoid. Earwigs (*Chelisoches morio*) reportedly feed on the larvae of *Brontispa*, and some control is also achieved by application of *M. anisopliae*, which apparently causes high mortality.

Anecdotal evidence suggests that the Local Tall and Rennell Island tall varieties in Solomon Islands are more resistant to attack by *Brontispa* than introduced varieties.

Little is known of the other *Brontispa* species and their natural enemies.

C. Coconut leafminer, coconut leaf hispid

Scientific name
Promecotheca caerulipennis, *P. opacicollis*

Distribution
Promecotheca species are known from Indonesia, Philippines and Oceania and also distributed among Pacific Island countries. *P. caerulipennis* is

*Figure 3. Coconut leafminer (*Promotheca caerulipennis*)*

recorded from American Samoa, Federated States of Micronesia, Fiji, French Polynesia, Papua New Guinea, Samoa, Solomon Islands, Tonga and Wallis and Futuna.

P. opacicollis is recorded from Solomon Islands (Temotu Province), and Vanuatu. CABI records another species *P. papuana* Csiki in Papua New Guinea and Solomon Islands.

Alternative hosts
Betel nut, sago palm. It is not a pest of oil palm

Symptoms
The adults feed on the lower surface of leaflets, leaving narrow furrows and the larvae mine the leaflets, leaving large areas of damage. The younger fronds are attacked first. Eggs, about 1.5 mm long, are laid on the underside of the leaflets of young fronds and covered with digested leaf fragments cemented together. Larvae hatch after 2-3 weeks and penetrate the leaflets and mine areas parallel to the midrib. The larvae moult 2-3 times enlarging the mined area as they grow. Mines may be 80 to 400 mm long, depending on the species and the number of larvae in the mine. The larval stage is up to 40 days and the pupal stage lasts about 12 days. After emergence, males and females fly to younger leaflets on the same palm or to a young leaf of a palm nearby, grouping together on the underside of the fronds. The beetles prefer the tallest trees. The adult is about 1 cm long.

Colour of the adults is variable and they live on average, 4 weeks.

Impact
In the past in PNG, severe outbreaks of *Promecotheca* have occurred only in the outlying islands of New Britain, the Duke of York Islands and Manus Island (Baloch, 1972) and not on the mainland. Mature palms are more susceptible. Occasionally, the entire epidermis of leaflets is destroyed and, consequently, yield is reduced. Sometimes, flower production ceases and palms may die. Severe outbreaks can affect production for at least 2 years. Outbreaks appear to be cyclical, every 10-15 years. Almost all the localities with severe infestations by *Promecotheca* appeared to be those in which this Hispid was accidentally introduced and the parasites were not yet established to be effective. Outbreaks have not been reported in recent times and so the current status of this pest in this country is not known.

Records of impacts in other Pacific Island countries are not available.

Symptoms
On mature coconuts, signs of adult feeding on the lower parts of young fronds will be evident by grooves or mines on leaflets parallel to the veins. The areas of the leaflets eaten by the beetle become white or grey tips shrivel and curl under. Look for the brightly coloured small beetles 7-9 mm long, during the day. Larvae may be present in the upper part of the leaflet.

Management
Natural enemies against larvae and pupae of *Promecotheca* (*Pediobius parvulus* (Ferriere) and parasites were introduced in the 1930's from Indonesia to control the pest. In New Britain a survey in 1969 showed that the principal parasites of *Promecotheca* (except for the indigenous *Eurytoma promecothecae* Ferriere) were well distributed throughout the area surveyed (Bedford, 1976). More recent investigations and records on this pest in Pacific Islands are not known.

D. Melanesian rhinoceros beetle, *Scapanes*

Scientific name
Scapanes australis.

Different sub-species (*Scapanes australis* and *Scapanes australis grossepunctatus*) exist in Papua New Guinea. In Solomon Islands the sub-species is *S. a. salomonenesis*.

Distribution
Southeast Asia, Oceania. In Pacific islands, it is recorded from Papua New Guinea and Solomon Islands. Males of *S. australis* show considerable variation in the size of the horns. Endrodi (1957) recognised four geographic subspecies based

Figure 4. Scapanes australis

on the following characters of adult males: body size, degree of elytral puncturation, and shape of pronotal and head horns. *S. a. australis* Boisduval occurs on the New Guinea mainland west of the Huon Gulf, and S. a. brevicornis Sternberg east of the Gulf; *S. a. grossepunctutus* Sternberg on New Britain and New Ireland, and *S. a. salomonensis* Sternberg on Bougainville and Solomon Islands (Bedford, 1976). The present day distribution of *Scapanes* in Solomon Islands is unknown.

Alternative hosts
Betel nut, banana, sugarcane and other palms.

Symptoms
The adults bore into crowns of coconut. Damage can be considerable, especially in immature palms up to 5 years' old. The emerging fronds show V-shaped cuts, twisting, spiralling and truncated leaflets. If the meristem is damaged, the palms die. Damage by boring allows entry of other organisms such as termites and weevils such as *Rhyncophorus* to cause further damage.

The eggs are creamy-white, about 5 mm long and 3 mm diameter, laid singly in soil near rotting logs or other decaying matter that provides food for the larvae. In Papua New Guinea, breeding sites occur in cocoa and coconut plantations associated with rotting stumps of shade tree (e.g., *Gliricidia sepium*). Eggs hatch after about 30 days producing larvae with of reddish-brown to brown heads. There are two moulting stages during larval growth and larvae reach 10 cm in length and 2 cm wide, before pupating at about 9 months. Adults are black, 4-6 cm long, and are strong fliers. Males are single-horned while females have small double horns on their heads. Adults live for about 4 months. Males and females have been observed in the same tunnel in the crown of a coconut, but it is usually the male that is most commonly observed.

Impact
Rotting logs provide breeding sites and damage can be severe where coconuts are planted into land cleared from forest. As the logs decay, reducing the available breeding sites, attack tends to decrease.

Outbreaks by *Scapanes* have been transient and usually on younger palms, especially where forested land has been cleared for planting. Lasting economic effects have not been seen.

Since coconuts are not usually planted into forested areas nowadays, this pest is of minor significance however may be a threat to young coconut or oil palms in plantations.

Detection
Larvae of the beetle will usually be seen beneath rotting logs. However, for correct identification,

they need to be bred to adults, as they are similar to other beetles in the Scarab family. Horns are clearly visible on the adult male beetles, whereas in females, the horns may be more difficult to recognize. There could be confusion with *Oryctes rhinoceros*, but that species usually attacks much older palms. As for CRB, V-shaped cuts in the frond leaflets, will be seen as well as distorted fronds and fibre pushed from the tunnels into the crown. Beetles will be found in these tunnels.

Figure 5. Oryctes rhinoceros

Management

Control of *Scapanes* is difficult as they can cause substantial damage even though the numbers of adult beetles per hectare may below.

The main factor in control of populations appears to be to the availability of suitable breeding sites. By reducing the number of breeding sites, beetle populations can be kept at manageable levels. This factor may account for the wide variation in levels of palm damage from one site to another. Although outbreaks are sometimes serious, they are usually transient as in new plantations. Once the debris resulting from bush clearance has decayed or has become concealed by ground cover, populations will decline rapidly and usually permanently.

Planting of cover crops such as *Pueraria phaseolodes*, *Mucuna pruriens* or other legume species as soon as the trees have been felled to cover the logs and stumps in order to interrupt egg laying.

Fast-growing varieties are more likely to outgrow the damage caused by the beetles. In Papua New Guinea, observations suggest that fewer palms of the Gazelle Tall died from attack compared to Rennell Tall or Malayan Dwarf which are introduced varieties.

Little attempt has been made for biological control of *Scapanes*.

A pheromone (that attracts both males and females) has been isolated and used in mass trapping trials in Papua New Guinea in the past (Bedford, 1976).

Chemical control of this pest is very difficult and not recommended under small-scale production systems.

E. Coconut rhinoceros beetle (CRB)

Scientific name

Oryctes rhinoceros.

Two strains are recognised in Pacific islands CRB-P and CRB-G.

Note that CRB-G has only been confirmed in Guam, Hawaii, PNG and Solomon Islands.

Distribution

South and Southeast Asia, Oceania. American Samoa, Guam, Fiji, Hawaii, Papua New Guinea, Palau, Samoa, Solomon Islands, Tokelau, Tonga, and Wallis and Futuna.

Although *O. rhinoceros* (CRB-P) was detected in New Britain about 1942, and subsequently was reported from New Ireland (l952), Pak Islands (1960) (Catley, 1969), and Manus Islands (1970), spread to the Papua New Guinea mainland, Bougainville or the Solomon Islands did not occur. In New Britain the pest is apparently restricted to the Gazelle Peninsula and has not been found in the West New Britain area. Movement of *O. rhinoceros* within PNG was not observed for many years, despite frequent air and shipping connections, occurrence of conditions favourable for its establishment, and absence of consistently applied quarantine measures against it (Bedford, 1976).

Recently, the virus resistant strain CRB-G has been detected in Guam, Hawaii, mainland Papua New Guinea, Solomon Islands (Marshall et al., 2017), and Vanuatu. The origin of this strain of the beetle is still unknown (M. Ero pers. comm.). The recent

Figure 6. Damage by Coconut rhinoceros beetle

arrival and spread of the CRB-G strain in PNG and Solomon Islands has been faster than the original introduction due to several factors including the absence or low infectivity of the *Oryctes* nudivirus in the new strain (Paudel et al., 2021).

Alternative hosts
Betel nut, sago palm, oil palm, banana, Pandanus, sugarcane and tree fern.

Symptoms
The adult beetle bores into the crown of coconut palms, chewing through young fronds. When the fronds emerge and unfold the damage can be seen as V or wedge-shaped cuts in the leaflets. Holes in may be observed in the base the fronds when beetle populations are high. Oval eggs (3.5 x 4 mm) are singly, 5-15 cm, below the surface of moist organic woody materials, such as sawdust, manure, compost and garbage heaps, or above ground in tunnels, debris in axils of coconut fronds, in standing dead and rotting coconut palms, and in the ends of rotting fallen trunks. Logs and stumps of many other kinds of trees are also hosts. Eggs hatch 8-12 days after being laid. The larvae or grubs are white then cream- coloured with brown heads and curved in appearance. There are three stages in the larval life cycle which lasts 80 to 200 days, with the third stage measuring up to 100 mm in length and 20 mm in diameter. There are two pupal stages lasting 25-40 days. Young adults remain in the breeding hole for 2-3 weeks and then exit the nest. The insects are black with horns - those of the female often shorter than the male. Females live on average 9 months and lay up to 50 eggs and males live about 5 months. The beetles are nocturnal, flying to the tops of coconuts where they use their mandibles, horn and strong forelegs to tunnel into the crowns. They do not eat the frass from the tunnels but drink the sap that exudes during tunnelling. The beetles are strong flyers and are attracted to lights.

Impact
The beetle continues to plague islands with intermittent severe outbreaks. In most countries, damage is caused by the CRB-P biotype and the *Or* NV is effective in managing population levels in combination with other biological controls however, in some cases the area of attack is extensive and minimising impact is difficult.

The CRB-G biotype has caused extensive damage in Guam, Solomon Islands and in some parts of the PNG mainland since it was first detected. Although the economic impact has not been fully documented, it is assumed to be high in these countries.

The damage caused by the beetle results in loss of leaf area, death of flowers and fruit (early nut fall) and, ultimately, lower yields. If the meristem of the palm is damaged through boring by the beetle, the palms will die.

Occasionally, the beetles bore through the midribs of fronds causing then to fracture. Few studies have related damage to lost production. Some research in Samoa showed that a 25% reduction in leaf area resulted in a 25% reduction in nut yield. Indirect damage also occurs. In Asia and parts of Papua New Guinea, *Oryctes* attack encourages secondary invasion by *Rhynchophorus* sp. as well as secondary pathogenic microorganisms.

Detection
Tunnels in the crown of coconut palms with frass - often more than one hole per palm are distinctive as are emerging fronds with V-shaped damage to the leaflets. Jet-black beetles up to 40 mm long with prominent horns. Differences between the different strains of *O. rhinoceros* can only be confirmed by molecular means.

Management
Research into management of *Oryctes* started in the Pacific islands in the 1960s. Today, the key agent is a virus (*Oryctes rhinoceros* nudivirus – Or NV) originally isolated from Malaysia in the native range of the beetle, although the virus does not appear to be effective against the CRB-G type.

The fungus, *Metarrhizium majus* (syn. *M. anisopliae*), is routinely used to control larval, pupal and adult populations by application to breeding sites and trapped beetles. Sanitation of potential breeding sites and substrates is a key element in reducing populations of the beetle. Pheromones traps are used to trap adults. The traps are constructed of buckets with wire coverings or polypipe. Control is usually implemented when 3-5 beetles occur per ha up to 2 years after planting, and 15-20 beetles per ha thereafter.

Chemical control is difficult due to the nature of feeding and has not been applied in coconut.

F. Coconut treehopper, long-horned grasshopper, Sexava (They are also known as katydids or bush crickets.)

Scientific name
Tettigonids.

Those recorded in Papua New Guinea on coconuts are *Sexava nubila*, *Segestes decoratus*, *Segestidia leefmansi*, *Segestidia rufipalpis*, *Segestidia uniformis*, *Segestidia defoliara*, *Segestidia novaeguineae*, *Segestidea gracilis* and *Pseudonicsara szentia*.

Figure 7. Sexava

S. decoratus, *S. defoliaria*, *S. novaeguineae* also occur on oil palm. Sexava species are also recorded from Solomon Islands.

Alternative hosts
Betel nut, nipa, oil palm, sago, banana, Heliconia, Pandanus, and sugarcane.

Distribution
Papua New Guinea, Solomon Islands.

Symptoms
Holes can be seen on affected fronds in early stages of attack and this can be followed by the stripping of entire leaflets to give a 'broomstick' appearance to palms in severe outbreaks.

Outbreaks may be localised in areas of untended coconuts where rainfall is evenly distributed or more widespread where rains follow droughts and mass egg hatchings occur. The insects feed at night and descend to the ground during the day or shelter on the undersides of leaves or at the base of leaves in the crown.

Figure 8. Coconut stick insect

Sexavae are not strong fliers, and mobility is mostly via leaf hopping or running.

Impact
The adults and nymphs occasionally cause severe damage to coconuts and oil palm and bananas. The leaflets are consumed entirely leaving only the midribs. Flowers and young fruits of coconut palms can also be damaged during a severe outbreak.

Where frond damage is severe, high yield losses will result due to the interference in nutrient uptake for fruit development. Yields begin to be affected when 40% defoliation occurs. Recovery from defoliations up to 70% takes about 2 years, before normal yields are returned.

Detection
Adults have large grasshopper-like forms measuring 50-60 mm in length (not including the antennae). The antennae are much longer than the body, a feature distinguishing the long-horned from the short-horned grasshoppers and locusts. The females have long slightly curved, sword-like ovipositors and this distinguishes them from the males.

Eggs are slender, slightly curved, about 10 mm long, mostly laid in the soil, but also on the butts of fronds or on plants growing on the stems of palms. Eggs hatch within 8 weeks of being laid. The nymphs are green or brown, depending on the species, and moult six times over about 3 weeks. Adults live an average of 110 days. The full life cycle is between 30-40 weeks.

Management
A number of parasitoids for eggs, nymphs and adults have been recorded from long-horned grasshoppers. The most reliable are the egg parasites (e.g. *Doirania leefmansii*) as the majority of Sexava eggs are laid in the soil. Raking or disturbing the soil around the base of palms will assist in exposing the eggs. He parasitoid, *Stichotrema dallatorreanum*, is considered to be effective in some species where it reduces the number of eggs laid by the Sexava females and reduces their lifespan but may not be as effective against the parthenogenetic females of *S. decoratus*.

As cultural and chemical control measures have proved to be impractical or uneconomical, the research in Papua New Guinea in the last 70 years has been to improve biological control, including the use of mycoinsecticides, but none are available commercially.

G. Coconut stick insect

Scientific name
Graeffea crouanii.

Distribution
American Samoa, Cook Islands, Fiji, French Polynesia, New Caledonia, Niue, Tonga and Wallis and Futuna.

Alternative hosts
Sago palm, Pandanus and other palms.

Symptoms
The adults strip the leaflets, mostly from the older leaves, leaving only the midribs remaining (similar to Sexava damage). Eggs are laid in the crown of the palms, and fall into the base of the fronds, or to the ground where they remain in leaf litter and among weeds. Eggs hatch after 12-16 weeks. The nymphs have the form of the of the adults and feed on the leaflets. There are five moults for males and six for females. The life cycle is approximately 3.5 months for males and 4 months for females. Only males have functional wings and can fly. The insect is nocturnal and both adults and nymphs feed at night.

Impact
Defoliation of coconut palms can be widespread, sometimes over several hundred hectares but outbreaks are not frequent. Apparently, older palms, over 25 m tall are more prone to attack and heavy damage. Defoliation, crop loss and death of palms have been reported in Fiji but economic losses are not documented (PestNet).

Management
Predators include chickens and birds but these animals do not effectively control populations, especially during outbreaks. Other small animals and insect may eat the eggs.

Egg parasites include the wasps *Paranastatus verticalis* and *P. nigriscutellatus*. *Paranastatus verticalis* has been bred in Fiji to control populations of *Graeffea*. Both species were imported into Samoa from Fiji and became established. *P. verticalis* was released into Tonga in 1977 and became established there.

Cultural practices used in the past include burning of fronds under the palms on still days creating smoke which causes the stick insects to fall to the ground where they can be collected and killed or eaten by chickens.

Horticultural glue bands can be used around the coconut palm trunks that prevents crawling nymphs from reaching the coconut leaves. One such product is called "Tanglefoot". Cleaning and controlling weeds around the bases of coconut palms is also beneficial as it exposes any eggs and nymphs which can be eaten by chickens and ants. Underplanting with cocoa is thought to be beneficial according to anecdotal evidence from Samoa.

*Figure 9. Coconut bud rot (*Phytophthora palmivora*)*

COCONUT DISEASES

The majority diseases of coconut have been caused by fungal pathogens. However, these diseases are considered transient, and most are manageable. On the contrary, a few diseases caused by viruses and a phytoplasmas, that appear to be endemic to particular countries are more difficult to control because of limited knowledge in their aetiologies and epidemiology. Some recorded diseases are presented here.

A. Coconut bud rot

Scientific name
Phytophthora palmivora.

There may be more than one species of *Phytophthora* in the Pacific islands causing bud rot. For instance, *Phytophthora hevae* is also said to occur, causing a bud and fruit rot of coconuts in New Caledonia.

Distribution
The disease is widespread throughout coconut growing areas of the world.

In Pacific islands, it has been recorded on coconut in Cook Islands, Fiji, FSM, New Caledonia, Papua New Guinea, Samoa, Solomon Is., Tonga, Vanuatu and Wallis and Futuna.

Alternative Hosts
Betel nut, oil palm, other palms, cocoa and papaya.

Symptoms
By the time symptoms appear, the disease is advanced with rotting of the bud and inner leaves. Wilting and bending of the spear leaf in affected palms with the bases of the petioles of the young leaves showing a yellow to brown-coloured rot. This is an advanced

stage of the disease, and it is likely that the bud is already affected and palms may not survive. Yellow to light brown, sunken patches occur on the leaf stalks. As the disease progresses, the central leaves fall out as they become completely rotten at the base of the leaf stalks, leaving only a few outer leaves. A foul smell occurs as the bud rots. Coconuts are also attacked and if infections occur at the point of attachment to the flower stalk it may lead to premature nut fall.

Affected fruit will have a black colour around the stalk and under the calyx.

Seedlings may also be affected and killed. *Phytophthora* survive in the soil and plant debris, probably in as thick-walled spores (chlamydospores). Sporangia are spread by wind, rain splash and possibly by insects.

Impact
Phytophthora palmivora is the common cause of bud rot of mature palms worldwide. A different species, *P. katsurae*, occurs in the Caribbean and West Africa. *Phytophthora* spp. are oomycetes or water moulds that infect the bud of the palms and cause a rot, which spreads to the base of other leaves, eventually killing the palm. Sometimes fruit are also invaded by *Phytophthora* and result in premature nut fall and hence loss of yield.

Bud rot is not a common disease in Pacific Island countries. In Samoa, it is limited to a mountainous, cool, wet area. Outbreaks of a seedling bud rot caused by *P. palmivora* have been recorded from coconut nurseries in Vanuatu.

In Indonesia and the Ivory Coast bud rot and premature nut fall caused by *Phytophthora* species are major disease problems. The disease mostly affects young palms, under 5 years.

Management
If the outer fronds are green then the decayed area of the spear leaves can be pruned and the palms may recover.

B. Coconut embryo rot, coconut pre-emergence shoot rot, coconut bole rot, lethal bole rot

Scientific name
Marasmiellus cocophilus, *M. inoderma* (syn. *M. semiustus*).

Distribution
South America, North Africa, Oceania.

*Figure 10. Coconut embryo rot (*M. inoderma*)*

M. inoderma is recorded from Federated States of Micronesia (coconut), Papua New Guinea (coconut), Samoa (coconut) and Solomon Islands. M. cocophilus is only recorded from Solomon Islands.

Alternative hosts
Banana, taro and unspecified weeds.

Infection by *M. inoderma* may occur while the fruit are attached to the coconut palm. In the nursery, the fungus colonises the husk and grows beneath the calyx in germinating fruit and causes a rot that penetrates into the endosperm and destroys the embryo or shoot. Usually, seedlings overcome the attack, but growth may be slow.

Impact
In Solomon Islands, it is reported that up to 15% of Malayan Red Dwarf seednuts germinate on the palm, and a small percentage of these are infected or killed by *M. inoderma*. Overall, losses from bole rot are not high, and vary between varieties. Losses of up to 50% have been reported of Malayan Dwarf x Rennell Island Tall seed nuts in in the nursery Solomon Islands (Jackson & Firman, 1979).

Management
De-husking or partial de-husking of coconuts in the nursery has been recommended but this affects the germination.

Paring of the husk on four sides and fungicide treatment has been practiced in the past where disease incidence was high.

Maintaining good air-flow and nursery hygiene should alleviate losses due to Marasmioid fungi.

C. Coconut foliar decay (CFDV) New Hebrides coconut disease

Scientific name
Cofodevirus sp. *sp. novo*. Family: *Naminiviridae* fam. *novo*. Vector: *Myndus taffini*.

Distribution
The disease is only recorded from Vanuatu.

Coconut foliar decay (CFD), a severe disease of coconut palms in Vanuatu, was first described around 1964 and a single-stranded (ss) DNA was found in 1985 when initial attempts at studying the aetiology of the disease were made (Randles et al., 1986). It was characterized at the time as circo- or geminivirus- like (Hanold & Randles, 1998; Wefels et al., 2015). The single sequenced circular ssDNA of CFDV has left the virus as an unassigned species within the family *Nanoviridae* until recently. Reanalysis of old virus samples by new methods have placed CFDV in a new genus and family (Gronenborn et al., 2018).

Gronenborn (2018), showed that although CFDV displayed combined features of geminiviruses and nanovirids, other features suggested a distinct new taxon of circular ssDNA plant viruses. The genus name *Cofodevirus* (**co**conut **fo**liar **de**cay **virus**) and a tentative family name *Naminiviridae* reflecting the combination of characteristics of both *Nanoviridae* and *Geminiviridae* family members was proposed to classify this novel species.

Alternative hosts
Hibiscus tiliaceous.

Symptoms
Currently the main mode of detection is by observations of symptoms which mainly include a pronounced yellowing of leaflets in susceptible varieties The first symptom on palms in the field is yellowing of leaflets on young fronds between position seven and 11 from the spear leaf. The yellowing spreads along the fronds, and the fronds fracture near the base. As the younger leaves age, reaching positions seven to 11, they, too, turn yellow, break and collapse. As the disease progresses, more mid- section fronds will be affected. Since fruit production is affected, the crown and trunk will narrow at the top and palms will succumb to the disease after 1-2 years. Some varieties which are tolerant to the disease may show remission of symptoms.

Figure 11. Coconut foliar decay

The virus that causes the disease present at low concentrations in coconut palms and occurs in the leaves, roots, trunks, embryo and the husk of the nut. It is not known if the virus is transmitted via the seed. The only known vector is the planthopper *Myndus taffini*, which breeds on the roots of *Hibiscus tiliaceous*. Wefels et al. (2015) proposed a persistent-circulative mode of transmission where the virus is acquired from *H. tiliaceus* by nymphs and transmitted transstadially to adults. Confirmation of this hypothesis is yet to be tested.

There is still limited information on the virus and its relationship with *M. taffini* and its host plant and further research is warranted to better understand disease aetiology.

Impact
The virus causes a lethal disease of all introduced coconut varieties and hybrids in Vanuatu but local varieties Vanuatu Tall and Vanuatu Red Dwarf are apparently resistant to infection by the virus. Some introduced varieties are more susceptible than others with Tall varieties such as Rennell Island Tall showing some tolerance to the disease and Dwarfs such as the Malayan Red Dwarf apparently highly susceptible. It is thought that the 'resistant' Vanuatu coconut varieties may contain the virus but remain asymptomatic. It is not known if the virus is transmitted through seed and is the reason why materials from the coconut gene bank have not been exchanged since the virus was discovered in the 1980's. The disease is significant in Vanuatu, because it affects improvements in yields through hybridisation. The susceptibility of the exotic

Figure 12. Coconut tinangaja disease

varieties to CFDV is carried through to hybrids and this limits the use of imported materials to generate high-yielding progenies. Several generations of selections and trials would be required in order to identify resistant or tolerant hybrids.

Molecular (PCR) tests are available for detection of CFDV however the virus is complex and represents a new genus (Gronenborn et al., 2018; Randles et al., 1999; Wefels et al., 2015). Improved methods of detection are required.

D. Tinangaja disease

Scientific name
Coconut Tinangaja viroid (CTiVd).

Alternative hosts
Unknown.

Symptoms
Tinangaja is a disease of coconut palm found on the island of Guam and was first described in 1917 (Boccardo, 1985; Weston, 1918). The disease is lethal and resembles Cadang-Cadang disease of coconut palm, which is caused by the coconut Cadang-Cadang viroid (CCCVd) and occurs in the Philippines (Haseloff et al., 1982; Randles, 1975). Coconut tinangaja viroid (CTiVd) is associated with Tinangaja disease and has a monomer size of 254 nucleotides The Tinangaja and Cadang-Cadang viroids share about 65% overall sequence homology (Keese et al., 1988).

At the early stage, the crown becomes slightly reduced in size, with an angular shape when viewed horizontally, and normal production of fruit. Middle-stage infections will produce small, deformed, narrow, elongated coconuts which usually lack a kernel. Late stage infection in palms is typified by reduced crowns with thin leaflets and a gradually tapering trunk. Fruit production ceases and leaf stippling is evident at the late stage (Hodgson et al., 1998).

Foliar symptoms are considered unreliable indicators for identifying Tinangaja-affected coconut palms, especially in the early stages of the disease. For example, an elongated nut shape which is supposed to be associated with CTiVd were not found to be positive for the viroid (Hodgson et al., 1998).

Molecular-based DOP hybridization or RT-PCR are the only suitable indicators of infection (Hodgson et al., 1998).

Impact
The disease is not of economic importance in Guam although large areas of palms have been affected in the past. Many of the coconuts are planted as landscape trees. The status of the disease at the present time is not documented.

Management
As the aetiology of the disease is unclear, management is difficult. Trials with antibiotics proved ineffective in supressing or arresting disease symptoms.

E. Bogia Coconut Syndrome (BCS)

Scientific name
Candidatus Phytoplasma *noviguineense*.

Proposed main vector – *Zophiuma pupillata* (Lophopidae) but other vectors are implicated (Lu et al., 2016).

Alternative hosts
Betel nut, banana.

Distribution
Papua New Guinea, Madang Province only. The disease is absent from other parts of PNG.

Symptoms
Affected coconut palms will exhibit yellowing of the leaflets and premature nut fall. Early symptoms will include a narrowing of the crown and premature nut fall. At later stages of the disease, fronds will wither, and collapse and fruit production will cease. Standing, dead palms will attract coconut

Figure 13. Bogia coconut syndrome

rhinoceros beetles which may increase the losses in production.

The disease is mostly seen in older plantations with senescing palms, however, younger palms of 15- 25 years may also be affected. Other palms or banana plants in areas of high disease incidence may also show yellowing symptoms.

Tree hoppers such as *Z. pupillata* may or may not be present.

Impact
The disease was first detected in 2008 (Kembu et al., 2009) and the incidence has progressively increased.

The disease has and continues to impact coconut production in Madang Province. It is estimated that >400,000 households have been affected by BCS. Thousands of coconut palms have been killed and/or removed in order to manage the spread of the disease.

Detection
Several assays are available for detection of BCS phytoplasma including nested-PCR, Real-time PCR and Loop mediated isothermal amplification (LAMP) (Lu et al., 2016). Each of these methods have their own limitations. A rapid, reliable field diagnostic is required for improved management of this disease.

Management
Current management strategies include removal of affected palms and burning of the upper parts of the trunk where the insects may still be present. Removal of any other plants that are showing symptoms such as banana is also important.

The leaf hoppers responsible probably do not fly long distances so maintaining a large buffer zone >100m between coconut palms and other alternative crops and weeds that might host the insects and the disease will also decrease the spread.

Long-term management of the disease is aimed at identifying resistant or tolerant coconut varieties.

PESTS AND DISEASES OF QUARANTINE IMPORTANCE

There are a number of major pests and diseases of coconut that are not yet recorded in the South Pacific Region. These include Red ring disease and its vector, Cadang-Cadang viroid and Lethal Yellowing (LYD) are considered of high quarantine priority. Disease such as Tinangaja, Coconut Foliar Decay and Bogia Coconut Syndrome, are of quarantine importance to Pacific Island countries where the diseases are not present. A comprehensive review of transboundary pests has been provided by Datt et al., 2020 from a biosecurity perspective and

Figure 14. Cadang-cadang disease

this section will include only pests and diseases of coconut known outside of the Pacific region.

A. Cadang-Cadang disease

Scientific name
Cocadviroid Coconut cadang-cadang viroid, CCCVd.

Alternative hosts
Buri palm (*Corypha elata*), Areca palm and other monocots including pandanus, gingers, arrowroots and grasses (Hanold & Randles, 1991b, 1998).

Distribution
Cadang-cadang disease is restricted to some areas (Central) of the Philippines. It is apparently not widespread.

Symptoms
The disease has a long incubation period. Affected palms show a series of symptoms before they eventually die, and three main stages of infection are described affecting different parts of the coconut palm (CABI, Invasive Species Compendium).

Initially, the leaflets develop yellow, non-necrotic leaf spots. This stage will last 2-4 years. Fruits become rounded, show equatorial scarring and a reduced husk thickness (Hanold & Randles, 1991b).

In the next stage, the leaf spots will become larger and more pronounced. Inflorescences will also develop spots. Frond growth decreases and the production of fruits ceases. This stage may last up to 2 years.

In stage 3 crowns of affected palms will be a reduced and most of the fronds will have the distinctive yellow spots. Spathes will be reduced in number and size, tips become necrotic, female flowers will be reduced in number or absent and abscission of male florets will be seen. The palm may survive for about 5 years in this state before death.

Impact
Although Cadang-cadang disease has not spread greatly over the years, it is a high risk viroid disease due to its lethal impacts on palms. It is estimated to have killed 300,000 palms per year since the first record in 1980 with up to 40 million trees over the last century, although the disease rate is slow at 0.1- 1.0% per annum (Rodriguez et al., 2017). The spread to other regions could cause major impacts to coconut industries as the current control methods are ineffective, and the mode of spread is still unknown.

Viroids are also known to have a high rate of mutation creating the risk of new strains.

Management
Because CCCVD may be seed-transmitted at the low rate of ca. 1 in 300 (Hanold & Randles, 1991a; Pacumbaba et al., 1994; Randles & Imperial, 1984) and is also mechanically transmissible exclusion and preventing the transport of plant material from diseased areas is the only effective method in controlling the spread of cadang-cadang disease.

An RT-PCR diagnostic test specific to CCCVd has been developed (Hodgson et al., 1998).

B. Coconut Lethal Yellowing

Scientific name
Candidatus phytoplasma (various species and strains).

Phytoplasmas are recorded from all regions where coconut is grown except South America. Information is not complete for Pacific Islands and Asia and the aetiologies of diseases such as Akwa wilt and Natuna wilt are as yet, unconfirmed.

A review of lethal yellowing type diseases caused by phytoplasmas in coconut has been published by Gurr et al., 2016. Figure 1 shows the current global distribution of the sub-groups of coconut lethal yellowing phytoplasmas.

Taxonomic Groups and sub-Groups of phytoplasmas are common to different regions possibly indicating similar vectors. For example, in North America and the Caribbean, sub-group IV-A is common and most likely because the vector, *Myndus crudus* is also present in these countries.

In many instances, the vectors of phytoplasmas and their biology are unknown as are the alternative hosts.

Alternative hosts
Unknown

Symptoms
General symptoms of LY-type diseases include gradual yellowing of leaflets, followed by necrosis of leaflet tips. Premature nut fall is typical. At later stages, flowers and immature fruit will become necrotic. The symptoms may be variable depending on the titre of the phytoplasma and usually a range of symptoms and susceptibilities is seen in the field.

The duration of symptoms in individuals may also vary although the incubation period prior to symptom expression, may be long.

If the vector is known, the insects may also be present in significant numbers.

Impact
The disease has had significant impact in several countries. Losses of coconut palms have been high in some countries in the Caribbean and Africa.

In the case of BCS, as indicted earlier, impacts have been high in the Madang Province of PNG.

Management
Field control has had variable results has also had variable results since a main mode of control could be through the management of vector populations. Because vectors are still unknown for most of the phytoplasmas affecting coconut, effective interventions cannot be applied.

Management of the phytoplasma also depends on the relationship between the vector and the plant host. If the vector completes its lifecycle on the plant host and the insect can reacquire the infection from that plant host the probability of an outbreak occurring will be higher (Gurr et al., 2016).

An integrated pest and disease management (IPDM) method, pioneered by Michael Black in Jamaica (Black's approach) has been quite successful in reducing the incidence of LYD (Serju, 2012) in that country. This method includes on-farm quarantine, regular surveillance, felling and burning of palms with LYD symptoms and

Figure 15. Lethal yellowing disease

replanting with a variety selected for high yield and LYD resistance in addition to extensive weed control and a good fertilization regime (Myrie et al., 2011). A significant reduction in disease incidence on four arms was observed using Black's method.

Curative treatments for LY are non-existent although some remissions have been reported with antibiotics such as tetracycline which are not cost-effective.

C. Red-ring disease

Scientific name
Bursaphelencus cocophilus (syn. *Rhadinaphelencus cocophilus*).

The nematode is transmitted by the beetle *Rhyncophorus palmarum*.

Alternative hosts
Unknown although in Colombia, the disease affects oil palm.

Distribution
South America and the Caribbean.

R. palmarum is listed by the European Plant Protection Organisation (EPPO) as an A1 pest.

Symptoms
The disease is characterised by a red-coloured ring that forms within the phloem tissue of the palm trunk. This region is populated by the nematode which interferes with water transport and nutrient uptake, resulting in wilting, malnutrition and eventual death of the palms.

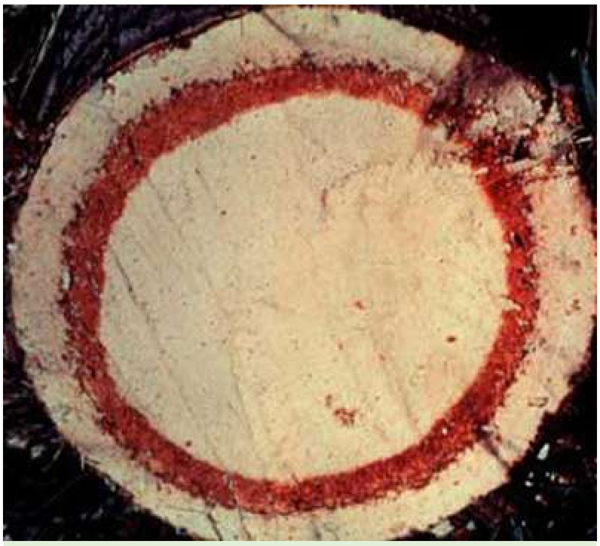

Figure 16. Red-ring disease

External symptoms appear about a month after infestation by the nematode. The oldest 2-3 leaflets may yellow with older fronds becoming necrotic. The fronds and leaflets in the crown may become shorter, more erect and narrower than normal. This is referred to as "little leaf".

After 42 days the trunk will have a high population of nematodes and petioles and roots will become infested. As a result, yellowing and bronzing of the fronds and leaflets will ensue. Dead fronds will fracture and hang down around the stem and flowers will also be affected, either withering or dying.

By this stage or earlier, premature nut fall will be observed in affected palms.

Younger palms (3-10 years old) are reported to succumb to the disease within 2-4 months after infection while older palms (>20 years) may be more tolerant and may survive to 5 months. This may be related to the larger root systems of older palms.

Internal symptoms are said occur between 14 and 21 days after infestation by the nematode.

The cross-section of the trunk will show red ring, 2-6 cm wide, from which the disease gets its name. The inside the roots and petioles of the leaves may also show yellow to brownish-red discolouring.

The symptoms may vary in different varieties and ages of coconut palms. The ring may appear brown rather than red in Dwarf varieties and some hybrids.

Core samples of the trunk tissue can be taken for diagnosis and identification of the disease and nematode. Juvenile nematodes can be collected from the leaf petioles and roots.

Impact

The red ring nematode causes severe damage and mortality in coconut palms. Some areas have reported around 22% of their coconut palms being infested. Annual losses in production of 10-15% are reported in areas where this disease is prevalent.

Management

Vector populations are targeted through an integrated programme of management (IPM) to a level below a satisfactory impact threshold. Multiple control options are used together for the economic control of pests (i.e., cultural, natural and chemical).

Cross contamination can be kept to a minimum by keeping tools clean, especially when removing infected palms. Palms should be destroyed by felling and burning. Infected palms are also said to attract weevils and cutting the affected palm into sections before burning will prevent the larvae and pupae emerging.

Trapping can be done with baited traps or guard baskets within and outside plantations. Traps put up at the borders of plantations are beneficial to guard against incursions. The baskets are usually placed on the ground around young palms at a density of 1 basket/acre and replaced bi-weekly. The method is apparently quite effective when the weevils are most active at night in the dry season.

GENERAL CONCLUSIONS

The coconut industry in the Pacific islands has been comparatively free of major pests and diseases that have impacted production in other countries. However, incursions of pests such as *O. rhinoceros* and new threats such as BCS have disturbed the complacency in this region of exclusion by isolation. This adaptation will no doubt be tested with the ever increasing impacts of climate change which may exacerbate rather than diminish biotic threats to the coconut palm thereby impacting the livelihoods of Pacific communities.

Vast areas of ocean are by themselves, not barriers to incursions by versatile pests and diseases whose ability to adapt and transcend boundaries are far superior to our ability to control them without recourse to the application of insecticides. The ever-present threat of new incursions of pests and diseases among islands is also exacerbated by frequent crossings between national and transnational maritime boundaries by island communities.

The preceding summary shows that many pest and disease problems affecting coconut still warrant further investigation and research to better understand their aetiologies and improve their detection and diagnosis. For perennial crops like coconuts increased and intensive application of proven biological control strategies against major pests should be implemented through mass production and redistribution of existing control agents to areas of ongoing concern and to arrest new incursions. A thorough surveillance of the region is warranted to ascertain existing pest distribution and infestation densities.

Furthermore, novel, modern biotechnological approaches such as the use of metabolomics or gene editing and genome sequencing are required to improve the management and control of pests and diseases that have been ongoing concerns for many decades and still continue to threaten the livelihoods of coconut farmers. Forward thinking in anticipating and preparing for new disease scenarios, both endemic and exotic and improving forecasting mechanisms for existing pests is paramount. Clearly, better resourcing and coordination of advanced research in biology and genetics, especially for major pests and diseases is required to complement improvements and incentives in other areas of coconut production. Such information can be used in a synergistic manner with other pest and disease management tools to enhance field control.

Advances in coconut production through new breeding programmes and exchange of breeding materials in Pacific Islands cannot be fully realised, without improved knowledge and information on the biology, genetics, distribution and management of major pests and diseases.

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Coconut Breeding Program in Jamaica to Support Sustainable Coconut Development

Millicent Wallace

The coconut population in Jamaica consists of varieties introduced from several international sources. The respective performance of these cultivars under local conditions has been assessed under the national breeding program since its inception in 1959. Many hybrids were made from the more promising performers. The Maypan (released in 1974) is an outcome of this exercise. The major challenges faced by the coconut industry in Jamaica include the incidence of maior pests and diseases (especially lethal yellowing), windstorm threat and (more recently) prolonged drought.

BREEDING FOR ADAPTATION, MITIGATION AND COPING

The main strategy employed was the continued introduction and testing of promising germplasm. Between 1859 and 1956 over fifteen introductions of various cultivars were made to Jamaica, from coconut growing countries in the world (Whitehead, 1961). Other introductions were made from 1963 through 2015. All have been subject to field assessment, for potential inclusion in the local breeding program.

Introductions After 1960: Pollen consignments were obtained from the Ivory Coast in 1963 – 1965. These included the Cambodia Tall, Tahiti Tall, Mozambique Tall, and Cameroon Red Dwarf cultivars. In 1964 - 1965, pollen consignments of Malayan Tall (originating from the Federal Malayan States), Solomon Island Tall, Rennell Tall, Tahiti Tall, Rangiroa Red Dwarf, Spicata and Nieu Leka (Fiji Dwarf) were introduced from the Pacific Islands. Seednuts were also introduced in 1964 from the Pacific Islands. These seed nuts are from Tahiti Tall, Western Samoa Tall, Tonga Tall, Vanuatu Tall

Table 1. Schedule of Coconut Introductions to Jamaica Prior to 1960

Date of Introduction	Details of Seed Introduced
1869	Introduction of dwarf King coconuts from Ceylon, via Kew Gardens
1903 & 1904	20,000 San Blas type coconuts ordered and distributed.
1905	14 San Blas coconuts planted at Hope Experiment Station.
1916	Importation of Panama coconuts (reported as very similar to San Blas type).
1917	Importation of "Choko" type coconuts from the west side of Panama – (no record to the number involved).
1921	Importation of 12 Dwarf nuts from Fiji.
1922	Importation of a further 2,500 Panama coconuts.
1933	Introduction of 12 open-pollinated nuts from two distinct hybrids of Malayan Dwarf x Niu Leka Dwarf growing at Nansori Experiment Station, Fiji.
1938	Single nut of Dwarf coconut ex Trinidad introduced.
1939	150 nuts of a strain of Malayan Dwarfs imported from Miami, Florida, from Mr. Hugh Matheson (100 nuts of the red type, 50 of the yellow).
1940	Private importation by Major Pease of Round Hill of a number of seeds of the Red Malayan Dwarf from Imperial College of Tropical Agriculture, Trinidad.
1944	Importation of many thousands of Malayan Dwarf coconuts from St. Lucia. (Three types, red, green and yellow).
1950	107 seednuts received from Cayman Brac.
1951	3 nuts imported privately ex Cuba, originating from India or Ceylon. Additional large-scale importation of Malayan Dwarf nuts from St. Lucia.
1956	A few nuts were brought privately from Trinidad. Considered to be "Malayan Giants".

Source: Whitehead, 1961

(Formerly New Hebrides), Bougainville Tall, Kar Kar Tall, Markham Valley Tall, Malayan Tall from the British Solomon Islands Protectorate (Solomon Islands), (BSIT) and the Federal Malayan States (FMS), Niu Leka, Spicata Orange Dwarf, and Rangiroa Red Dwarf varieties (Whitehead, 1966). In 1967, the Chowghat (Indian Green), Sri Lanka Green and Sri Lanka Yellow Dwarf varieties were introduced from India and Sri Lanka.

Recent Introductions: In 2000 a consignment of Brazil Green Dwarf was introduced from Brazil. In 2000 and 2001, six hybrids from the Marc Delorme Research Station, Ivory Coast (West Africa), were introduced to Jamaica. These were to be planted as part of an International Multilocation Trial organized by COGENT. In 2001 seednuts of the Panama Tall variety were reintroduced from Mexico along with two of their locally made hybrids. In 2004 seednuts were introduced from Brazil, representing five introductions - Brazil Green Dwarf, Brazil Tall, and three of their locally made hybrids.

In 2009 an introduction was made from the gene bank at the Marc Delorme Research Station in Ivory Coast, Africa. Included were fourteen varieties not previously tested in Jamaica, plus additional Brazil Green Dwarf Germplasm in 2015 a consignment of 100 Thailand Tall seednuts was donated by the Government of Thailand.

Deployment of Introduced Germplasm - Inter-Continental Hybridization

Inter-origin crosses were made from introduced material, mostly with one parent selected from introductions from the Pacific region and the other parent from the Atlantic region. This strategy served to capture the best of many traits. The Maypan hybrid is one such example (Malayan Dwarf - Pacific, Panama Tall - Atlantic).

Testing by Field Trials on Selected Farmers' Holdings

Coconut breeding for adaptation, mitigation, and coping responses included then (and still does) the testing of promising introductions by field

Table 2. Percentage Lethal Yellowing Mortality at Drax Hall HE1/80 Hybrid Trial 15 Years after Planting (1980 - 1995)

Variety / Hybrid	Lethal Yellowing Mortality (%)
MD (Malayan Dwarf)	25
MD X Bougainville Tall	84
MD x Cambodia Tall	63
MD X Niu Leka	50
MD X Kar Kar Tall	67
MD X Malayan Tall	80
MD X Markham Valley Tall	70
MD X Panama Tall	70
MD X Peru Tall	60
MD X Sarawak Tall	60
MD X Thailand Tall	33

Source: Coconut Industry Board, Report for Research Committee Meeting, September 2003

Table 3. Lethal Yellowing Disease Incidence Categories

Disease Mortality	Resistance Category
< 15%	Highly Resistant
15 – 50 %	Moderately Resistant
51 – 85%	Moderately Susceptible
> 85%	Highly Susceptible

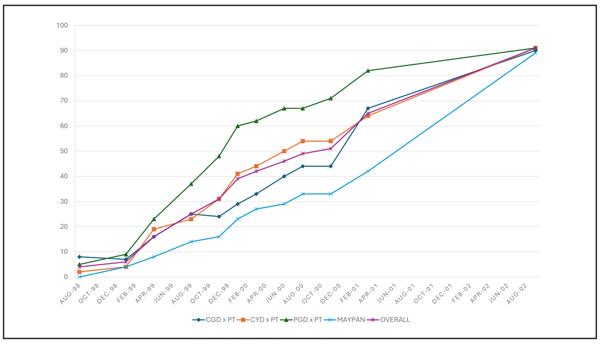
Source: Been (1981)

experiments on selected farmers' holdings. These are sited in various locations across the island to capture climate diversity. Collection of data spans up to fourteen years, in order to capture local climate fluctuation. The distinct advantage to of this practice is the accelerated adaptation of commercially released varieties (and their respective hybrids).

Field Assessment of Lethal Yellowing Disease Incidence

Lethal yellowing disease progress is observed in field experiments and gene banks affected. Data were collected twice per year, but more often (up to monthly) in disease hotspots. Cumulative mortality percentage for each cultivar is recorded. Disease resistance status is therefore assessed.

Percentage Lethal Yellowing Mortality at Drax Hall HE1/80 Hybrid Trial 15 Years after Planting (1980 - 1995): In this Experiment, the Malayan Dwarf was hybridized with selected tall cultivars obtained from the Pacific in 1964 (Whitehead, 1966a). These hybrids were tested along with the Niu Leka (Fiji Dwarf), and the Malayan Dwarf itself. After exposure to lethal yellowing, the Malayan Dwarf showed a significantly lower mortality rate than its hybrids, rivaled only by the hybrid with the Thailand Tall (Table 2).



Source: Coconut Industry Board Report, 2002

Figure 1. Lethal Yellowing Mortality at Porter Hill, St. Thomas, 1998- 2002

Other Field Assessment: Been (1981) assessed the performance of local cultivars present in the lethal yellowing disease outbreak in the 1970s. The populations assessed included germplasm collections. They were placed into four resistance categories according to their respective percentage disease mortality during this period. (Table 3). Assessment of survival of local germplasm revealed that the Malayan Green Dwarf, Chowghat Green Dwarf, Sri Lanka Green Dwarf, Sri Lanka Yellow Dwarf and other introduced dwarf varieties were classified in the "Highly Resistant" category. The local landrace, the Jamaica Tall (adjudged to be very similar to the West African Tall) was placed in the "Highly Susceptible" category. This information was used in the selection of future candidates in the local breeding programme.

In order to further broaden the genetic base of the coconut industry in Jamaica, alternative mother palms were selected from the "Highly Resistant" category for use in the local breeding programme in the 1990's. The Chowghat Green Dwarf, Sri Lanka Green Dwarf and Sri Lanka Yellow Dwarf were crossed with the Panama Tall as the pollen parent. The resulting hybrids were incorporated in field experiments with the Maypan as control. The lethal yellowing outbreak in the 1990s afforded the opportunity for assessment of their performance against the disease as one affected experimental site (Porter Hill in St. Thomas). Lethal yellowing mortality data (Figure 1) illustrates that the

Table 4. Survival Among Cultivars Introduced from the Genebank in Ivory Coast (2009 -2019)

Variety	Symbol	Survival (% of Number Planted)
Brazil Green Dwarf	BGD	73.9
Catigan Green Dwarf	CATD	96.4
Tacunan Green Dwarf	TACD	91.3
Aromatic Green Dwarf	AROD	83.3
Thailand Green Dwarf	THD	59.4
Kinabalan Green Dwarf	KIND	77.4
Philipog Green Dwarf	PILD	80.6
Tahitian Red Dwarf	TRD	38.5
Ternate Brown Dwarf	TBD	73.1
Tagnanan Tall	TAGT	38.5
Laccadives Micro Tall	LMT	7.7
Tenga Tall	TGT	29.2
Bay Bay Tall	BAYT	40.7
Gazelle Peninsula Tall	GPT	26.9
Palu Tall	PUT	46.7
Overall		**59.9**

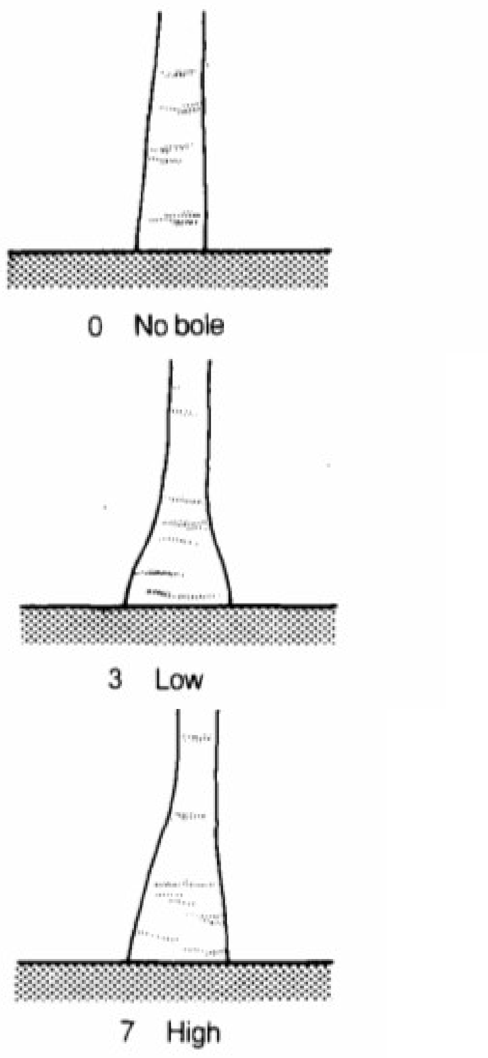
Source: Coconut Industry Board Report, 2020

hybrids largely appear to resist the 'explosive phase' for almost three years, after which they all abruptly lost the resistance.

Recent Field Assessment: The performance of the cultivars received in 2009 was assessed by the occurrence of lethal yellowing disease at one of the sites planted. Table 4 shows survival percentages at Plantain Garden, St. Thomas (There was an outbreak of lethal yellowing disease at this site during this period). The dwarf varieties appear to be generally better survivors than the tall varieties.

Bud Rot Disease

Local research commissioned by the Coconut Industry Board (Steer, 1988) revealed that the



Source: (IPGRI, 1995)

Figure 2. Illustration of the Trait of the Bole in Coconuts

bud rot disease in Jamaica was caused mainly by *Phyophthora palmivora* and *Phytophthora katsurae*. and was the most effectively control was obtained by use of the fungicide Ridomil MZ 58 WP.

This disease was found to thrive in moist conditions, with outbreaks mostly in the wet season. Dwarf varieties were found to be more susceptible than dwarf x tall hybrids or tall varieties. Coconut palms planted on flat lands with a high-water table were most vulnerable. Farmers were advised to carry out prophylactic spraying with fungicide (e.g., Ridomil) at the beginning of the wet season, and to destroy affected palms. Farmers establishing plots in the most vulnerable areas were advised to plant more dwarf x tall hybrids and tall varieties. They were also advised and to increase the spacing between palms above the 8 m (for hybrids) and 9 m (for talls) usually recommended (give the spacing).

Table 5. Mean Proportion of Palms Killed Outright by Hurricane in Jamaica in 1988

Variety	Mean	Caenwood	Wilming-ton	Elmwood	Drax Hall	Orange River	Green Castle
Malayan Dwarf	0.37	0.5	0.5	0.3	0.5	0.2	0.2
Malayan Dwarf x Peru Tall	0.24	0.6	0.3	0.1	0.3	0.1	0.0
Malayan Dwarf x SarwakTall	0.22	0.6	0.2	0.0	0.0	0.1	0.1
Malayan Dwarf x Markham Valley Tall	0.20	0.6	0.1	0.3	0.0	0.1	0.0
Malayan Dwarf x Kar Kar Tall	0.18	0.5	0.1	0.3	0.0	0.1	0.0
Malayan Dwarf x Niu Leka	0.17	0.4	0.3	0.0	0.1	0.1	0.1
Malayan Dwarf x Bougainville Tall	0.16	0.5	0.2	0.1	0.1	0.0	0.0
Malayan Dwarf x Cambodia Tall	0.15	0.5	0.1	0.1	0.0	0.1	0.1
Malayan Dwarf x Thailand Tall	0.14	0.3	0.3	0.0	0.1	0.0	0.0
Malayan Dwarf x Malayan Tall	0.09	0.2	0.2	0.1	0.0	0.0	0.0
Malayan Dwarf x Panama Tall	0.07	0.2	0.1	0.0	0.2	0.0	0.0
MEAN		**0.44**	**0.20**	**0.12**	**0.12**	**0.07**	**0.06**

For varieties MSEM (Mean Standard Errors of the Mean) 0.028
For sites MSEM (Mean Standard Errors of the Mean) 0.0.19

Source: Johnston et al. (1994)

Windstorm Incidence

Assessment of hurricane damage to HE1/80 Hybrid Experiment in 1988 (Johnston et al., 1994) showed that Malayan Dwarf suffered higher mortality than its hybrids with Tall varieties. A similar observation was made among the introduced varieties in 1980 (Coconut Industry Board, 1980).

The Possession of a Bole - A Major Contributing Factor in Windstorm Resistance: One major phenotypic difference between the Malayan Dwarf (and most other dwarf varieties) and tall varieties is the possession of a bole in the latter. This is indicated by a greater stem circumference at soil level than at 15 cm or higher on the trunk (Figure 2). This trait is present in dwarf x tall hybrids, apparently inherited from the tall parent.

During windstorms coconut palms with a bole exhibit greater resistance to being 'toppled over' by high winds than those without. Data collected on windthrown and surviving palms after Hurricane "Gilbert" showed positive correlation between bole girth and wind resistance (Coconut Industry Board, 1989). Table 7 refers.

Windstorm Damage - Other Contributing Factors: Coconut palms planted on hillsides have been observed to be more susceptible to windstorm damage than those planted on flat lands (Coconut Industry Board, 1989). Table 5 shows that Wilmington suffered higher proportions of loss than most others (0.20), surpassed only by Caenwood (0.44). Coconut Industry Board (1985 & 1986) describes Wilmington as: "inland site on steep rocky hillsides with fairly shallow, well drained loamy limestone clays…" Caenwood was described as: "flat seaside site on well drained silty soils with sandy layers and a high water table." Furthermore, Caenwood was situated at the location where the hurricane made landfall. Both sites could be regarded as high risk for hurricane fatalities.

Table 6. *Losses of Breeding Material Caused by Hurricane in Jamaica in 1980*

Variety	Number of Palms present at time of Hurricane	Percentage of Palms Destroyed by Hurricane
Bougainville Tall	37	0
Cambodia Tall	16	13
Sri Lanka Dwarf	30	3
Niu Leka	56	4
Fiji Tall	15	0
Chowghat Green Dwarf	8	0
Kar Kar Tall	43	5
King Coconut (ex. Sri Lanka)	7	0
Malayan Dwarf	677	16
Malayan Tall	139	14
Markham Valey Tall	24	3
New Hebrides Tall	4	0
New Ireland	2	100
Panama Tall	91	3
Peru Tall	18	0
Rangiroa Dwarf	2	0
Rangiroa Tall	8	0
Rennel Tall	26	0
Rotuma Tall	18	0
Samoa Tall	13	8
Sarawak Tall	21	14
Seychelles Tall	16	6
Solomon Is. Tall	13	8
Spicata Dwarf	8	0
Tahiti Tall	144	0
Thailand Tall	51	4
Yap Tall	27	0
TOTAL	**1385**	**12**

Source: Been (1981) in Coconut Industry Board (1980)

Young palms in heavy bearings with short stems have also been found to be quite susceptible to being 'toppled over', due to their 'top-heavy' condition.

Increased Incidence of Prolonged Drought

The years 2014 and 2015 Jamaica experienced intense drought. All coconut landss have been affected, to varying extent (Figures 3 & 4). The performance of various varieties / hybrids under these conditions was observed. These observations will inform future decisions as to the deployment of suitable varieties on a commercial basis.

Supporting strategies

Some strategies employed may not be classified as breeding *per se* but played a supporting role in the process of breeding to support sustainable coconut development.

Table 7. Mean Bole Girth for Surviving and Windthrown Palms affected by Hurricane in Jamaica in 1988

CULTIVAR	CAENWOOD					WILMINGTON				
	Surviving		Windthrown		T–Test Sig.	Surviving		Windthrown		T–Test Sig.
	#	Mean	#	Mean		#	Mean	#	Mean	
Malayan Dwarf	5	1.22	11	1.28	n.s.	14	1.15	14	1.13	n.s.
Malayan Dwarf x Bougainville Tall	17	2.03	13	1.75	***	19	1.35	5	1.06	***
Malayan Dwarf x Cambodia Tall	14	2.11	11	1.83	***	22	1.41	2	1.56	***
Malayan Dwarf x Niu Leka	20	178	9	1.51	***	19	1.15	8	1.13	***
Malayan Dwarf x Kar Kar Tall	11	1.73	16	1.53	***	22	1.15	2	0.97	***
Malayan Dwarf x Malayan Tall	22	2.00	3	1.40	***	19	1.34	5	1.06	***
Malayan Dwarf x Markham Valley Tall	9	1.98	16	1.93	***	21	1.25	3	1.04	***
Malayan Dwarf x Panama Tall	21	1.92	6	1.96	n.s.	22	1.41	2	1.35	n.s.
Malayan Dwarf x Peru Tall	15	1.79	10	1.36	n.s.	16	1.18	7	1.01	***
Malayan Dwarf x SarwakTall	11	1.99	16	1.86	***	19	1.30	5	1.05	***
Malayan Dwarf x Thailand Tall	23	1.89	5	1.67	***	17	1.37	7	1.01	***
TOTAL	168		116			210		60		
MEAN +/- S. E.		1.86 +/- 0.07		1.67 +/- 0.07			1.28 +/- 0.03		1.12 +/- 0.05	

Source: Coconut Industry Board (1989)

Planting of Coconuts in Non-Traditional Areas: This strategy employs diversity of crop location to areas not previously planted with coconuts on a commercial scale. It is aimed at assisting survival of the industry in the event of a major disease outbreak in the traditionally planted areas.

Sanitation: This strategy involves rouging of farms with prompt removal of diseased palms, in order to hinder or arrest disease spread. This serves to 'buy time' until resistance investigations at the molecular level are accomplished. The Coconut Industry Board has a running Tree Felling Programme which assists farmers in this activity.

Landscape Epidemiology: The concept of geoinformatics is used to assess the potential risk of lethal yellowing (and other factors), based on the location and terrain of the farm (Brooks et al., 2008; Chellemi et al., 1988; Plantegenest et al., 2007; Wallace, 2010). It was discovered that due to the wind-borne nature of the phytoplasma vector(s), coconuts planted on the windward side of a mountain range, on coastal plains and at the base of wide river valleys were especially vulnerable to lethal yellowing disease infection. The intent of this exercise is to heighten the awareness of existing and prospective farmers of the levels of lethal yellowing disease risk involved at a given site, and the level of mitigation strategies that might be needed. This work is still in progress.

Molecular Markers: Molecular markers (and respective molecular probes) for lethal yellowing resistance are being investigated and developed (Wallace, 2012). This has the potential to circumvent the need for lengthy (and uncertain)

Figure 3. Severe drought conditions at Plantain Garden Field Station in St. Thomas in 2015.
Source: Coconut Industry Board Report, 2016

Brazil Green Dwarf after Severe Drought in 2015

Brazil Green Dwarf after 2021 Wet Season

Figure 4. Illustration of Impact of and Recovery from Severe Drought Conditions at Plantain Garden Field Station in St. Thomas in 2015.
Source: Coconut Industry Board Report, 2016

field exposure and assessment. This work is still in progress. There is, however, a promising population consisting of a subset of Malayan Dwarf identified by microsatellite technology (Myrie, 2012) that is currently being assessed in the field.

Tissue Culture: Jamaica currently partners with Mexico in the production of tissue culture coconut material. Arrangements are in progress for the hardening stage of plantlets supplied to Jamaica. This holds the prospect of increased rate of production of planting material to farmers.

CONCLUSION

The search continues for a collection of coconut varieties / hybrids with the potential to perform successfully under local commercial and environmental conditions. This will make a significant contribution to sustainable coconut development in Jamaica. The collective results of these investigations will inform their selection/development.

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Coconut Biomass Waste Briquettes: Innovative Approach in the Valorization of Coconut Biomass Waste

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Coconut palm is one of the most extensively cultivated crop in Kerala and it grows virtually everywhere in the state. Nowadays coconut cultivation is severely affected by amplified entemopathogenic incidents or by occurrence of climate change and natural disasters. To improve the productivity of coconut, replanting of senile and disease advanced palms are recommended, which results in enormous amount of palm wastes, that can be further used in economically feasible ways like coconut briquettes. Due to high heating value of palm stems, there is a worldwide focus on the production of energy briquettes with palm wastes, especially in countries where its availability is high and inexpensive.

What are briquettes?

Briquetting is the process of converting low density biomass into high density and energy concentrated solids ie. briquettes. Briquettes are fuels whose energy conversion occurs through direct burning and are used for heating and cooking, for domestic or industrial uses. The production of briquettes is commonly associated with second-generation biofuels, promoting the reuse of agricultural and forestry residues such as stem, bark, leaves, straw, wood or sawdust. Production of briquettes from waste materials is getting more emphasis in the view of waste management. Solid waste management and the increasing energy demand are a global concern. Waste can act as an alternative fuel, partly reducing the environmental footprint in the waste management sector. Waste briquetting is used as a treatment option for improving waste combustion efficiency, as well as its management and handling. Briquettes are very cheap as they are manufactured from waste. Besides, the product gains more value due to its ease in transport, handling and storage.

Figure 1. Coconut biomass briquette

Table 1. Specifications of coconut biomass waste briquettes

Properties	Specifications
Diameter (cm)	7.5
Density (g/cm^3)	1.15
Moisture content (%)	<5
Ash content (%)	~ 20
Calorific value (MJ/kg)	~ 18
Texture	Smooth
Cohessiveness	Compact
Shape	Cylindrical

Calorific value of briquette is one of the important aspects which affects the combustion behavior and is directly related with efficiency of the briquettes.

Calorific value is measured using bomb calorimeter, and the values are nearly 3,300 cal/g for saw dust briquettes and 2,300 cal/g for coir pith briquettes. Higher ash content lowers the calorific value. The ash formed during combustion causes slagging and fouling which in turn lead to corrosion. Agricultural waste-based and wood-based briquettes are the most investigated, because they have a calorific value of 16.22 ± 1.65 MJ kg^{-1} and 19.03 ± 2.46 MJ kg^{-1} respectively. Biomass briquettes can meet the energy demands for cooking and heating needs, especially in rural areas where abundant biomass feedstock is available and it is more cost effective compared to electricity, fuel wood, gas and kerosene.

Coconut biomass waste briquettes

For the production of coconut biomass waste briquettes, the biomass materials like coconut shell, husk, leaf and wood will be collected and sundried. The waste material is powdered either using shredder or thresher machine and then the powder is dried to get a moisture content of 10 to 15 percentage. The ideal size of the dust particle will be 6 to 8 mm in diameter. By feeding the dried coconut biomass waste powder to briquetting machine, cylindrical briquettes of 7.5 cm diameter can be produced.

Briquette production

Adequate selection and setup of processing variables are fundamental for briquetting optimization. The parameters, such as pressure, temperature, particle size, type of binder and characteristics of the chosen biomass have a great influence on the compression strength, density and energy potential of the briquettes. Based on the applying temperature and pressure, the coconut biomass waste briquettes can be produced in three ways.

Low cost briquetting machines with less efficiency will produce briquettes at low pressure. These machines are comparatively small in size and can be operated manually but addition of different kinds of binders is essential for such briquette production. A binder is a sort of glue (preferably combustible) which is compressed with the briquettes in order to prevent it from falling apart. The binders that are commonly used for making briquettes were cow dung, clay, starch, molasses etc. higher ash content and low heating value are the problems of such briquettes.

Briquettes produced using moderate pressure demands an additional heating at high temperature for setting the briquettes. Now a days briquette press machines using high pressure briquetting are widely accepted because there are no extra requirement of either binders or heating equipments. These types of briquettes have high heating value as well as low ash formation rate whereas its durability is less. High compaction technologies used for making briquettes are piston press and the screw press methods. Piston press machines produces complete solid briquettes where as screw press machine produce hollow briquettes with more surface area. The power consumption in the former is less than that of the latter. But in terms of briquette quality and production procedure, screw press is superior to the piston press technology.

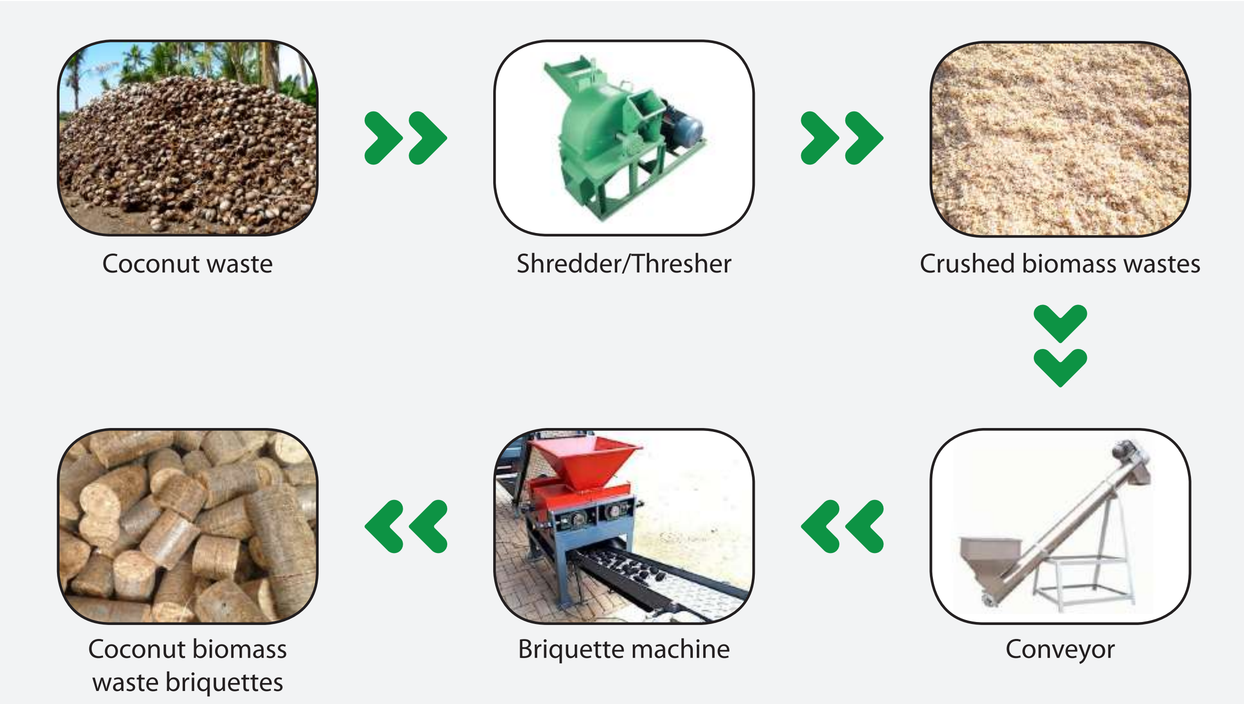

Figure 2. Coconut biomass briquette production

Coconut biomass waste briquettes

Briquetting procedure:
The steps involved in the briquetting of coconut biomass waste are described below,

1. Collection of raw material – easily available biomass waste materials and suitable binders are collected.

2. Crushing - The biomass material is sundried to remove moisture content and then powdered by shredder or thresher and the sample was sieved in order to remove large particles to make uniform briquettes

3. Drying - The pulverized materials are again sun dried to remove remaining moisture content and is completely dried

4. Briquetting - The mixture of biomass and binders are then introduced into the briquetting machine and briquettes are prepared

Future prospects

Coconut biomass waste briquettes are a biofuel substitute to coal and charcoal. As like other biomass briquettes, the main objectives of production of coconut biomass waste briquettes are for using or electricity generation, heat and cooking fuel. In addition to the researches related to fuel efficiency, production of nutrient enriched coconut biomass waste briquettes as a slow release fertilizer is also in progress to increase fertilizer use efficiency and to improve soil physical properties.

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Drought Management Strategies in Coconut

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Coconut (Cocos nucifera L.) palm often referred to as the "Tree of Life," holds a special place in the agricultural landscape of Karnataka, India. Coconut has many uses, including providing food, beverage, wood, medicine and edible oil and ornamental aesthetics. With a crop area of about 2.15 million hectares, India is the world's third largest coconut producer, growing the crop in four of its southern states: Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. The coconut palm generally grows well in areas receiving an annual rainfall of 1300 to 2500 mm or more. A prolonged dry season lasting for up to four months may adversely affect the palms. This constraint occurs recently in various coconut growing states. This erratic behaviour of monsoon has made the sustainability of coconut production dangerous. The drought stress not only causes decline in productivity and also could be the reason for mortality of palms in extreme cases.

Drought is one of the most important limiting factors for crop productivity and ultimately the food security in the wake of changing climate. The reduced precipitation and changed rainfall patterns are causing the frequent onset of droughts around the world. Severe droughts cause considerable decline in crop yields through negative impacts on plant growth, physiology and reproduction. Plants are subjected to the drought conditions when either the water supply to the root is limited or the loss of water through transpiration is very high. Coconut is mainly grown as a rainfed crop and the

Figure 1. Drought management and soil moisture conservation

productivity is 50% more when cultivated under well irrigated areas. Coconut is a perennial crop with long duration of inflorescence primordia initiation to nut maturity (about 44 months duration). Pre fertilization period is about 32 months and post fertilization period are around 12 months. Hence drought occurred in any of these critical stages of the inflorescence development stages affects the nut yield. The effects of drought could be observed in next three years. In worst affected situations, it takes four years to recover. Drought at early stages affects the growth and lead to seedling mortality. Depending on the soil type and the critical level of soil moisture, the water stress on coconut varies.

Effect of drought on coconut palm

Drought stress in plants is characterized by reduced leaf water potential and turgor pressure, stomatal closure, decreased cell growth and enlargement (Farooq et al., 2009). Drought stress reduces the plant growth by influencing various physiological as well as biochemical functions such as photosynthesis, chlorophyll synthesis, nutrient metabolism, iron uptake and translocation, respiration and carbohydrates metabolism (Jaleel et al., 2008 and Farooq et al., 2009) Drought slows down the activity of the growing point of stem. Leaf production is reduced and causes early aging and collapse. Palms without a minimum of about twenty leaves lack the vitality to produce nuts. Droughts arrest spikelet formation in the inflorescence bud, resulting in loss of female flowers. Heavy button shedding and immature nut fall is observed. Weight of fruit, husk and endosperm is reduced. When soils dry up for prolonged periods, outer cells in the absorbing region of roots develop thickened walls through which water cannot enter. The typical symptoms of drought affected coconut palm is bending and breaking of dry leaves, poor spathe development and bunches with one or two nuts. Activity of roots and transpiration rates also show marked variations.

Figure 2. Mulching technique, with husk and farm waste

Drought management techniques

Drought management involves soil moisture conservation measures like mulching around palms by spreading vegetable material, e.g. coconut fronds, husks, lopping of trees and shrubs and plant management. These strategies should be effectively transferred to the farmers to minimize socioeconomic losses of the coconut sector

Mulching

Mulching can be done with various types of organic materials like dried coconut leaves or any other leaf material. The best time for mulching is before the end of the monsoon and before the top soil dries up. To cover 1.8 m radius of coconut basin, 10 to 15 fallen coconut leaves are required and can be spread in two to three layers. Mulching with composted coir pith to 10 cm thickness (around 40-50 kg/palm) around coconut basin is also an ideal method to conserve moisture. Coir pith can hold moisture five times its weight. Due to its fibrous and loose nature, incorporation of coir pith considerably improves the physical properties and water holding capacity of soil. Coconut husks are also used as surface mulch around the base of the palm. It can hold moisture to the tune 3 to 5 times of its weight. Mulching is

Figure 3. Half-moon bund around coconut basin reinforced with pineapple

usually done up to a radius of 2 m leaving 30 cm near the palm and approximately 250 to 300 husks will be required for mulching one coconut basin. Two layers of husk may be buried in the coconut basin with the concave side facing upwards. Effect of this mulch lasts for about 5-7 years.

Husk burial

Burial of husk in trenches in between the rows of palms is also effective for moisture conservation in coconut gardens. Husk burial is to be done at the beginning of the monsoon, in linear trenches of 1.2 m width and 0.6 m depth between rows of palms with concave side of husks facing upwards and each layer is to be covered with soil.

Catch pit filled with coconut husk

Catch pits can be constructed at slopes to conserve soil and water. Though there are no standard dimensions for catch pits, catch pits of 1.5 m length x 0.5 m width x 0.5 m depth can be constructed. A bund is to be made at the downside using the excavated soil and pineapple suckers may be planted on it. This pit is also to be filled with coconut husk.

Catch pit filled with coconut husk and farm waste

Catch pits can be constructed at slopes to conserve soil and water. Though there are no standard dimensions for catch pits, catch pits of 1.5 m length x 0.5 m width x 0.5 m depth can be constructed.

A bund is to be made at the downside using the excavated soil and pineapple suckers may be planted on it. This pit is also to be filled with coconut husk.

Half-moon bund around coconut basin reinforced with pineapple

This measure is to be taken up where there is mild slope (15-20%). Here a flat basin with a slight inward slope towards upstream is made by excavating soil from the upstream side and filling the excavated soil at the downstream side. After making the basin, a bund of 30 cm height and >50 cm width is made at the down stream side of the coconut using the excavated soil. Two layers of pineapple plants could be planted with a spacing of 20 cm row to row and 20 cm plant to plant on the bund. The bund prevents runoff and water gets collected within the basin and percolates down. Pineapple would help to protect the bund and stabilize the same in addition to giving fruit yield.

- **Pottasium application:** Potassium can be applied at double recommended dose than regular fertilizer application. Common salt also applied at 2 kg/palm. Potassium regulates water economy and thus enabling the palm to withstand drought. Potassium is also known to help root development in certain locations, enabling the palm to take up more nutrients from the soil.

Conclusion

Coconut palm is influenced both by environmental and soil droughts, as the palms are mainly cultivated on the coastal sandy, red sandy loam and laterite soils as rainfed crop. Drought induces several biochemical and physiological responses in plants, and it is one of the most adverse environmental factors of coconut plant growth and nut production. As coconut is perennial in nature, the impact of drought stress will be having long-standing ill effects, consequently, which may adversely affect the economy of coconut sector. Hence there is much need for the adoption of mitigation measures for soil moisture conservation techniques to manage the drought conditions in coconut without hampering the nut production.

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

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. 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

Experts' Finding
on the Health Benefits of Coconut

DR. D. P. Athukorale
Cardiologist, Pharmacologist, Academician, Colombo, Sri Lanka

Green Coconut has much water and is rich in proteins, minerals, vitamins, calcium, phosphores, iron, iodine, chlorine, sulphur, potassium, carbohydrates and vitamins, B1, B2, B5 and magnesium. The water also helps the hydration of the body. The green coconut has a ratio of amino acids arginine, alanine, cisteína (essential) and serina, greater than those found in cow's milk. It is perfect and natural isotonic to restitute energies in the human body.

Tender coconut water has been used in other areas of the world where intravenous solutions cannot be obtained. Japanese have used tender coconut water (T. C. W.) intravenously in Sumatra, Indonesia in World War I. Pradera et. al. have used intravenous T. C. W. for pediatric patients in Havana, Cuba without any serious reactions.

Source: Dr. D.P. Athukorale 2008. Tender Coconut Water – Its Health Benefits Cocoinfo International, 15 July: 14-16

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. (Mrs.) E.R.H.S.S. Ediriweera
Senior Lecturer, Department of Nidana Chikithsa, Institute of Indegenous Medicine, University of Colombo, Rajagiriya, Sri Lanka

- Young coconut water could be drunk to alleviate the burning sensation during micturition
- Young coconut water, breast milk, treacle of *Saccharum officinarum* (*F. Graminae*) and sugar are mixed together and given for hiccough
- Leaves of *Dregia volubilis* (*F. Asclepiadaceae*) are to be pounded and mixed with tender nut water. The juice is extracted and given in treatment of poisoning of *Nerium indicum* (*F. Apocyanaceae*)
- Water of young king coconut (before flesh is formed inside) is given for fever and it can be consumed as a diuretic in dysuria.
- A King coconut is to be opened by slicing off the top.30 gms of powdered fruits (without seeds), of *Terminalia chebula* (*F. Combretaceae*) are added to the King coconut water inside and stirred. Sliced top is then replaced (as a cover) and kept outdoors in the dew overnight. Following morning, the mixture inside is to be filtered and drunk as a purgative. This is called El Vireka by Sri Lankan traditional physicians. The number of bowel motions will increase as the person continues to drink cold water from time to time during the morning. He should not consume hot or warm food and liquids. This is good for purifying blood and cooling the body.

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 2024

Alit Pirmansah[1]

In 2024, the global production of lauric oils is forecasted to see a modest expansion, with output expected to reach 11.58 million tons, a slight increase of 0.1% from the 11.57 million tons produced in 2023. This growth, however, masks a significant contrast between the two key oils that dominate this market: palm kernel oil (PKO) and coconut oil (CNO).

2024, the global production of lauric oils is forecasted to see a modest expansion, with output expected to reach 11.58 million tons, a slight increase of 0.1% from the 11.57 million tons produced in 2023. This growth, however, masks a significant contrast between the two key oils that dominate this market: palm kernel oil (PKO) and coconut oil (CNO).

In contrast to the decline in coconut oil production, palm kernel oil production is anticipated to grow by 67 thousand tons in 2024. This increase is expected to be led by the largest palm kernel oil-producing nations, Indonesia and Malaysia. Indonesia is projected to expand its palm kernel oil output to 5.0 million tons, while Malaysia's production is expected to reach 2.15 million tons. This growth reflects the resilience of the palm oil industry, which continues to expand despite environmental concerns, particularly surrounding deforestation.

The growing palm kernel oil production highlights a diverging trend between the two main lauric oils.

Table 1. Coconut Oil Production, 2022-2024 (000MT)

Countries	2022	2023	2024e
Philippines	1,359	1,245	1,238
Indonesia	886	893	850
India	360	368	370
Mexico	132	131	130
Sri Lanka	67	61	54
Malaysia	55	56	56
Vietnam	41	41	41
Papua New Guinea	47	44	46
Thailand	29	29	29
Other countries	**265**	**269**	**268**
World	3,241	3,137	3,081

Source: Oil World and ICC estimates

While coconut oil producers struggle with declining output, palm kernel oil producers are capitalizing on their ability to ramp up production, particularly in response to rising global demand.

The decline in coconut oil production is likely to have a significant impact on global import demand. With lower production levels, the availability of coconut oil on the global market will be constrained, and as a result, import volumes are expected to decrease by at least 52 thousand tons in 2024. Despite this decline,

Table 2. Palm Kernel Oil Production, 2022-2024 (000MT)

Countries	2022	2023p	2024e
Indonesia	4,835	4,968	5,000
Malaysia	2,097	2,117	2,150
Thailand	296	308	300
Nigeria	163	168	171
Other countries	**844**	**867**	**874**
World	8,235	8,428	8,495

Source: Oil World and ICC estimates

Table 3. Coconut Oil Imports, 2022-2024 (000MT)

Countries	2022	2023	2024e
EU-27	691	654	654
USA	535	415	460
Malaysia	360	262	200
China	219	182	210
UK	24	20	20
Other countries	**520**	**641**	**578**
World	2,349	2,174	2,122

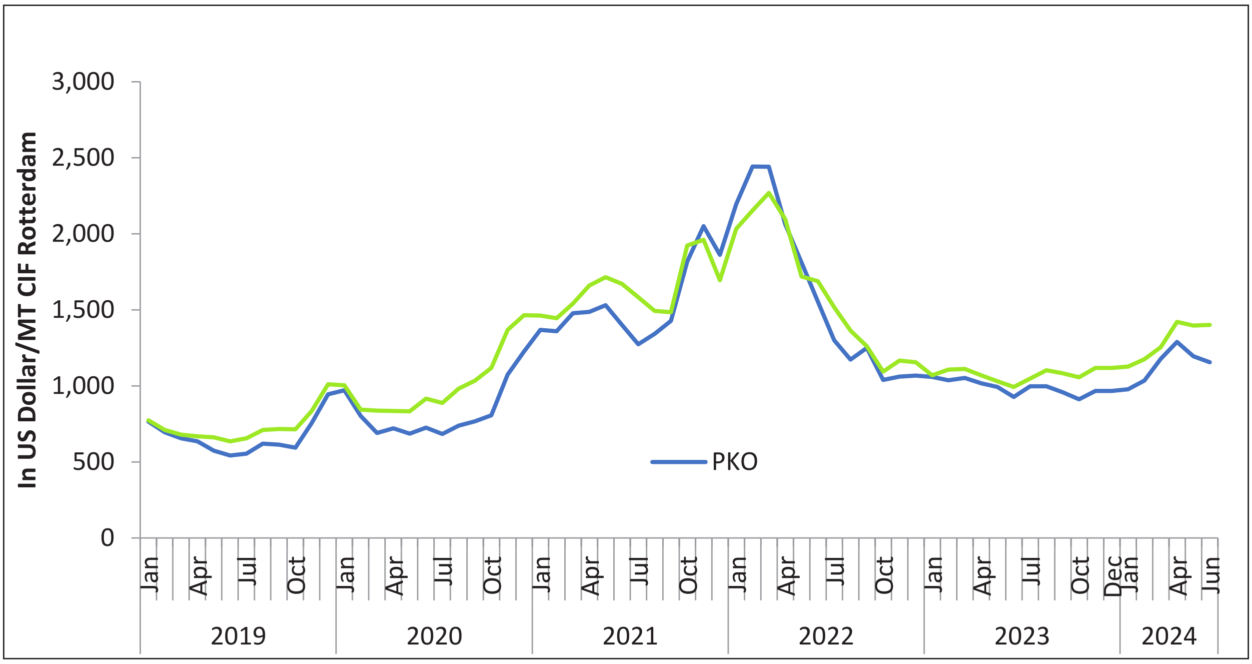
Source: Oil World and ICC estimates

demand for coconut oil in certain markets remains stable or is even projected to increase slightly.

In Europe, for example, demand for coconut oil is expected to remain steady, with a slight possibility of growth due to regulatory shifts such as the European Union Deforestation Regulation (EUDR). European buyers are increasingly concerned with the sustainability of their supply chains, and coconut oil, which is seen as a more sustainable option compared to palm kernel oil, could see a small uptick in demand. In the United States, coconut oil import demand is projected to rise by 11%, driven by a growing interest in plant-based and health-conscious products. Similarly, China is expected to significantly increase its coconut oil imports, with a projected increase of 28 thousand tons.

In contrast, the higher price premium of coconut oil relative to palm kernel oil is expected to prompt many buyers to shift their focus toward palm kernel oil. As a result, global demand for palm kernel oil is forecasted to increase by 96 thousand tons in 2024. Specifically, European demand for PKO is expected to rise by 17 thousand tons, while U.S. imports are projected to increase by 30 thousand tons, reflecting a broad shift in global consumption patterns. Other markets around the world are also expected to follow this trend, with at least 60 thousand tons of additional palm kernel oil imports projected globally.

Figure 1. Price Trend of Lauric Oils, January 2019-June 2024 (USD/MT)



Source: Oil World

Table 4. Palm Kernel Oil Imports, 2022-2023 (000MT)

Countries	2022	2023e	2024e
EU-27	600	604	621
USA	348	345	375
China	535	720	720
Malaysia	252	161	150
Brazil	230	220	250
Other countries	**973**	**1,144**	**1,174**
World	2,938	3,194	3,290

Source: Oil World, USDA, and ICC estimates

The global consumption of coconut oil is expected to decline in line with falling production levels. The contraction in production is likely to curtail both exports and domestic consumption. Exports of coconut oil are projected to decrease by around 140 thousand tons in 2024, while domestic consumption is expected to decline by 64 thousand tons. However, the global impact of this contraction may be mitigated by reductions in stockpiles. Global coconut oil stocks are projected to decrease by 47 thousand tons, offsetting some of the reductions in consumption and exports.

Lauric oils witnessed significant price increases during the first half of 2024. Palm kernel oil (PKO) started the year at US$978/MT, gradually rising to US$1,156/MT by June. Coconut oil (CNO) saw a similar trend, with prices increasing from US$1,126/MT in January to US$1,400/MT in June.

The average price during this period was US$1,138/MT for PKO and US$1,295/MT for CNO. When compared to the same period in 2023, PKO prices had risen by 12%, while CNO experienced a 22% increase. This price divergence is expected to persist, with coconut oil maintaining its premium over palm kernel oil due to sustained demand, particularly in Europe. As the EUDR regulations come into effect, European buyers are likely to favor coconut oil over palm kernel oil due to its perceived sustainability benefits, further reinforcing its price strength.

The lauric oils market is set for a dynamic and challenging year in 2024. The projected decline in coconut oil production, coupled with rising palm kernel oil output, will shape the market's supply and demand dynamics. Shifts in consumer preferences, particularly in response to price differentials and sustainability concerns, are expected to drive significant changes in global demand patterns.

For industry stakeholders, it is crucial to closely monitor these trends and adapt to the evolving market landscape. The continued rise in palm kernel oil production offers opportunities for growth, but the price premium commanded by coconut oil, driven by regulatory pressures and shifting consumer behavior, will continue to influence purchasing decisions. This report provides a comprehensive analysis of the key factors shaping the lauric oils market in 2024, equipping stakeholders with the insights needed to navigate this complex and evolving sector.

[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	
	2023	2024e	2023	2024e	2023	2024e
Beginning Stocks	440	297	1,350	1,302	1,790	1,599
Production	3,137	3,081	8,428	8,495	11,565	11,576
Imports	2,174	2,122	3,194	3,290	5,368	5,412
Total Supply	**5,751**	**5,500**	**12,972**	**13,087**	**18,723**	**18,587**
Exports	2,464	2,324	3,290	3,319	5,754	5,643
Domestic Consumption	2,990	2,926	8,380	8,522	11,370	11,585
Ending Stocks	297	250	1,302	1,246	1,599	1,359
Total Distribution	**5,751**	**5,500**	**12,972**	**13,087**	**18,723**	**18,587**

Source: Oil World, USDA, and ICC estimates

NATIONAL COCONUT WEEK IN KENYA

International Coconut Community (ICC) recently attended the inaugural National Coconut Week held from 18th to 19th April 2024 at the Kilifi Convention Centre in Kilifi County, Kenya. Organized by the Agriculture & Food Authority, Nuts and Oil Crops Directorate, Kenya, the event aimed to promote sustainable development and investment opportunities in the coconut industry.

Dr. Jelfina was invited as a panelist for a seminar focusing on the global scenario of sustainable and resilient coconut industry. During her presentation, she introduced ICC as an intergovernmental organization of coconut-producing countries and emphasized the importance of attracting investment in the coconut industry. She highlighted the challenges and enormous potential of coconuts as the "tree of life" and a source of green energy. Dr. Jelfina stressed the need for sufficient coconut supply to drive investment and encouraged increased consumption of coconut products to meet family needs for healthy coconut products and improve economies. Additionally, she informed the audience that ICC has released quality standards of coconut products as references for member countries to meet market requirements.

Furthermore, ICC Technical Working Group member, Dr. Lalith Pereira, provided valuable technical guidance on sustaining the coconut sector through sustainable farming practices. He emphasized the importance of rehabilitating existing coconut palms, gradually replanting senile palms, and establishing seed gardens to ensure the long-term sustainability of the sector.

As part of the event, a small exhibition showcased various coconut products including coconut oil, Virgin Coconut Oil (VCO), coconut flour, desiccated coconut, and briquettes. This exhibition provided attendees with insights into the diverse range of products that can be derived from coconuts, further highlighting the economic potential of the industry and the need to enhance product quality to compete in local and global markets.

The first National Coconut Week kicked off on 17th April, with the Minister of Agriculture encouraging farmers to replant coconuts during the favorable rainy season. The government distributed coconut seedlings to farmers, emphasizing the importance of coconut cultivation for both health benefits and improving family incomes.

Dr. Jelfina's visit to Kenya and her participation in the National Coconut Week underscored the ICC's commitment to promoting sustainable development and investment in the coconut industry, while also fostering collaboration and knowledge-sharing among coconut-producing nations.

COCONUT FESTIVAL 2024 : PROMOTING SUSTAINABLE AGRICULTURE AND CIRCULAR ECONOMY IN INDIA'S COCONUT SECTOR

Dr. Jelfina C. Alouw, Executive Director of the International Coconut Community (ICC), and Mr. Alit Pirmansah, Market and Statistic Officer, participated in the Coconut Festival 2024, held at the Anna Auditorium of Tamil Nadu Agricultural University (TNAU) in Coimbatore, India. The event was a collaborative effort between TNAU, the Parachute Kalpavriksha Foundation, and the Coconut Development Board (CDB), featuring a symposium, exhibition, and an awards ceremony honoring key stakeholders for their significant contributions to India's coconut sector.

The event was inaugurated by Coimbatore Collector Kranthi Kumar Pati, who emphasized the importance of mechanization in coconut farming. He encouraged farmers to adopt technologies such as harvesters, coconut peeling machines, and fertilizer-spraying drones to enhance productivity and reduce costs, particularly in light of the current labor shortages.

Dr. Jelfina C. Alouw delivered the keynote address. She said that this year, we are celebrating the coconut festival under a timely and visionary theme "Coconut for a Circular Economy & Partnership for Maximum Value." This theme reflects the essence of what the coconut industry must aspire to in the years ahead—a sustainable, inclusive, and innovative approach that maximizes the value of every part of the coconut, from the tree to the fruit, and beyond. She expressed the ICC's commitment to fostering partnerships and supporting initiatives that drive the transition to a circular economy. Other distinguished speakers included Dr. V. Geethalakshmi, Vice-Chancellor of TNAU, Nitin Kathuria, Director of the Parachute Kalpavriksha Foundation; Kamatchi Chellammal, recipient of the 2024 Padma Shri Award and Hanumantha Gowda, Chief Coconut Development Officer at CDB.

The symposium was divided into two sessions. The first session underscored the importance of collaboration within the coconut industry to promote sustainable agriculture, featuring nine speakers, including Dr. Alouw who was sharing insights on global opportunities and partnerships within the coconut industry. The second session, with eight speakers, focused on the role of coconuts in a circular economy, highlighting innovations aimed at fostering a sustainable future.

COCONUT SHELL EXPORT PRODUCTS IN SRI LANKA ACHIEVE INCREASE

The export of coconut shell products earnings such as active carbon has been able to achieve an increase of 11.25 percent up to 11.7 million USDs in 2024 February, said Mr. Mahinda Amaraweera, Minister of Agriculture and Plantation Industries.

Yesterday, a special program took place at the Southern Lanka Coconut Training Center in Madamulana to celebrate the 52nd anniversary of the establishment of the Coconut Cultivation Board. Dr. Madhavi Herath, the Chairman of the Coconut Cultivation Board, along with the General Manager Athila Wijesinghe and other officials, participated in the event. The Minister of Agriculture and Plantation Industries, Mr. Mahinda Amaraweera, presided over the commemorative ceremony.

Coconut growers, farmers and industrialists participated in this event. Distributing coconut saplings as well as granting loans under Kapruka Credit Investment Program took place during the event. At the same time, an awareness program was also implemented under the theme of 'Protecting the Kapruka like the children' by focusing on school students.

The Minister who expressed his views here, told that the Central Bank of Sri Lanka has issued a report on the progress of exporting products related to the coconut industry in the country for the month of February andaccordingly, compared to the month of February 2023, the export income of coconut and related products has grown by 25.17 percent in the month of February 2024. In terms of exporting coconut water, 3439 metric tons have been exported in the month of February 2024 and an income of 894 million rupees has been earned.

The export of coconut milk earned 2971 million rupees in February this year. Also, in terms of activated carbon earnings, the export of coconut shell products increased by 11.25 percent to 11.7 million USD in 2024.

Also, it has been predicted that this year we will be able to reach the goal of earning one billion USDs in income from export coconut and its related products for the first time.

However, in order to get more income from coconuts and related products, we can avoid wasting coconuts. Our country is the first country in the world to waste coconuts. I advise the Coconut Cultivation Board as well as the Coconut Development Authority to take steps to provide people with new technical knowledge on how to reduce wastage in using coconut for food.

It is also predicted that we will be able to reach 3000 million coconuts this year. In the past, our main export crops were tea, coconut and rubber. Later, this position has taken over the supplies services such as house maids. Now again, tea, coconut and rubber stand out as the most profitable plantation crops in the world.

Therefore, we have to dedicate ourselves to achieve rapid growth in these sectors, minister concludes *(Daily News)*

INDONESIA SUPPLIES 27% OF THE WORLD'S COCONUTS, LOMBOK BECOMES A CENTER FOR DOWNSTREAM EXPORTS

Indonesia is set to produce 17,190,327 tons of coconuts in 2022, representing 27 percent of the world's coconut production. In 2023, the country is expected to export coconut and its derivatives, generating a revenue of 1.5 billion US dollars. Indonesian coconuts are becoming a valuable commodity.Quoted by the Antara news agency from an official release, the Ministry of Industry stated that Lombok Island, in the Province of West Nusa Tenggara (NTB) is considered to be a model or center of excellence for the coconut processing downstream program.

Putu Juli Ardika, Director General of Agro Industry in Jakarta, stated that the potential for coconut in Lombok is very abundant. Therefore, his party will maximize this potential by compiling a roadmap for integrated coconut downstreaming and establishing an appropriate business model to develop the coconut processing industry ecosystem.

"Currently, the Ministry of Industry together with relevant stakeholders are preparing this coconut roadmap," he explained during a working visit to Lombok last week.

In realizing this supporting ecosystem for coconut downstreaming, from 2022 to 2024 the Argo Industry Directorate disbursed Special Allocation Funds (DAK) amounting to IDR 16.8 billion to North Lombok Regency.

The Director General of Agro Industry stated that North Lombok was chosen because the coconut industry players in that region can produce Virgin Coconut Oil (VCO), oil, and coconut flour.

Then, in addition to the downstream road map and establishing a good ecosystem, the Directorate of Agro Industry will carry out training to improve the quality of local human resources (HR), in order to maximize the potential of the processing industry in the Lombok region.

"Human resources also need to be paid attention to in order to keep up with the times and consumer demands. We recognize the need for HR training, which can be facilitated by the Industrial Human Resources Development Agency, or BPSDMI, of the Ministry of Industry," he concluded. *(Suara)*

THE CHIEF MINISTER OF INDIA ANNOUNCES COCONUT FARMERS SUPPORT MEASURES

M K Stalin, the chief minister of Tamil Nadu, has declared financial assistance for coconut producers whose crops have been impacted by pest infestations.

At a function held in Pollachi, the Chief Minister said ₹14.4 crore will be distributed to farmers to remove the pest infested trees and three lakh coconut saplings will be distributed free of charge to farmers which are worth ₹2.80 crore. The government will also enable farmers to sell coconut.

Mr. Stalin said a new bus stand will be constructed in Ukkadam in Coimbatore city at ₹20 crore and a hockey playground will be developed at the R.S. Puram Corporation Higher Secondary School.

He also inaugurated a new super-speciality block constructed at ₹163.53 crore at the Coimbatore Medical College Hospital and spread over 1.95 lakh sq.ft.

A new facility to house the Centre of Excellence in Biotechnology at Tamil Nadu Agricultural University (TNAU), Coimbatore, was inaugurated by the Chief Minister.

An allocation of ₹430 crore was made in the Assembly for establishing the facility for undertaking research activities in crucial sectors such as agricultural science, food technology, green biotechnology, biosynthesis, bioresource utilisation and bioinformatics.

The announcements for Tiruppur district include road developments, construction of an office complex for Tiruppur corporation at ₹75 crores, construction of 13 community halls at ₹11.17 crore, and establishment of an emergency and orthopedics ward at Palladam Government Hospital at the cost of ₹4 crores.

In the Nilgiris district, the Chief Minister said the government botanical garden will be upgraded to world class standards at ₹3 crores, 10 PDS outlets functioning in private properties will be shifted to own buildings at ₹1.5 crores and two community halls will be constructed. *(The Hindu)*

PLAN TO CULTIVATE 45,000 KING COCONUT PLANTS IN 86 VILLAGES

The Coconut Cultivation Board has taken steps to prepare a program for the expansion of king coconut cultivation in Sri Lanka.

Accordingly, 86 villages have been identified as suitable areas for king coconut cultivation in the island.

A huge demand for Sri Lankan king coconut has been created in the international market and Sri Lanka has the monopoly on supplying the king coconut in the international market. The reason for this is that the taste and quality of king coconut in Sri Lanka is very high.

Also, although many countries have tried to grow king coconut, they have not been able to get the quality of king coconut in Sri Lanka. Therefore, the demand for king coconut in Sri Lanka is increasing daily.

A discussion on popularizing king coconut cultivation as a crop was held under the patronage of the Minister of Agriculture and Plantation Industries, Mr. Mahinda Amaraweera. Officers of Coconut Cultivation Board and Coconut Development Authority as well as Coconut Research Institute also participated in the event.

Accordingly, 86 villages of the island were selected and it was decided to plant 45,000 king coconut plants in those villages. minister advised that if someone wants to grow more acres of king coconut in one village even though they are selected as villages, then steps should be taken to provide the necessary facilities for that.

Under this, king coconut seedlings and technical knowledge as well as advices will be provided free of charge.

Monaragala 03 villages, 01village in Matara, 08 villages in Kurunegala, 09 in Kuliapitiya, 08 in Kegalle, 09 in Gampaha, 10 in Kalutara, 09 in Maravila, 04 in Ratnapura, 08 in Hambantota, 02 in Anuradhapura, 02 in Trincomalee, 02 in Polonnaruwa, 02 in Ampara, 04 in Matale, 08 in Galle , 02 in Batticaloa, 03 in Jaffna, 04 in Kandy and 86 villages have been selected for the program.

Minister of Agriculture and Plantation Industry, Mr. Mahinda Amaraweera, who expressed his opinion, said that the demand for king coconut also have been increased due to the dry weather these days and the prices have also increased.

But by achieving export targets of king coconut, farmers can get more income and are also the researchers are advised to carry out new technical research to introduce king coconut juice in the market as a value-added product. *(Daily News)*

RESEARCHERS TRANSFORM COCONUT JELLY BIO WASTE INTO HIGH-PURITY ADDITIVES

Researchers from the Petroleum and Petrochemical College at Chulalongkorn University (Chula), in Bangkok, Thailand, have transformed coconut jelly biowaste into valuable food ingredients.

The collaboration between Chula researchers and companies such as Ampol Food Processing, has effectively reproduced leftover coconut jelly scraps into efficient food additives.

The innovation, named 'cello-gum,' can be used in the food, pharmaceutical and cosmeceutical industries. which would potentially reduce the need for "costly imported additives" within Thailand.

The research team, led by Hathaikarn Manuspiya, is very much confident that the ingredient will propel circular economy development within the country while increasing the value of waste generated by the food and agricultural industries.

Cello-gum is a nanocellulose product made from residual jelly scraps, typically discarded as waste from the coconut jelly production process. These, which are abundant in Thaliand, are transformed into products that serve as effective additives in food and other industries.

Coconut jelly is a bacterial cellulose that possesses strong mechanical properties, high porosity and substantial water absorption capacity. It is easily moldable, biodegradable and non-toxic and when used as a composite material or additive, it ensures good adhesion of other substances.

The bacterium responsible for producing coconut jelly is Acetobacter xylinum, which can be cultured in a lab and fed with sugar and carbon sources. When the bacteria get fed, they excrete fiber, which is a good type of cellulose.

"The additives are high in purity and safe," Manuspiya explained. "Food stabilizers play a pivotal role in industries. Rice milk products, for example, additive substances are essential to maintain colloidal properties, preventing the milk from separating into layers. This enhances the texture, giving the product the appearance of containing rice. The same goes for fruit juices which often incorporate cellulose-based additives to augment content."

The collaboration with Ampol Food Processing, a global exporter of coconut jelly, aims to leverage the knowledge of bacterial cellulose to create additives that add significant value to the coconut jelly scraps.

Manuspiya added: "Upon discovering research on transforming coconut jelly scraps into high-value materials, the company expressed interest in such possibilities. Enormous amount of scrap are generated daily during the production process and typically discarded through burning. By reproducing them into additives, we can contribute to reducing Thailand's importation of various additives, which amounts over 10 Billion THB (approx. $278.5 million) per year."

She further explained that various agricultural wastes, despite containing smaller amounts of cellulose, can be turned into cello-gum. "The production process can incorporate bagasse, corn and pineapple, albeit with potential alterations or additions," Manuspiya said.

Owing to the success of cello-gum, Chula's College of Petroleum and Petrochemicals, Center for Excellence in Petrochemical and Materials Technology has launched a spin-off company, Bionext.

Bionext aims to expand commercial production capacities of cello-gum and collaborate with large companies. To do this, Bionext expects to scale up its development, conduct research and implement various projects. *(FoodBev)*

MALAYSIA TO TAKE STERN ACTION AGAINST DISCRIMINATORY PALM OIL PRODUCTS LABELING

In a statement, the Ministry of Plantations and Commodities (KPK) said it will take the issue of discriminatory or negative labeling of palm oil products seriously and will take strict action in accordance with the laws and regulations against importers, traders, sellers, and related parties who commit such offenses. The penalty for a violation of the regulation is a fine of up to RM220,000 or imprisonment of up to 5 years.

The Multi-Agency Enforcement Force inspected several premises in Selangor on January 26 and revealed that some food products in these establishments were conspicuously labeled with discriminatory labeling against palm oil (DLAPO), for example, with statements such as 'no palm oil' or 'without palm oil.' These shops included those selling local products such as baby food and imported food labeled DLAPO.

According to KPK, such labeling techniques give consumers the negative impression that the use of palm oil is harmful to health if the product contains palm oil. "Apart from that, the action also damages the good reputation of the palm oil industry in the country and violates the principles of fair and transparent trade," it said. *(UCAP Bulletin)*

COCONUT INDUSTRY BOARD OF JAMAICA IS EXPANDING AGRO-PROCESSING

To satisfy rising consumer demand for coconut by-products, the Coconut Industry Board (CIB) is implementing measures to improve agro-processing. Chief Executive Officer (CEO) of the CIB, Shaun Cameron, told JIS News that while there is significant demand for coconut water and coconut oil "we want our agri-processors, our small to medium-sized farmers to look at other value-added coconut products that can add value and diversity to the industry".

"The direction that the Coconut Board is focusing on now is agro-processing – how to get cottage industries up, how to get small to medium-sized farms producing," he noted.

The Caribbean Agricultural Research and Development Institute (CARDI) in a recent statement noted that Jamaica can benefit from the global resurgence in the demand for fresh and processed coconuts.

"The dynamics in the coconut market offer fadaf tremendous opportunity to agribusiness industries in Jamaica and the Caribbean. There are huge opportunities for thousands of smallholder farmers to raise incomes and profitability by connecting them to local, regional and international value chains," the statement said.

Mr. Cameron said coconut growers and agro-processors are benefiting from the CIB's research and technical support and more players are investing in the sector.

"We were able to help revive and sustain the coconut industry by working with our farmers and our partners, applying proper research technology and good agricultural practices to come up with methods of managing and maintaining the spread of lethal yellowing disease" he said.

The disease is no longer a threat to the industry as farmers are applying the best practices that have been developed over the years.

"They've come up with hybrids that are somewhat resistant to lethal yellowing due to the research. I know the industry is looking to grow. We have more getting registered as coconut farmers because they're looking for long-term investment, something that will benefit them after they retire. The beauty of the coconut orchard is that it can be passed on from generation to generation," he said. *(Jamaica Information Service)*

GOVERNMENT OF FIJI PLEDGES TO PROMOTE THE COCONUT INDUSTRY PROGRESS

The government is dedicated to advancing the coconut sector and enhancing income by expanding coconut consumption.

Sakiusa Tubuna, Assistant Minister in the Office of the Prime Minister, emphasized this point during the inauguration of the Bu replanting and coconut training workshop in Vakacoko settlement in Naboro, in January.

He highlights that copra remains the most traded coconut commodity in Fiji, with virgin coconut oil production gaining popularity in rural and maritime communities.

Tubuna states that Fiji boasts approximately 10 million coconut trees spread across an area of around 65,000 hectares of land, with 70 percent situated in the Northern Division.

However, he says 65 percent of these trees are senile and require replanting.

The Assistant Minister also shared that the focus of the training is to economically empower and enhance the Bu coconut knowledge base in rural communities.

He says the training aims to equip participants with the necessary knowledge and skills for sustainable replanting, promoting livelihoods in the process.

Tubuna also notes that, according to their survey, Suva requires approximately 5,000 Bu nuts daily, but we are unable to meet this demand, hence the initiation of this program. *(FBC News)*

GLOBAL DEMAND FOR SRI LANKA'S KING COCONUT, GOVERNMENT PLANS BRANDING

Amidst global demand for the king coconut grown in Sri Lanka, the Ministry of Agriculture and Plantation Industries is now taking steps to cultivate it as an export crop.

"There is demand in the United Arab Emirates for king coconut from Sri Lanka. 200 containers of king coconuts are exported to the country a month," Minister of Agriculture, Mahinda Amaraweera was quoted as saying in a government information department (DGI) statement.

A king coconut from Sri Lanka sells for the equivalent of 2,500 rupees in the UAE coastal regions, the minister said, adding that demand had recently tripled.

"Many countries have tried to grow king coconut, but all those efforts have failed. The tastiest ones in the world are the Sri Lankan thembili.

"Therefore, steps will be taken to make our thembili popular in the world by branding it as Sri Lanka Sweet Coconut. The Coconut Development Board and the Coconut Development Authority will work on this."

Due to the establishment of a regulatory system by the Coconut Development Authority, a king coconut fetches about 0.8 dollars (roughly 296 rupees) at the UAE's port, according to the DGI statement.

Sri Lanka exports 252,000 king coconuts a week to the UAE, it said. "Last year we earned 2 billion rupees from exporting king coconuts, and this year the expected income is 6 billion rupees."

A king coconut export model village was established in Muruthawela this week, and 1,500 coconut saplings were distributed to families in a pilot project. *(Economy Next)*

THE PCA PROJECT AIMS TO PLANT 8.5 MILLION COCONUT SEEDLINGS IN 2024

The Philippine Coconut Authority's Massive Coconut Planting and Replanting Project, coinciding with President Ferdinand R. Marcos Jr.'s commitment to the objective of planting 100 million coconut trees by 2028, is set to plant at least 8.5 million coconut seedlings this 2024, after planting more than 2.1 million coconut seedlings in 2023.

Administrator Bernie F. Cruz states that the PCA predicts the quantity of seedlings to be planted in 2024 based on its available stocks and the number of seednuts currently sown in its nurseries, which the PCA has amassed in part through partnerships with local government units (LGUs) and coconut farmers' cooperatives and without any additional funding beyond its regular budget.

"We made use of remaining funds from previous years to partner with supportive LGUs and cooperatives to establish nurseries and expand our sources of planting materials, in compliance with the President's directives," said Cruz. "We are also maximizing our resources and stepping up our efforts in our regular planting programs."

Last October, the President reiterated the Administration's commitment to the Massive Coconut Planting and Replanting Project, which the PCA designed to address increasing senility and loss of bearing trees. The PCA had previously created a Task Force for Massive Coconut Planting and Replanting and Productivity Enhancement primarily tasked with undertaking partnerships with LGUs, coconut farmers' organizations and cooperatives, and the private and business sectors in a "whole-of-nation" approach to reach the planting targets.

Currently, more than one million seedlings are expected to be produced from provincial or communal nurseries established through partnerships with the municipalities of Sampaloc, Quezon, and Sulat, Eastern Samar; the provincial government of Camarines Sur; and the Kalipunan ng Maliliit na Magniniyog ng Pilipinas Agricultural Cooperative of Jaro, Leyte, and San Lorenzo Ruiz Farmers Agricultural Cooperative of San Lorenzo Ruiz, Camarines Sur.

Cruz anticipates a substantial increase in the amount of seedlings for planting in the coming years to rise significantly as more than two million "parental palms" shall be planted this year, which in turn shall be used to produce more high-quality planting materials under the PCA's Coconut Hybridization Program.

The Massive Coconut Planting and Replanting is an exceptional endeavor that has been carried out throughout the country since the 1970s. Cruz lauds the President's vision in supporting a multi-year effort where the benefits will be fully realized after his term in office.

"The President expressly told us not to worry about political terms. While the planting goal is for 2028, he told us to abide by a plan that looks ahead in terms of fully rehabilitating the coconut industry and ensuring that every peso invested is well-spent. We appreciate and share the President's commitment in this regard," said Cruz. *(Manila Standard)*

Statistics

Table 1. WORLD Exports of Coconut Oil, 2018-2024 (MT)

COUNTRY	2018	2019	2020	2021	2022	2023	2024[F]
A. ICC Countries	**1,806,267**	**2,045,944**	**1,684,594**	**1,727,806**	**2,170,165**	**2,052,885**	**1,955,722**
F.S. Micronesia	57	-	-	-	-	-	-
Fiji	3,261	2,487	2,533	1,460	1,210	1,948	2,043
India	7,323	6,814	7,870	12,270	20,755	16,202	17,234
Indonesia	675,138	610,812	577,645	611,452	685,797	722,517	614,522
Jamaica	5	6	9	16	29	2	16
Kenya	36	44	55	665	215	74	318
Kiribati	3,493	3,561	2,517	1,829	1,528	1,116	1,491
Malaysia	121,914	223,078	203,362	186,606	134,871	165,986	128,093
Marshall Islands	2,229	1,085	1,115	402	709	-	502
Papua New Guinea	12,566	20,975	17,732	10,099	30,184	34,637	24,973
Philippines	951,320	1,146,642	842,533	881,085	1,252,054	1,090,188	1,144,618
Samoa	141	424	8	115	100	12	76
Solomon Islands	5,432	4,561	5,272	5,225	4,554	5,974	5,551
Sri Lanka	4,606	4,056	5,180	3,825	4,712	5,518	6,107
Tonga	-	-	-	-	-	-	-
Thailand	1,268	1,337	1,745	1,686	740	836	1,087
Vanuatu	3,669	3,498	1,367	711	428	317	343
Vietnam	13,784	16,527	15,641	10,275	10,311	7,558	8,749
B. Other Countries	**317,856**	**317,371**	**339,210**	**345,928**	**347,760**	**411,012**	**368,233**
TOTAL	**2,124,123**	**2,363,315**	**2,023,804**	**2,073,734**	**2,517,925**	**2,463,897**	**2,323,955**

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

Table 2. Prices of Coconut Products and Selected Vegetable Oils, July 2023 – June 2024 (US$/MT)

Products	2023						2024					
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Copra	642	637	608	599	618	626	628	635	654	682	647	632
Coconut Oil	1,047	1,102	1,084	1,058	1,118	1,118	1,126	1,175	1,254	1,420	1,396	1,400
Copra Meal[2]	270	266	255	247	248	252	249	244	232	191	154	135
Desicc. Coconut[2]	1,690	1,690	1,690	1,690	1,690	1,749	1,764	1,800	1,874	1,874	1,911	2,006
Mattress Fiber[1]	48	51	51	57	57	58	56	64	68	67	65	57
Shell Charcoal[2]	351	350	339	335	354	360	360	363	361	365	367	363
Palm Kernel Oil	998	998	958	912	968	966	978	1,034	1,177	1,290	1,196	1,156
Palm Oil	879	861	830	804	830	814	845	857	943	936	859	874
Soybean Oil	1,136	1,127	1,112	1,134	1,118	1,062	971	912	965	959	988	1,011

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

Table 3. World Oil Balance 2022-2024 (million tons)

Oil/Year	Oct-Sept 23/24F	Oct-Sept 22/23	Oct-Sept 21/22
Palm Oil			
Opening Stocks	15.03	14.66	12.48
Production	81.52	81.53	77.46
Imports	50.65	53.30	47.38
Exports	50.59	53.47	47.81
Disappear	82.88	81.00	74.84
Ending Stocks	13.73	15.03	14.66
Soybean Oil			
Opening Stocks	6.34	6.34	6.68
Production	61.31	59.39	59.91
Imports	11.72	11.97	13.00
Exports	11.78	12.04	13.11
Disappear	61.07	59.08	60.15
Ending Stocks	6.75	6.57	6.34
Groundnut Oil			
Opening Stocks	0.24	0.28	0.30
Production	4.48	4.45	4.71
Imports	0.35	0.40	0.30
Exports	0.36	0.39	0.32
Disappear	4.46	4.49	4.72
Ending Stocks	0.25	0.24	0.28
Sunflower Oil			
Opening Stocks	4.59	3.51	2.48
Production	23.12	22.05	20.47
Imports	14.94	14.18	11.28
Exports	15.031	14.04	11.44
Disappear	23.27	21.12	19.28
Ending Stocks	4.35	4.59	3.51
Rapeseed Oil			
Opening Stocks	3.78	2.90	3.58
Production	31.11	30.23	26.12
Imports	7.25	6.98	5.31
Exports	7.21	7.09	5.35
Disappear	30.74	29.24	26.75
Ending Stocks	4.19	3.78	2.90
Cotton Oil			
Opening Stocks	0.29	0.28	0.32
Production	4.50	4.41	4.40
Imports	0.13	0.12	0.15
Exports	0.12	0.12	0.15
Disappear	4.51	4.41	4.43
Ending Stocks	0.28	0.29	0.28

Oil/Year	Oct-Sept 23/24F	Oct-Sept 22/23	Oct-Sept 21/22
Palm Kernel Oil			
Opening Stocks	1.45	1.36	1.27
Production	8.49	8.39	8.11
Imports	3.28	3.28	3.02
Exports	3.26	3.32	3.11
Disappear	8.56	8.27	7.93
Ending Stocks	1.39	1.45	1.36
Coconut Oil			
Opening Stocks	0.52	0.46	0.36
Production	3.09	3.16	3.20
Imports	2.04	2.22	2.36
Exports	2.10	2.23	2.30
Disappear	3.07	3.09	3.16
Ending Stocks	0.48	0.52	0.46

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

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