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The Current Scenario and Development of the Coconut Industry

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*Coconut (*Cocos nucifera*) or commonly known as 'tree of life' is planted in over 90 countries, mainly in Asia, Pacific Islands and South America. The total world planted area of coconut is about 12 million ha with the annual estimated potential production of 70 billion nuts. Currently, India, Indonesia and Philippines are the major coconut producers, contributing more than 75 per cent of the total global production. The coconut industry has shown rapid growth in the development of coconut products and is in great demand from the American, European, Middle East and East Asian markets. Coconut oil, copra meal, desiccated coconut and coir products are the traditional coconut products, whereas coconut water, virgin coconut oil, coconut milk and cream are amongst those that show the fastest growth. New coconut hybrids have been introduced, whereby their potential copra yield ranged from 7.65 to 9.12 tonnes per hectare per year. New invasive pests such as* Brontispa longissima, Rhynchophorus ferrugineus, Aceria guerreronis *and* Aspidiotus rigidus *have recently been reported attacking coconut farms in South East Asia. Meanwhile, lethal yellowing disease (LYD) that is caused by phytoplasma is the most devastating coconut disease that is currently affecting the coconut production in the Caribbean, Americas and African countries. However, the recent discovery of Bogia coconut syndrome in Papua New Guinea (PNG), the first report of a lethal yellowing disease in Oceania, brings great concern. The coconut industry is driven by the rapid growth and significant demand of coconut based products globally, which has proven to generate greater economic returns for the coconut producers. Therefore, the countries that are heavily dependent on a single industrial crop should take this opportunity to diversify their plantation crop to coconut as their new economic crop.*

Keywords: *Coconut production, coconut supply and demand, coconut products, planting material, pest and disease.*

Coconut (*Cocos nucifera*) is said to have been originated from the coastal areas of South East Asia in Malaysia, Indonesia and the Philippines. It was widely distributed and cultivated in the tropics and subtropics (Lim, 2012). Coconut has been planted in over 90 countries, especially in Asia, Pacific Island and South America as an important oil and food crop.

GLOBAL COCONUT PRODUCTION

The major coconut producing countries include India, Indonesia, the Philippines, Brazil, Sri Lanka, Papua New Guinea, Vietnam, Mexico, Thailand and Malaysia (*Table 1*). The total world coconut production was 69.8 billion nuts in 2014 and the production stabilised between 65-70 billion nuts annually from 2010 to 2014 (*Table 1*). In 2014, India, Indonesia and the Philippines were the largest coconut producers, producing 21.7 billion, 16.4 billion and 14.7 billion nuts, respectively. This is equivalent to 75.6 per cent of the total world production (*Table 1*). Meanwhile, Brazil and Mexico are the major coconut producers in South America with the annual production of 2.9 billion nuts and

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TABLE 1
MAJOR COCONUT PRODUCING COUNTRIES (2010-2014)

Countries	*Coconut production (billion nuts/year)*				
	2010	*2011*	*2012*	*2013*	*2014*
India	16.9	16.9	23.4	22.7	21.7
Indonesia	16.2	16.2	16.3	16.5	16.4
Philippines	15.5	15.2	15.9	15.4	14.7
Brazil	3.4	3.5	2.9	2.9	2.9
Sri Lanka	2.6	2.7	2.9	2.5	2.9
Papua New Guinea	1.5	1.5	1.5	1.5	1.5
Vietnam	0.8	0.9	1.2	1.2	1.2
Mexico	1.4	1.4	1.1	1.1	1.1
Thailand	1.0	0.8	0.8	0.8	1.0
Malaysia	0.6	0.6	0.6	0.6	0.7
World	65.6	65.4	72.1	70.9	69.8

Source: APCC (2016)

1.1 billion nuts in 2014, respectively (*Table 1*). India is the only country that showed an increasing trend in coconut production from 16.9 billion nuts in 2010 to 21.7 billion nuts in 2014, whereas production in the other countries plateaued (*Table 1*). The total world coconut planted area has been saturated at 12 million ha since 2010 until 2014. Indonesia, the Philippines and India have the largest coconut planted areas with 3.610 million ha, 3.502 million ha and 2.141 million ha, respectively and had contributed about 75.9 per cent of the total world coconut planted area. India has been aggressively expanding its coconut planting since 2010 increasing the area under coconut cultivation from 1.895 million ha to 2.141 million ha in 2014 (*Table 2*).

COCONUT PRODUCTION IN MALAYSIA

Coconut is the fourth important industrial crop in Malaysia after oil palm, rubber and paddy. The majority of the coconut planted in Malaysia is managed by smallholders as mono-crop or intercropping with cocoa, coffee or fruit crops. The total area planted with coconut in Malaysia is recorded at 84 609 ha in 2016 (*Table 3*). In terms of acreage, Sabah, Sarawak, Johor, Kelantan, Selangor and Perak are the major coconut planted states, whereby the area planted with coconut ranged between 9 266-16 600 ha (*Table 3*). Although Sabah and Sarawak were the States with the largest coconut areas in Malaysia, however, their nuts yield was very low, about 2.43-2.82 tonnes per hectare, as compared to Selangor, Perak and Johor that were able to achieve better yield at 8.14-10.74 tonnes per hectare (*Table 3*). Therefore, Selangor, Johor and Perak were the major coconut producers in Malaysia that had produced 99 674 tonnes, 95 677 tonnes and 87 890 tonnes in 2016, respectively (*Table 3*). In 2016, the annual coconut production in Malaysia was 504 772 tonnes with the average yield of 5.97 tonnes per hectare (*Table 3*). The major coconut producing region in Malaysia is mainly situated in the west coastal region of

TABLE 2
MAJOR COCONUT PLANTED COUNTRIES (2010-2014)

Countries	*Coconut planted area ('000 ha)*				
	2010	*2011*	*2012*	*2013*	*2014*
India	1895	1896	2071	2137	2141
Indonesia	3739	3768	3782	3654	3610
Philippines	3576	3562	3574	3551	3502
Brazil	273	273	279	279	251
Sri Lanka	395	395	395	395	440
Papua New Guinea	221	221	221	221	221
Vietnam	147	155	157	158	159
Mexico	179	179	176	176	169
Thailand	232	216	214	209	206
Malaysia	106	106	101	88	88
World	12021	12035	12241	12224	12196

Source: APCC (2016)

TABLE 3
MAJOR COCONUT PRODUCING STATES IN MALAYSIA (2016)

State	*Production (t/yr)*	*Planted area (ha)*	*Average yield (t/ha/yr)*
Selangor	99674	9281	10.74
Johor	95677	11751	8.14
Perak	87890	9266	9.49
Kelantan	68890	9326	7.39
Sabah	46732	16600	2.82
Sarawak	30654	12616	2.43
Pahang	29781	6135	4.85
Melaka	16490	2254	7.32
Terengganu	10692	3345	3.20
Negeri Sembilan	10109	1398	7.23
Kedah	6689	2273	2.94
Labuan	778	141	5.52
Perlis	472	183	2.58
Pulau Pinang	244	40	6.10
Total	504772	84609	5.97

Source: Department of Agriculture of Malaysia (2017)

Peninsular Malaysia, such as Sabak Bernam, Hilir Perak, Pontian, and Batu Pahat. In the east coast, the major coconut producing area is Bachok in Kelantan with the annual production of 34 620 to 91 619 tonnes in 2016. Their respective planted areas being about 3 829 to 8 662 ha with the average yield achievement of 7.8 to 10.9 tonnes per hectare

(*Table 4*). Coconut production in Malaysia declined from 539 000 tonnes in 2005 to 379 000 tonnes in 2009. However, there was an improvement in production between 2010 and 2016 achieving 505 000 to 625 000 tonnes annually (*Figure 1*). Meanwhile, the area under coconut in Malaysia gradually declined from 120 000 ha in 2005 to 85 000 ha in 2016 (*Figure 1*). The reduction of area planted with coconut in Malaysia by 30 per cent within 10 years was mainly due to the conversion of coconut planting into oil palm or other crops.

SUPPLY AND DEMAND OF COCONUT PRODUCTS IN WORLD MARKET

Coconut oil (CNO) is a major traditional product of the coconut industry. However, the CNO production in world vegetable oil market was low as compared to palm oil, soybean oil and other vegetable oils. CNO only contributed

TABLE 4
MAJOR COCONUT PRODUCING REGIONS IN MALAYSIA (2016)

Region	*Production (t)*	*Planted area (ha)*	*Average yield (t/ha/yr)*
Sabak Bernam	91 619	8 397	10.9
Hilir Perak	80 702	8 662	9.3
Bachok	51 315	5 903	8.7
Pontian	36 980	3 829	9.7
Batu Pahat	34 620	4 450	7.8

Source: Department of Agriculture of Malaysia (2017)

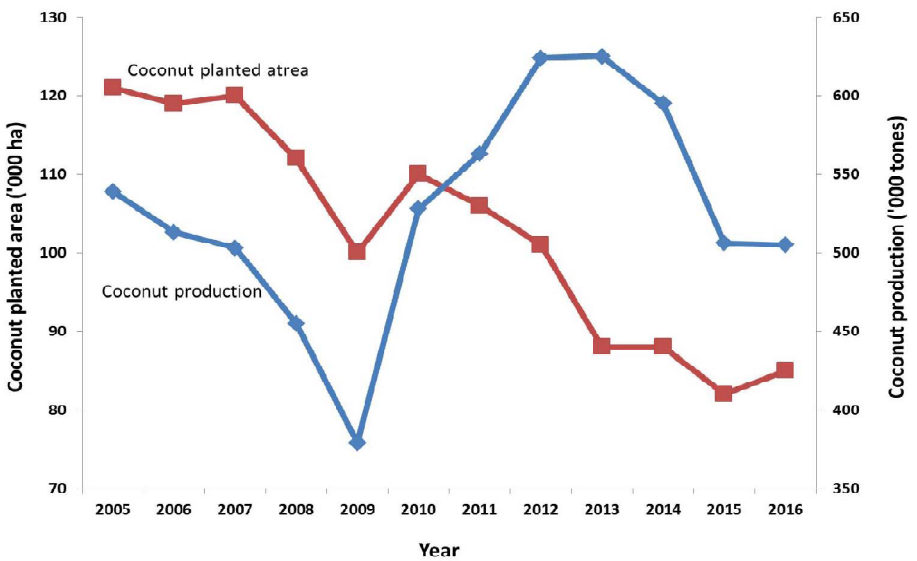

Figure 1 Trends of coconut planting and production in Malaysia (2005-2016)
Source: Department of Agriculture of Malaysia (2017)

2.65 million tonnes or 1.5 per cent of the total vegetable oils market in 2016 (*Figure 2*). The market price of CNO fluctuated between USD900-USD1 500 per tonne in 2012 to 2016. However, CNO has always enjoyed higher premium price as compared to palm kernel oil (PKO) in the lauric oil market, especially between 2014 and 2016 recording more than 20 per cent of higher premium market price (*Figure 3*). This is mainly due to the higher market demand for CNO as compared to palm kernel oil (PKO). The recorded CNO export and import volume was about 1.86 - 2.58 million tonnes from 2010 to 2014 (*Table* 5).

Copra meal, desiccated coconut, coir and coir-based products are the other traditional coconut products that are traded in the global market. Copra meal is the second largest coconut product, its export volume was 0.61-1.18 million tonnes during 2010-2014. However, its import volume declined from 1.14 million tonnes in 2010 to only 0.29 million tonnes in 2014 (*Table 5*). Coir and coir-based products recorded an increase of 0.77 to 1.02 million tonnes in its import market between 2010 and 2014, which is almost triple as compared to its export volume (*Table 5*). The export and import of desiccated coconut was more stable and maintained around 300 000-500 000 tonnes (*Table 5*).

The Philippines and Indonesia are the major exporters of CNO, copra meal and desiccated coconut, whereas the United States of America, China, the Netherlands, Germany, Malaysia, Italy, South Korea, Belgium, Japan and Russia are the major importers of CNO. Copra meal was mainly imported by South Korea, China, Vietnam, India, Taiwan and the Netherlands. The United States of America, Singapore, the Netherlands, Germany and Belgium were the largest importers of desiccated coconut. Meanwhile, coir and coir-based products are mainly exported by Sri Lanka and India to China, the United States of

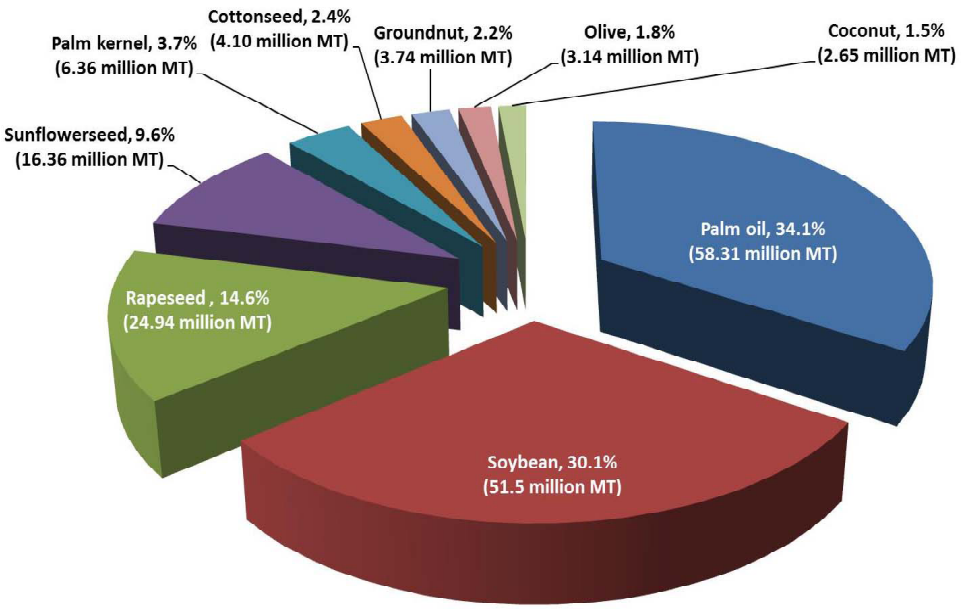

Figure 2 Major vegetable oils production in world market (2016) (Salum, 2017)

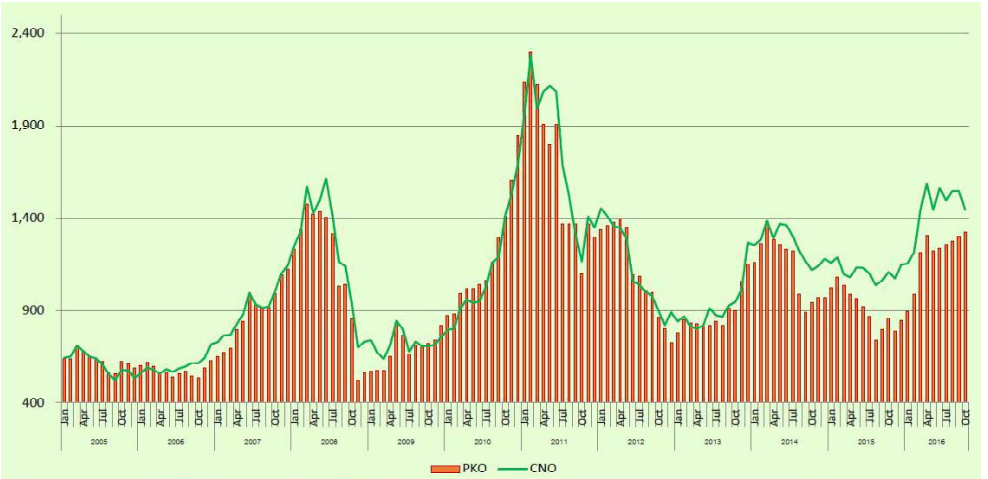

Figure 3 The price movement of CNO and PKO on lauric oil market (2005-2016) (Salum, 2017)

TABLE 5
WORLD EXPORT AND IMPORT OF MAJOR COCONUT PRODUCTS (2010-2014)

Products	*2010*	*2011*	*2012*	*2013*	*2014*
Coconut oil					
Export (tonnes)	2 417 041	1 860 582	2 083 854	2 230 963	2 190 911
Import (tonnes)	2 587 567	2 109 062	2 018 441	2 462 181	2 065 444
Copra meal					
Export (tonnes)	1 014 463	611 710	1 060 417	1 184 585	866 441
Import (tonnes)	1 138 907	614 555	675 445	674 995	291 608
Coir and coir products					
Export (tonnes)	299 820	304 505	296 701	290 654	331 021
Import (tonnes)	769 978	871 865	933 601	905 538	1 021 916
Desiccated coconut					
Export (tonnes)	354 485	386 286	360 916	386 319	440 983
Import (tonnes)	301 435	308 775	313 108	478 658	502 148

Source: APCC (2016)

America and the Netherlands (APCC, 2016).

Malaysia is an important player in the export and import markets of coconut products. Currently, Malaysia is the third largest CNO exporting country after the Philippines and Indonesia with the annual export volume of 131 068-187 665 tonnes in 2010-2014 (*Table 6*). Singapore, Russia, the United States of America, Australia and Ukraine are the major CNO importers from Malaysia (APCC, 2016). The CNO importation of Malaysia has recorded about 157 611-197 967 tonnes in 2010 - 2014 (*Table 6*). Meanwhile, Malaysia is the fourth important coconut shell activated carbon

TABLE 6
MALAYSIA'S EXPORT AND IMPORT OF MAJOR COCONUT PRODUCTS (2010-2014)

Products	*2010*	*2011*	*2012*	*2013*	*2014*
Coconut oil					
Export (tonnes)	132964	143611	136783	131068	187665
Import (tonnes)	197967	162162	187473	157611	173115
Shell activated carbon					
Export (tonnes)	19755	20557	16066	16222	15197
Import (tonnes)	3984	4983	6925	11613	8333
Coconut milk powder					
Export (tonnes)	3213	3925	3493	3600	3575
Import (tonnes)	3232	1760	1026	857	1159
Coir fibre					
Export (tonnes)	14243	12570	13963	14027	11877
Import (tonnes)	1951	1056	2601	1764	1501
Desiccated coconut					
Export (tonnes)	6762	8194	7762	7137	9800
Import (tonnes)	371	2262	3060	4043	4722

Source: APCC (2016)

exporter after the Philippines, Sri Lanka and Indonesia. Its export volume was recorded as 15 197-20 557 tonnes annually in 2010 - 2014 (*Table 6*). Japan, Taiwan and Italy were the major importers of activated carbon from Malaysia (APCC, 2016). Malaysia is the second largest exporter of coconut milk powder after Sri Lanka with the total export volume of 3 213-3 925 tonnes annually in 2010-2014 (*Table 6*). Jamaica, Middle East countries (United Arab Emirates, Saudi Arabia and Qatar), China and Hong Kong were the major importers of coconut milk powder from Malaysia (APCC, 2016). Malaysia was also involved in desiccated coconut and coir fibre export markets with the total export volume of 11 877-14 243 tonnes and 6 762-9 800 tonnes in 2010-2014, respectively (*Table 6*). Singapore and Pakistan were the major importers of desiccated coconut from Malaysia and China was the major importer of coir fibre (APCC, 2016).

DEVELOPMENT OF NEW EMERGENT COCONUT PRODUCTS

The development of coconut products can be categorised into traditional products and new emergence products. Prior to 1994, the coconut industry mainly concentrated on their traditional products in fresh produce from upstream activity, such as fresh coconut, matured coconut, dehusked nut, kopyor/makapuno, coconut water, coconut milk and coconut seedling. Their midstream products were heavily dependent on CNO to supply cooking oil manufacturers and the oleochemical industry to produce alkanolamides, glycerine and other oleochemicals. The downstream activity was focussed on producing detergent/healthcare products (toilet/ bath soap and laundry soap), processed foods (coconut vinegar, nata de coco, paring oil, coco cream powder, frozen coco meat, shortening and desiccated coconut) and

supply of the raw material for non-food products (coco chips, coco lumber, coconut shell, coconut shell charcoal powder, coco coir waste, coco hush, coco husk chips and coco coir fibre) (*Table 7*).

However, from 1994 until recently, new emergent coconut products are focusing on diversified food products (coco jam, special creamed coconut, coconut water concentrate, coconut milk powder, coconut liquor, coco sauce, grated coconut meat, coconut honey, margarine, coconut flour, hydrogenated coconut oil and virgin coconut oil) and valued-added non-food products (coco handicrafts, coco shell powder, coco wood pallet, coco fibre dust, coir net, coir doormats, coir twine, coir pads/ liner and coco husk cubes) (*Table 7*). Coconut water, coconut milk and virgin coconut oil are coconut products with the fastest growth in world market. The market volume of coconut water is expected to be increased by 149 per cent during 2013-2018, followed by coconut milk and virgin coconut oil at 54 per cent and 33 per cent, respectively (*Figure 4*).

HEALTHY BENEFITS OF COCONUT PRODUCTS

Clinical studies conducted by Verallo-Rowell (2016) in Pediatric Out-patient and Microbiology Department of Makati Medical Centre, the Philippines has shown that the mono-laurin, a derivative from coconut oil, has significantly higher anti-microbial effect on childrens' skin disease than or comparable with commonly used antibiotics (penicillin, oxacillin, erythromycin, fusidic acid, mupirocin and vancomycin). In addition coconut oil, which is rich in lauric acid (a medium-chain fatty acid), is used in supplementary diet and disease prevention for neuro-degenerative disorders (Alzheimer's and Parkinson's diseases) and epilepsy through ketogenic dieting (Kotchabhakdi, 2015). Coconut oil in Thailand was consumed for medicinal uses for periodontal prevention and treatment, constipation problem, as energy enhancer, cholesterol balance, induce weight loss of obesity, diabetes mellitus, Alzheimer's disease, improve digestion problem, antimicrobial infections and treatment of skin lesions (Wongsawasdi, 2015). Coconut oil is normally converted into ketones in the liver when consumed by the body and able to serve as an alternative fuel to glucose for supply to the brain and other organs. This has been shown to improve memory and cognition in Alzheimer's patients (Newport, 2017).

HIGH YIELDING COCONUT PLANTING MATERIALS

The availability of high yielding planting materials is very important to ensure the productivity and profitability of coconut planting as compared to other industrial crops. However, the majority of the coconut varieties planted in Malaysia by smallholders are the Malayan Talls that have relatively long maturity period, low nuts and copra yield per hectare, which has affected the competitiveness of coconut with the other vegetable oil crops. Improvement of coconut planting materials by hybridisation between the dwarf x tall crosses, tall x tall crosses and dwarf x dwarf crosses is an important step to introduce new coconut hybrids that have early maturity traits, high nut yield and high copra production. Currently, the MATAG hybrid resulting from the crosses of Malayan Yellow Dwarf (MYD) or Malayan Red Dwarf (MRD) with Tagnanan Tall is still the most promising coconut hybrid used by majority of smallholders and plantations in Malaysia. The MATAG hybrid which begins

TABLE 7
DEVELOPMENT OF TRADITIONAL AND NEW EMERGENCE COCONUT PRODUCES AND PRODUCTS

Fresh produces	*Coconut oil*	*Detergent/ healthcare*	*Processed food*	*Non-food*
A). Traditional coconut products (prior to 1994)				
Fresh coconuts	Cooking oil	Toilet/	Coconut vinegar	Coco chips
Matured coconuts	Alkanolamide	bath soaps	Nata de coco	Coco lumber
Dehusked nuts	Glycerine	Laundry soap	Paring oil	Coconut shell
Kopyor/ makapuno	Others		Coco cream	Coconut shell
Coconut water	oleochemical		powder	charcoal
Coconut milk			Frozen coco	powder
Coconut seedlings			meat	Coco coir
			Shortening	waste
			Desiccated	Coco husk
			coconut	Coco husk
				chips
				Coco coir fibre
B). New emergence coconut products (1994-2016)				
		Shampoo	Coco jam	Coco
		Soap chips	Special creamed	handicrafts
			coconut	Coco shell
			Coconut water	powder
			concentrate	Coco wood
			Coconut milk	pallet
			powder	Coco fibre
			Coconut liquor	dust
			Coco sauce	Coir net
			Grated coconut	Coir doormats
			meat	Coir twine
			Coconut honey	Coir pads/
			Margarine	liner
			Coconut flour	Coco husk
			Hydrogenated	cubes
			coconut oil	Activated
			Virgin coconut oil	carbon

Source: Salum (2017a)

to flower about 36 months after planting, can produce up to 103-163 nuts per palm per year with the potential yield of 25 000 to 30 000 nuts per hectare per year. Their copra content is about 250 g per nut with the potential copra yield of 7.24 tonnes per hectare per year (*Table 8*). MATAG seedlings are currently produced by the Department of Agriculture and two private companies (United Plantations Berhad and NALFIN Planting Materials Sdn Bhd) in

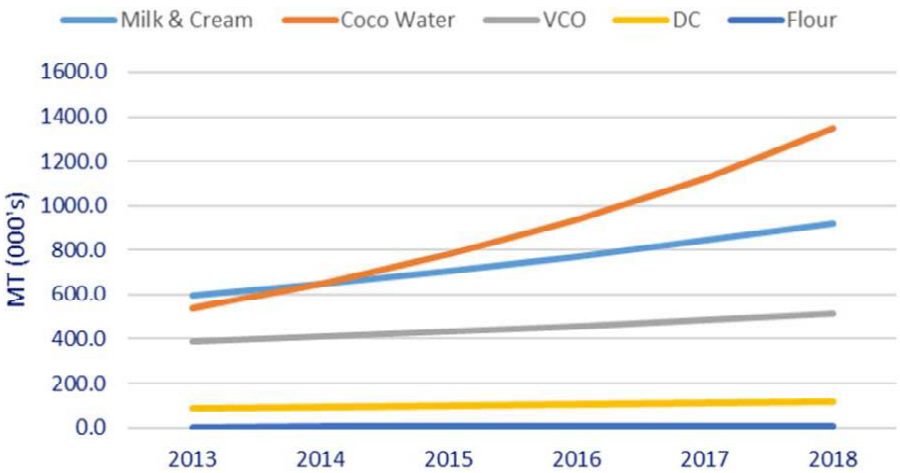

Figure 4 Global coconut market volume by product in 2013-2018 (Gibson, 2016)

Malaysia. Meanwhile, the Malaysian Agricultural Research and Development Institute (MARDI) has recently released three new hybrids (MYLAG, MARLECA and CARECA) with the potential yield that are comparable with MATAG.

Due to the high demand of elite coconut planting materials in India, some private companies are aggressively involved to produce high yielding coconut hybrid seedlings. For example, Deejay Farms has established 30 000 mother palms in eight locations near South India (Lobo, 2016). Currently, they have commercialised Deejay Sampoorna hybrid and Deejay Pushkala hybrid seedlings for domestic and export markets. Deejay Sampoorna hybrid is a cross of dwarf x tall coconut varieties, whereby it begins to flower after 24 months of planting with the potential nut yield of 250 nuts per palm per year and able to achieve 43 417 nuts per hectare per year during prime age (*Table 8*). Deejay Sampoorna hybrid contains about 250 g of copra per nut with the potential copra yield of as high as 9.12 tonnes per hectare per year (*Table 8*). Meanwhile, Umapathy Coconut Hybrid Centre is another company that produces hybrid coconut seedlings in South India (Mohan, 2016). Their commercial coconut hybrid seedling called Ram Ganga Hybrid, is a cross between Ganga Bondam Dwarf x West Coast Tall. The Ram Ganga Hybrid flowers at 24-30 months after planting, and the nut yield is about 250-350 nuts per palm per year. It is able to achieve 42 500 nuts per hectare per year. The copra content and potential copra yield of the Ram Ganga hybrid range from 180-200 g per nut and 7.65 tonnes per hectare per year, respectively (*Table 8*).

Indonesian Palmae Crops Research Institute (IPCRI) has developed a few coconut hybrids by using the crosses of dwarf x tall varieties. Coconut hybrids KHINA-1, KHINA-2 and KHINA-3 were released by IPCRI in 1984 and hybrid KHINA-4 and KHINA-5 were released in 2006. KHINA hybrids are able to produce 75-104 nuts per palm per year with the potential copra yield of 4-5 tonnes per hectare per year (Novarianto, 2016). Currently, IPCRI is evaluating a new coconut variety, namely Bido coconut that originated from Morotai Island, North Maluku

TABLE 8
COCONUT PLANTING MATERIALS

Characteristic	*MATAG*[1]	*Deejay Sampoorna*[2]	*Ram Ganga*[3]	*Bido*[4]	*PCA 15-9*[5]
Material	Hybrid	Hybrid	Hybrid	Tall variety	Hybrid
Beginning flowering (months)	36	24	24-30	36	36-42
Nuts yield (nuts/ palm/year)	103-163	250	250-350	124	128
Nuts yield(nuts /ha/year)	25 000-30 000	43 417	42 500	-	17 295
Copra content (g/nut)	250	210	180-200	-	303
Copra yield (t/ha /year)	7.24	9.12	7.65	4.0	6.0

Sources: [1]United Plantation (2017), [2]Deejay Farms (2017), [3]Mohan (2016), [4]Novarianto (2016), [5]Philippines Coconut Authorities (2017)

Province of Indonesia. This new coconut variety is an early bearing variety with big fruits and start to flower after 36 months of planting. It can produce up to 124 nuts per palm per year with the potential copra yield of 4 tonnes per hectare per year (*Table 8*). Bido coconut has been officially released end of 2017 as the national superior coconut variety of Indonesia (Novarianto, 2016).

In the Philippines, the Philippines Coconut Authority (PCA) (2017) has recommended 16 coconut hybrid varieties for commercial planting. Among the recommended coconut hybrid is PCA 15-9, a cross between Tacunan Green Dwarf x Tagnanan Tall. This hybrid has early flowering at 36-42 months after planting and start to produce nuts 1-2 years earlier than other local varieties. PCA 15-9 has medium to large fruits with the copra content of 303 g per nut. It produces about 128 nuts per palm per year and the potential nuts yield and copra yield are 17 295 nuts per hectare per year and 6.0 tonnes per hectare per year, respectively (*Table 8*).

THREAT OF PESTS AND DISEASES ATTACK IN COCONUT PLANTING

The red palm weevil (*Rhynchophorus ferrugineus*) is the new invasive and most severe pest of coconut in Malaysia. It was first detected in 2005 by the Department of Agriculture in Terengganu, Malaysia (Sivapragasam, 2012). The larva of red palm weevil is a tissue borer that attacks the trunk from the top crown and bore into the trunk. The severe attack by the red palm weevil causes large cavities to the trunk, wilting of fronds and drooping of dried fronds like an umbrella-shaped canopy until the total death of the palm (Azmi *et al*., 2013). Meanwhile, the major coconut pests in Indonesia are *Oryctes rhinoceros*, *Brontispa longissima* and *Sexava* spp., where the new invasive *Aceria guerreronis* attack was also reported in certain regions e.g. in Northern Sulawesi. The integrated pest management approach through sanitation, pheromone-base trap, coconut sap-base attractant and biological

control (*Baculovirus* and *Metarhizium anisopliae*) are the standard practices to control the *Oryctes rhinoceros*. Biological control approach has been practiced to control *Brontispa longissima* attack in coconut by releasing the egg parasitoids (*Ooencyrthus podontiae*), larvae parasitoids (*Tetrastichus brontispae; Asecodes hispinarum*), natural predator (*Celisoches morio*) and spray of entomopathogen (*Metarhizium anisopliae*) or pathogenic bacteria (*Serratia marcecens*). *Sexava* spp. attack in coconut is normally controlled by release of egg parasitoid (*Leefmansia bicolor*), intercropping of coconut with other crops to improve their biodiversity and installation of *Sexava* traps around the coconut farm (Alouw *et al*., 2016). A new invasion of coconut scale insect species, *Aspidiotus rigidus* was detected as mixed population with *Aspidiotus destructor* has caused serious spread and outbreak in the Philippines since 2011. This sucking insect attack causes progressive yellowing of the older leaves and eventually drying due to serious loss of sap. Currently, trunk injection of systemic insecticide and release of potential predators and parasitoids are the control measures taken to manage the coconut scale insect attack (Eusebio, 2016). The major coconut pests in South East Asia, such as *Oryctes rhinoceros, Rhynchophorus ferrugineus*, *Aceria guerreronis* and *Aspidiotus destructor* have also been reported as the major coconut pests in the Caribbean countries. Meanwhile, red palm mite (*Raoiella indica*), ambrosia beetle (*Xyleborus ferrugineus*), coconut mealy bug (*Nipaecoccus nipae*), coconut moth borer (*Castnia daedalus*) and armyworm (*Spodoptera frugiperda*) attack have also caused economic loss in the coconut industry of the Caribbean (Myrie, 2016).

Lethal yellowing disease (LYD) which is caused by phytoplasma is one of the most devastating coconut disease that is currently affecting coconut production in the Caribbean, American and African countries. LYD causes pre-mature fruit abortion, flower necrosis with no fruit set, yellowing and senescence fronds, eventually the whole crown will wither and become topless, leaving a bare standing trunk. Planting mixed varieties was recommended to reduce the incidence of LYD infestation in the Caribbean (Myrie, 2016). However, development of LYD resistant coconut varieties is the most effective approach to manage this disease. Screening of LYD resistant coconut varieties in the coconut germplasm of Mexico has shown that the Malayan Yellow Dwarf (MYD) that originated from Malaysia has recorded the lowest mortality by LYD infection at 5.7 per cent as compared to other coconut varieties and hybrids (Zizumbo-Villarreal, 2008). Evaluation and selection of LYD tolerant/ resistant coconut in Caribbean and African countries were conducted by using MYD varieties and MYD crosses (Myrie, 2016; Louis, 2016).

CHALLENGES AND OPPORTUNITIES OF COCONUT INDUSTRY

More than 70 per cent of the existing coconut planting of the coconut producing countries are reported to be past their productive life span, whereby the coconut productivity is in decreasing level after 60 years of planting (Salum, 2017). The majority of the coconut planted areas are now due for replanting to replace the low productive and senile coconut palms in order to fulfill the aggressive market growth and high demand of coconut globally. However, insufficient superior coconut planting materials for replanting programmes throughout

the world has caused the global coconut planting to be saturated at 12 million ha since the past ten years. Therefore, more efforts from the public and private coconut stakeholders should be focussed to produce sufficient high yielding, pest and disease tolerant coconut planting material to support the coconut planting programme and sustainable growth of the global coconut industry.

The recent development in micro-propagation technology of coconut has showed encouraging and promising results, where the Centre de Investigaci'on Cienti'fica de Yucat'an (CICY) from Yucatan, Mexico has successfully produced coconut plantlets through somatic embryogenesis by using plumule and floral explants (Oropeza, 2016). This achievement in micropropagation technology of coconut is very important for mass propagation of reliable high yielding, pest and disease tolerance planting materials in future to overcome the problem of shortage of superior coconut seedlings faced throughout the world. The spread of new invasive pests and diseases has also threatened the sustainability of coconut planting. It is timely to develop a data base and directory of coconut pests and diseases management, information sharing, connecting the experts and local authorities to control the coconut pests and diseases more effectively among the coconut producing countries (Fernando, 2016).

The coconut industry is currently driven by the rapid growth and huge demand of coconut based products globally. It has proven to generate greater economic returns for the coconut producers. Therefore, the traditional coconut producing countries should take this opportunity to improve and upscale their coconut manufacturing facilities to fulfill the huge market demand, especially from America, Europe, Middle East and East Asia. The private sector should actively be involved in upstream activities to develop coconut planting into plantation scale to improve their productivity and profitability in coconut production. Meanwhile, the countries that are heavily dependent on single industrial crop, such as Malaysia that is overly dependent on oil palm, should diversify their investment to develop coconut as their new economic crop for the country.

REFERENCES

ALOUW, J. C., MAWARDI, S., LOLONG, A. A., MASKROMO, I. and HOSANG, M. L. A. 2016. Innovative technologies and strategies for integrated pest management of coconut in Indonesia. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

ASIAN AND PACIFIC COCONUT COMMUNITY (APCC). 2016. *Coconut Statistical Yearbook 2014*. Jakarta: Asian & Pacific Coconut Community.

AZMI, W. A., CHIK, Z., RAZAK, A. R. A and GHANI, N. I. A. 2013. A new invasive coconut pest in Malaysia: the red palm weevil (Curculionidae: *Rhynchophorus ferrugineus*). *The Planter* **89** (1043). 97-110.

DEEJAY FARMS. 2017. https://deejayfarm.com/deejay-coconut-breeding/ (Retrieved on 6 Dec 2017).

DEPARTMENT OF AGRICULTURE OF MALAYSIA. 2017. Industrial Crops Statistics Malaysia 2016. http://www.doa.gov.my/index/resources/aktiviti_sumber/sumber_awam/maklumat_pertanian/perangkaan_tanaman/perangkaan_tnmn_industri_2016.pdf. (Retrieved on 2 December 2017).

EUSEBIO, J. E. 2016. Pest Management of Coconut in the Current Scenario of Climate Change. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

FERNANDO, F. 2016. Networking for effective management of threats from emerging pests and diseases of coconut. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

GIBSON, K. 2016. Consumer behaviour and market performance relating to the products of coconut.

Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

KOTCHABHAKDI, N. 2015. Medium chain fatty acids in coconut oil as potential supplementary foods and nutriceutical products for better health and prevention of diseases. In: *Proceeding of The International Conference of Coconut Oil (ICCO)*. 17-20 March 2015, Bangkok, Thailand, 56-57.

LIM, T. K. 2012. *Cocos nucifera*. In: *Edible Medicinal and Non-Medicinal Plants: Volume 1, Fruits* (pp. 301-334). B.V.: Springer Science+Business Media.

LOBO, D. J. 2016. Potential for commercial production of elite planting material. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

LOUIS, K. K. J. 2016. Current status of the lethal yellowing disease of coconut (*Cocos nucifera* L.) in Grand Lahou, Côte d'Ivoire. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

MOHAN, R. 2016. Experience of Umapathy Coconut Hybrid Centre in India. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

MYRIE, W. 2016. Pests and diseases of coconut palms in the Caribbean. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

NEWPORT, M. T. 2017. Coconut oil and MCT oil: Ketones as alternative fuel for Alzheimer's disease and Other Conditions. In: *Proceeding of the Second International Conference on Coconut Oil (ICCO 2017)*. 15-18 March 2017, Bangkok, Thailand, 49-58.

NOVARIANTO, H., SANTOSA, B., TULALO, M., MAWARDI, S. and MASKROMO, I. 2016. Varietal Improvement in Coconut in Indonesia. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

OROPEZA, C. S. 2016. Coconut Micropropagation in Mexico Using Plumule and Floral Explants. Presented at the 47th APCC Cocotech Conference 2016. 26-30 September 2016, Bali, Indonesia. (Slide presentation).

PHILIPPINES COCONUT AUTHORITIES. 2017. http://www.pca.da.gov.ph/coconutrde/images/var5.pdf. (Retrieved on 6 Dec 2017).

SALUM, U. N. 2017. Global scenario on production, productivity and marketing of coconut commodities. In: *Proceeding of the Second International Conference on Coconut Oil (ICCO 2017)*. 15-18 March 2017, Bangkok, Thailand, 17-34.

SALUM, U. N. 2017a. Coconut Oil Production and Diversification in Asia and Pacific. Presented at the Second International Conference on Coconut Oil (ICCO 2017). 15-18 March 2017, Bangkok, Thailand. (Slide presentation).

SIVAPRAGASAM, A. 2012. Red palm weevil and other major pests of coconuts. In: *Proceeding of Fourth IOPRI-MPOB International Seminar: Existing and Emerging Pests and Diseases of Oil Palm – Advances in Research and Management*. 13-14 December 2012, Bandung, Indonesia.

UNITED PLANTATIONS BHD. 2017. http://www.unitedplantations.com/products/documents/coconutbrochure1.pdf (Retrieved on 6 Dec 2017).

VERALLO-ROWELL, V. M. 2015. Clinical studies on coconut oil. In: *Proceeding of The International Conference of Coconut Oil (ICCO)*. 17-20 March 2015, Bangkok, Thailand, 33-38.

WONGSAWASDI, L. 2015. Medicinal use of coconut oil in Thailand. In: *Proceeding of the International Conference of Coconut Oil (ICCO)*. 17-20 March 2015, Bangkok, Thailand, 73-75.

ZIZUMBO-VILLARREAL, D., COLUNGA-GARCÍAMARÍN, P., FERNÁNDEZ-BARRERA, M., TORRES-HERNÁNDEZ, N. and OROPEZA, C. 2008. Mortality of Mexican coconut germplasm due to lethal yellowing. In: *Plant Genetic Resources Newsletter*, 2008, No. 156: 23-33.