Worlds Apart

Agronomy Capital Advisors Limited

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PT. Riau Sakti United Plantations

Brazilian Green Dwarf plantation, Luiz Mirisola Fihlo, Touros, Rio Grande do Norte, Brazil

Executive Summary – A Seismic Divide

Agronomy Capital Advisors Ltd (ACAL) has sought to provide an analysis of the global coconut producer sector. While the data are not available to compare operational and financial efficiencies by corporate producers across the sector, we have focused the operational and sector differences between Brazil (with a spotlight on that country's agro-industrial and vertically integrated producers) and the major global producer countries Indonesia, the Philippines and India.
The findings have been stark. In comparison with a well-funded, progressive and vertically integrated agro-industrial coconut producer sector, which has been developing in Brazil since the second half of the 20th Century, but which has picked up significant pace in the 21st Century in tandem with the global surge in demand for modern coconut products, almost the entirety of the global producer sector is structurally constrained by the dominance and central importance of smallholders, in some cases producing coconuts as a secondary activity. However, in Eastern Sumatra, in the province of Riau, dispersed smallholder production has been integrated seamlessly into a massively scaled industrial economic activity. The Sambu Group, an Indonesian family business, has established a fully integrated value chain business in the production and supply of coconut products to some 150 countries around the world, receiving and processing circa 5 million coconuts per day at three industrial scaled plants in the region. At 5 million nuts per day processed, the Sambu Group processes more than 3x the volume of coconuts of its nearest rival, Franklin Baker in the Philippines.

Very small (less than 1 hectare) and widely scattered, subsistence farms across Asia, (Indonesia, the Philippines and India which between them account for more than 70% of the global coconut crop), characterised by ageing, low yielding coconut palms (most commonly Tall varieties) of unproven genetic provenance, and managed by ageing (and 'unbankable') farmers, many of whom live below the poverty line, achieve an average yield of 4.8 MT of coconuts per hectare annually. In the case of the Philippines, with the world's largest production area, the yields are lower at 3.9 MT/Ha. As 'price takers', achieving (typically) between US$0.071 cents and US$21 cents ($0.30 cents per nut at the very best), these farmers are not incentivised typically, to invest in fertilisers or crop protection systems, or in high yielding planting material (even if they could access such). For some the production of coconuts is a secondary activity and 'orchards' may be no more than rows of palms planted along farm boundaries or around homesteads. Frequently, depending on farmgate 'collectors', farmers receive the lowest value for the coconut along the value chain, and for much of the production across Asia, there has been a traditional focus on low value products such as copra, coconut oil and coconut meal. Near impossible logistics, and local processing facilities which may be basic and even unsanitary, precludes any opportunity to address high value end user markets. Remarkably, whereas some 50% of the population of the Philippines and more than 25 million Indonesians, are thought to depend directly or indirectly on the coconut industry, in both countries, the sector appears to lack strong official support; in the Philippines there is even political impatience with the sector. The contrast with the modern agro-industrial Brazilian sector could not be greater.

Modern coconut production in Brazil, as exemplified by names like Aurantiaca, Ducoco, and Sococo (all with proprietary plantations), CocoSamba, Coco do Vale, and others (drawing off 3rd party producers), is based on vertical integration of the value chain. Processing facilities, designed to extract maximum value from

the coconut feedstock, are located within easy transport reach of the plantations. Modern plantations are being architected for technologically based farming, with advanced irrigation systems and high yielding varietals, purpose bred for specific product niches. A well-funded state agricultural research agency, Embrapa, provides indirect support to the industry with development of planting materials and supportive technologies. Importantly too, the modern Brazilian sector has access to a significant domestic market for higher value coconut products, a sophisticated modern distribution network, and access to capital via private wealth and commercial banks.

While we have not been able to drill down into the cost of production for specific commercial producers in Brazil, local intelligence indicates that the cost of production per nut on professional farms, may vary from US$0.053 to US$0.123 for Dwarf production and US$0.084 to US$0.211 per nut for Hybrid production. The world market for coconuts (as established across Asia) is very substantially based on a 'price taking' model: while largely informal, price data confirms that smallholder farmers in Indonesia and the Philippines are receiving between US$0.07 to US$0.21 (India and Vietnam appear to be higher at up to US$0.30 per nut, from time to time). For processors the cost of goods may be nearer to US$0.15-US$0.30, once payments to aggregators and logistics costs are included, but some are likely able to still acquire raw materials at nearer to US$0.10 per nut, adjusting the price of nuts to the international price for coconut oil. Across the big three Asian producer countries, it is not unfair to describe the coconut supply model as stagnating and structurally impaired, with the Sambu Group's globally scaled operations in Riau Province, Sumatra a notable exception. By contrast with the Asian model (ex-Sambu Group), the modern Brazilian producers look to have a competitive lead on most other producers in the world.

Source: Brazilian Green Dwarf plantation, Luiz Mirisola Fihlo, Touros, Rio Grande do Norte, Brazil

Modern Demand Drivers

Every so often a new dietary fashion captures the popular imagination. Whether it is blueberries, kale, goji berries, or high cocoa content dark chocolate, health and dietary commentators have a history of hyping the qualities of one fruit or vegetable, to elevate its desirability in the minds of consumers. One such phenomenon, born of this century, has been coconut water. The growth in demand for packaged coconut water has been attributed to the appeal of the product to 'Millennial' consumers; the research and consultancy firm New Nutrition Business was reported to have remarked that 'Millennials' perceived coconut as "a naturally healthy food". [1]

Packaged Coconut Water

The marketing of coconut water, and its appeal to consumers has focused on its dietary, health and functional benefits. Amongst the nutrients it contains, are vitamins, minerals, amino acids, antioxidants and enzymes. The product is said to represent a rich source of such important minerals as potassium, calcium and magnesium, in addition to the trace elements iodine, zinc, sulphur, selenium, manganese, boron and molybdenum. In June 2018 Reuters published an article reviewing a market outlook study of demand for packaged coconut water: "*The worldwide market for Coconut Water is expected to grow at a CAGR of roughly 14.4% over the next five years, will reach 13,800 million US$ in 2023, from 6,150 million US$ in 2017, according to a new GIR (Global Info Research) study*". [2]

ACAL notes that there is a wide range of projections for the size of the market today and its growth rates, most likely based on the distinction between packaged coconut water from mature nuts (mostly) and green nuts, and fresh coconut water, direct from green or immature nuts (mostly) and in some cases mature nuts. This range extends from the Reuters reported global value of $6bn, to sundry other estimates ranging from $3.0bn and upwards. What is not in question is that this market has developed primarily, since the turn of the present century. Demand for packaged coconut water (the modern product, distinct from drinking fresh coconut water direct from the nut at or near the site of production), has been driven by so called 'Millennial' consumers, who are reputed to be focused on healthier, natural products with an ethical provenance. The $6.15bn market estimate for 2017 compares with a similar estimate (by Euromonitor International) of $6bn for the global packaged water market in 2019.[3] Euromonitor's estimate was contrasted with a global market value of $1.9bn in 2014. These various data indicate that the market for packaged coconut water has been exceeding growth expectations. If there was early phase concern that the 'craze' for the beverage would peter out, these data imply that the product line is now well entrenched in consumer purchasing patterns.

According to the research report referenced by Reuters, "…*the global production of coconut water will increase from 1,138.32 Million Litres in 2011 to 2,310.08 Million Litres in 2016 at an average annual growth rate of more than 15.00%*". Definitions are important: packaged water (as opposed to coconut water consumed fresh from the nut), narrows the category.US market leader Vita Coco, sells in Walmart at circa $5.17 per litre, at which price a global market of $11.9bn would be implied.

Green coconut water is produced from green, immature coconuts,

1 Food Navigator.com 31st August 2017; Katy Askew
2 https://www.reuters.com/brandfeatures/venture-capital/article?id=38929
3 The Grocer (25th August 2016; Julia Glotz)

6-7 months of age. This product must be drunk within 10 days of harvesting, or packaged aseptically, most commonly in Tetrapak containers. In 2016 Vinay Chand Associates (VCA) estimated that the green water segment had an annual value of circa US$600 million at retail. VCA was of the opinion that the majority of these coconuts were consumed in the source countries as a component of the ordinary diet. The market is mostly informal, and these nuts (sold for drinking) are typically significantly cheaper than packaged mature coconut water products, notwithstanding that green coconut water is considered to be very much superior to water from mature nuts. VCA estimated that if this segment was to be priced at global retail market levels, the combined segment of mature packaged water products and green water / fresh immature nuts for drinking, would be equivalent to circa $5bn. This correlates closely with the $6bn market referenced by Reuters (above). Packaged coconut water by contrast may also be sourced from mature nuts of 10 months or older. Water produced from these nuts is typically a co-product associated with the production of desiccated coconut. While considered to be an inferior product (from consumer experience) than green coconut water, this segment has dominated the market place.

The growing appetite of populations around the developed and developing worlds for packaged coconut water has transformed the status of this 'tree' crop, and it has created an appetite for other modern coconut products including virgin coconut oil and coconut 'dairy' products including 'milk' and 'cream'.

Jax Coco – The Chicest Coconut Water (Vogue)

Jax Coco, launched in Hong Kong and London in 2012, was conceived to win consumer trust and loyalty with a premium product, entirely natural and unadulterated, and stylishly packaged. The company's website observes that Jax Coco unites "*the best coconuts with chic, minimalist design*". Sourced from the South of Luzon in the Philippines, Jax Coco coconut water is packaged in chic, stylish glass bottles. The brand was created by renowned U.K. designer Alasdhair Willis the creative director of Hunter - a British heritage brand, and previously publishing director of Wallpaper, the Time Warner magazine focused on design, architecture, fashion, travel, art, and lifestyle.

The brand promise could not have come at a better time. As reported in The Grocer (25th August, 2016) "*In August 2014, an explosive document appeared on the website of US juice supplier ITI Tropicals. The company (ITI Tropicals) had hired an independent consultant…to run tests on 20 coconut waters on sale in the US…to look for undeclared sugars and preservatives – and it found plenty…twelve out of twenty contained added sugar not declared on the label; two had undeclared preservatives"*.

Jax Coco surveyed a sample group of millennial consumers, identifying that amongst this consumer cohort:

- 30% sought products with no artificial flavours
- 29% sought products with no artificial colours
- 24% sought products that were certified organic
- 20% sought products that were certified sustainable and Fairtrade.

Amongst other research sourced by Jax Coco, it identified that 42% of global respondents stated that they were prepared to pay a premium for products made with organic or all-natural ingredients. These findings informed the development of the Jax Coco product ethos and product portfolio. Jax Coco's product story is built around its origin in the volcanic region of Southern Luzon, and its all-natural, low calorie, hydrating properties. The brand is positioned alongside other premium beverage brands such as Evian, San Pellegrino and Fever Tree, and is distributed through a variety of upscale outlets including such iconic

names as Claridges (London) Mandarin Oriental (London, Paris and Hong Kong), Selfridges and Harvey Nichols (London), The Four Seasons (Hong Kong), The Ritz (Paris).

Coconut Milk -Dairy Alternatives

According to Future Market Insights, the conventional coconut milk segment, (as opposed to the 'organic' segment) was estimated to be valued at more than US$600 million at end 2017 and was expected to increase at a CAGR of 7.0% over the period to 2027, to reach a market valuation of more than US$1,100 million. Revenue from the organic coconut milk segment was expected to increase at a CAGR of 8.2% during the forecast period and was anticipated to be valued at more than US$220 million in 2017, and projected to reach a market valuation in excess of US$500 Million by the end of 2027.[4]

A Multi-segmented Product Sector

Readers should note that the coconut milk market is bifurcated between milk used for cooking, typically to make sauces, (an important dietary feature across Asia), and coconut milk as a nutritious beverage. Market sources inform ACAL that in China, coconut milk consumption is as much as 10x greater than consumption of packaged coconut water.

Coconut Milk Nutrition

Coconut flesh is highly nutritious and rich in fibre, vitamins C, E, B1, B3, B5 and B6 and minerals including iron, selenium, sodium, calcium, magnesium and phosphorous. Because coconut milk is lactose free, it can be used as a milk substitute by consumers with lactose intolerance. Coconut milk is reputed also as a source of energy boosting lauric acid. Detailed studies have shown that the majority of ingested lauric acid is transported directly to the liver where it is directly converted to energy and other metabolites rather than being stored as fat. Such metabolites can be used by extra-hepatic tissues, such as the brain and heart, as an immediate form of energy. (BBC Good Food website). As detailed on http://www.med-health.net/Coconut-Milk-Benefits.html, one cup of coconut milk or 240g contains the nutrients below.

Minerals		**Vitamins**	
Calcium	38.4mg	Vitamin C	6.7mg
Magnesium	88.8mg	Vitamin E	.4mg
Potassium	631mg	Vitamin K	.2mcg
Phosphorus	240mg	Niacin	1.8mg
Iron	3.8mg	Folate	38.4mcg
Zinc	1.6mg	Vitamin B6	.1mg
Copper	.6mg	Thiamine	.1mg
Manganese	2.2mg	**Others**	
Selenium	14.9mcg	Carbohydrates	13mg
Fat		Fiber	5mg
Total Fats	57.2 g	Proteins	5mg
Saturated Fats	50g	Calories	552
Omega-6 Fatty Acids	626mg	Sodium	36mg
Monounsaturated Fats	2.4g	Cholesterol	0mg

Source: http://www.med-health.net/Coconut-Milk-Benefits.html

4 https://www.futuremarketinsights.com/reports/coconut-milk-market

To manufacture coconut milk and coconut cream, coconut flesh is grated and soaked in hot water. As the coconut cream rises to the top, it is skimmed off. The remaining liquid is squeezed through a cheesecloth to extract a white liquid that is coconut milk. By repeating this process, the coconut milk becomes thinner. The thicker version is used for desserts and rich sauces. Thin coconut milk is used for cooking curries and soups. Coconut milk is widely used across the food industry for enhancing the flavour, aroma and the nutrient content of food.

During this century, global demand for coconut milk has been increasing owing to a growing focus on health, and rising consumer interest in vegan diets and dietary alternatives. In particular, consumer interest in dairy alternative, plant-based beverages have seen coconut milk evolve from simply being a cooking ingredient to becoming a health drink and beverage alternative. Coconut milk has become popular with vegans, seeking dairy substitutes, in which category it competes with a range of plant-based alternatives including soya milk and almond milk.

Dairy Alternatives Market Segment

As reported by Amanda Del Buono (November 10, 2016)[5] , Packaged Facts, a Rockville, Md.-based market research firm, projected (in 2015) that the dairy and dairy alternative beverages market would reach $31.5 billion by 2019, up by about a third from circa $23.8 billion in 2015 "Dairy and Dairy Alternative Beverage Trends in the U.S." Projecting a compound annual growth rate (CAGR) for the five-year period [2015-2019] of 5.8%, the research consultancy attributed this to the expected introduction of new and innovative products, and to the widespread penetration of premium products in the market. Chicago-based Mintel in its April 2016 "Non-Dairy Milk – US" report, noted that soy milk made up approximately 19.3% of the dairy alternative beverage market in 2015, but noted that soy milk could be surpassed by the 'other' non-dairy milk segment by 2017 and coconut milk by 2018, as consumers looked to other plant-based beverages.

Food and beverage market specialists, like Packaged Facts, indicate that plant-based dairy alternatives are commanding increasing attention from consumers. The 2015 report from Packaged Facts observed that "…*consumers are clearly intrigued by other plant-based beverages that are being introduced in greater number including those made from cashew, quinoa, sunflower and flaxseed*…". Market leaders in the category include WhiteWave Foods (US), Pure Harvest (Australia), Goya Foods, Inc. (US), McCormick & Company (US), Theppadungporn Coconut Co. Ltd. (Thailand), Native Forest (US), and Ducoco Produtos Alimenticios S/A (Brazil). According to the Packaged Facts report, Denver-based WhiteWave Foods, now owned by Danone had the largest share of the market at 13% of overall sales, as well as a 22% of the shelf-stable market. Nestlé and Dr Pepper/Snapple were also reported to have double-digit shares in the shelf-stable market.

Virgin Coconut Oil

According to a report by Goldstein Research[6], the global virgin coconut market is expected to increase at a CAGR of 9.8% over the period 2016-2024. Growing over the period from US$2.1 billion in 2016 to reach US$ 4.2 billion by 2024. The report observed that this growth was expected to be driven by rising consumer interest in natural beauty products. Indicative of the segment's appeal to modern, younger consumers, the global market for organic virgin coconut oil is projected to reach a market value of US$1.28 billion at a CAGR of 10.98% by 2022. Asia Pacific is anticipated to account for a major

5 https://www.bevindustry.com/articles/89751-almond-coconut-cash-ew-milks-gain-in-dairy-alternatives

6 https://www.goldsteinresearch.com/report/virgin-coconut-oil-market-outlook-2024-global-opportunity-and-demand-analysis-market-forecast-2016-2024

market share of more than 95% during the forecast period.[7] The report cited as key players in the sector: Nutiva, Inc. (U.S.), Celebes Coconut Corporation (the Philippines), Greenville Agro Corporation (the Philippines), Earth Born Company Ltd. (Thailand), Vita Coco (U.S.), Farm Direct Coconuts (U.S.), Parker Biotech Private Ltd (India). In 2016, VCA noted that demand for virgin coconut oil was then growing at some 35% pa, being a relatively new product segment manufactured from fresh coconuts as opposed to dried coconut flesh, more commonly known as copra.

Activated Carbon Products

According to a report published by MarketsandMarkets™, the global activated carbon market was valued at US$ 4.74 billion in 2015, and is projected to reach US$ 8.12 billion by 2021, at a CAGR of 9.4% from 2016 to 2021. The market size in terms of volume was 2,743.4 kiloton in 2015 and is projected to reach 3,587.9 kiloton, by 2021, at a CAGR of 8.4% from 2016 to 2021. In this study, 2015 has been considered the base year, 2016 as estimated year and 2021 as the forecasted year to estimate the market sizes of activated carbon.

An August 2018 report by Energias Market Research projected that the global activated carbon market is projected to witness a CAGR of 12.1% over the period 2017-2024. Energias noted that "T*he industry is likely to expand from USD 4.2 billion in 2017 to USD 10.2 billion by 2024. The growth can be primarily attributed to the increasing use of activated carbon for addressing the concerns regarding mercury emissions. The growing environmental concern for pollution control has fostered the use of activated carbon for reducing mercury emissions from power plants. Also, rising investment in the use of activated carbon for water purification has fuelled the market demand over the years to come*". Reporting on the Energais report, Global Newswire observed that "… *high end research and development is underway in order to develop new uses of activated carbon. Various key industry experts have been focusing on the use of activated carbon in food products that can cleanse or detoxify the body. These activated carbon food products such as black ice cream, black burger buns, black smoothies and black cheese, have recently witnessed a rise in social media coverage*".

According to the Energais report, the coconut shell segment of the active carbon products market, is expected to account for a significant share of the market owing to its widespread use. The most commonly used raw materials in the manufacture of activated carbon include coal (bituminous, sub-bituminous, lignite and anthracite), coconut shells, wood-sawdust (soft as well as hard) and peat. However, various other raw materials have been identified for the manufacture of activated carbon such as walnut shells, olive stones and palm kernels but their commercial application is limited due to their supply. Coconut shells, being a renewable source of carbon offer hardness and low dust generation along with high resistance to abrasion. Therefore, the use of coconut shells in the production of activated carbon products is expected to increase.

Activated carbon may be made available in different forms such as granular, powdered, impregnated, extruded, woven, polymer coated and more. Among these the granular activated carbon offers high adsorption that makes it ideal for removing contaminants from air, water, liquids and gases. Granular activated carbons have relatively larger particle size as compared to powdered ones. In addition, these activated carbons can be used for liquid as well as gas phase applications, thereby driving the market demand.

Asia Pacific emerged as the leading regional market owing to the

7 http://www.abnewswire.com/pressreleases/global-organic-virgin-coconut-oil-market-2018-to-reach-valued-at-128-billion-and-grow-at-a-1098-cagr-forecast-to-2023_176720.html.

rapid industrialization along with the initiation of various stringent regulations so as to address the rising environmental concerns. Also, the growing demand from countries such as China, Japan and India, has significantly contributed to the market growth in the region. Moreover, its increasing application in the food and beverages industry, the pharmaceutical sectors and water and air purification, have all contributed to demand growth for the category.[8]

Activated carbon, also called activated charcoal, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions. According to Wikipedia," *Due to its high degree of micro-porosity, one gram of activated carbon has a surface area in excess of 3,000 m2 (32,000 sq ft) as determined by gas adsorption. An activation level sufficient for useful application may be obtained solely from high surface area. Further chemical treatment often enhances adsorption properties*". Adsorption is the process in which atoms, ions or molecules from a substance (it could be gas, liquid or dissolved solid) adhere to a surface of the adsorbent. The Indonesian producer of activated carbon products from coconut shell, PT Freeman, notes on its website: "*Activated carbon is an amorphous form of graphite with a highly developed internal pore structure that gives the material its unique adsorptive properties*".

The natural hardness of coconut shell renders derived carbon highly resistant to physical breakdown through attrition. PT Freeman produces activated carbons from coconut shell using a steam activation technology in rotary kilns.

8 Global Activated Carbon Market Outlook, Trend and Opportunity Analysis, Competitive Insights, Actionable Segmentation & Forecast 2024

The Traditional Coconut Economy

Consumers' engagement with coconuts has traditionally taken one of four principal forms:

1. Fresh coconuts as a fruit, predominantly in source countries
2. Desiccated coconut for use in baking and food preparation – a global product
3. Coconut oil as a dietary product (and not without some controversy as detailed in the paragraph below)
4. Coconut oil as the principal oil in body care products and cos metics.

Coconut Oil

Coconut oil is about 90% saturated fat, which is a higher percentage than butter (about 64% saturated fat), beef fat (40%), or even lard (also 40%). Coconut oil is considered to be very effective at boosting levels of "good" HDL cholesterol. But dietary advisors in the late 20th Century and into this century have argued for the sparing use of coconut oil in the diet, citing concerns about its possible contribution to heart disease and promoting as more 'healthful', vegetable oils such as olive oil and soybean oil, which are mainly unsaturated fat and which lower the LDL and increase the HDL forms of cholesterol.[9] From an economic perspective, the production of coconut oil from copra, and its co-product, coconut meal has been described by Mr Vinay Chand of Vinay Chand Associates (VCA), as "a pursuit to keep farmers in poverty". According to Chand, the coconut sector's most traditional product segment, copra, should be reviewed and its production downscaled (a view echoed in this report by various commentators in the Philippines). The dried flesh of the coconut is used for the production of coconut oil and coconut meal, but the profile and economics of both commodities,

9 http://www.health.harvard.edu/staying-healthy/coconut-oil

render them less competitive than palm oil products and soya bean meal.

Desiccated Coconut

Desiccated coconut is a dried (a maximum of 3% moisture content), grated and unsweetened fresh kernel or meat of a coconut's mature fruit. It is used as an ingredient in food manufacturing and home cooking. Desiccated coconut is predominantly produced in the Southeast Asian producer countries, and is traded worldwide. Since the ingredient is used in food industries such as bakery, confectionery, culinary, beverages etc., the growth and demand for desiccated coconut has a high correlation with the performance of the above-mentioned food industries. Attributed to its low cholesterol or trans-fats content while rich in a variety of essential nutrient contents which includes dietary fibre, copper, manganese and selenium, the product has witnessed increased demand during this century. The global segment is described as fragmented with numerous manufacturers operating over a number of regional markets. The category can be segmented on the basis of cut: regular cut, fine cut, medium cut, super fine cut, fancy cut, chips, flakes, threads and shreds.

During 2017, the price of desiccated coconut, in the main producer countries, Philippines and Indonesia, was relatively stable at annual average of US$2,537/MT and US$2,409/MT respectively.

In 2017, official data from the Philippines Statistics Authority, indicated that in the period January to November 2017 108,561 MT were exported, which was 33.7% higher than previous year's volume for the same period. North America and Europe remain major destinations for desiccated coconut from the Philippines accounting for more than 82% of the total export. In Asia, China, Korea and Malaysia were amongst the largest importing countries of the product from the Philippines.

In the period January-December 2017, BPS-Statistics Indonesia recorded that export volume of desiccated coconut from Indonesia was 98,038 MT. This was higher by 23.7% compared to the volume of the same period in previous year. The export level was even higher than that of 2014's volume which was 86,797 MT Asia and Europe are the principal markets for desiccated coconut from Indonesia. 49.2% out of 98,038 MT desiccated coconut from Indonesia was shipped to Asian countries. Europe absorbed 32.5% of Indonesia's desiccated coconut exports. The global market for desiccated coconut is estimated by ACAL at between US$800 million to US$1 billion annually.

Coconut Milk

The processing of mature coconuts for the production of coconut milk is dominated by consumption within the source countries where it has traditionally been used for culinary purposes and as a drink (packaged whole coconut milk and skimmed milk). Coconut milk is also highly suitable for the production of coconut ice cream and coconut yoghurt. In 2016 VCA estimated that the international market for packaged coconut milk products was then relatively mature with a retail value of $400m pa. The market has proven to be anything other than mature. Chand opined that the market for fresh coconut milk products (in the source countries) could be 10x larger than the packaged segment.

Coir

Rubberised coir is derived from the husks of mature coconuts. Coir can be rubberized for use in mattresses for which there is strong demand in Asia. In 2016 VCA estimated that the segment had a factory gate value of circa $1bn annually and a retail value of perhaps $2bn. Chand noted however, that only 17% of the annual crop of coconut husks was then used in the manufacture of coir, but the consultancy observed that demand had increased strongly (by an estimated 50% in the period 2012-2015).

Profile of The Global Coconut Production Sector

Coconut is one of the most important palm crops of the tropics with over 12 million hectares planted with the crop in more than 90 countries.

Coconut withstands conditions considered to be marginal for many other crops, and its considerable hardiness contributes as a stabilising factor in the farming systems of marginal and fragile environments. The Philippines, Indonesia and India produce more than 70% of the world crop, for an average yield in metric tonnes of nuts at 4.8 per hectare. Some 95% of the crop is produced by an estimated 10 million resource-poor smallholder and sharecropper families, on smallholdings under 4 ha, and most frequently under one hectare. Sources, including Oil World and the Coconut Statistical Yearbook of the APCC, estimate that one third of the global crop is consumed fresh, with 70% of coconuts utilised within country of origin.

Five countries produce more than 80% of the global coconut harvest. Four of these countries are relative neighbours, extending in an arc from the South West coastline of India with the Arabian Sea, to Sri Lanka in the Indian Ocean, and then East to Indonesia and the Philippines which is flanked by South China Sea on its Western coastline, and Pacific to the East. These producer countries are also the largest consumers of coconuts in the world, with collectively some 58% of production being consumed domestically. Brazil sits apart, the leading producer in the Americas, 4th ranked for supply of the global crop.

Of the other countries listed in Table 2, Viet Nam is noteworthy for its growth during this century and its apparent ambition. Production has expanded by 66% since 2000 and yields have widened from 6.3

Table 1

Coconut Production 2016 Data	MT Nuts Produced	Hectares Harvested
Indonesia	17,722,429	3,105,259
Philippines	13,825,080	3,565,059
India	11,127,898	2,155,749
Brazil	2,649,246	234,012
Sri Lanka	2,520,095	408,918
Viet Nam	1,469,960	146,835
Papua New Guinea	1,191,438	207,679
Mexico	1,157,481	183,637
Thailand	815,406	177,063
United Republic of Tanzania	555,836	732,189
Sub-Total	53,034,869	10,916,400
World Total	**59,012,581**	**12,168,799**
Top Ten as % of World	89.90%	89.70%
Yield (MT/Ha) For Top 10	4.86	

Source: FAOSTAT 2016/ACAL

MT/Ha to 10.0. In all the 10 countries listed in the table, account for 90% of the global harvest of coconuts, but the top 5 names are hugely dominant.

Growth in world supply has exceeded 15% during the period 2000-2016 (inclusive), but this growth has been overwhelmingly a feature of the top 6 producer countries, accounting for nearly 97% of the increased tonnage. Leading producer Indonesia, was surpassed by India in terms of total tonnage increase, while Viet Nam turned in the largest percentage gain at 66%. The Philippines lagged the sector, with growth nearly 9 percentage points lower than the world average.

Table 2

Coconut Production (MT)	2016	2000	Change (%)	Increase (MT)
Indonesia	17,722,429	15,240,000	16.30%	2,482,429
Philippines	13,825,080	12,994,654	6.40%	830,426
India	11,127,898	8,350,000	33.30%	2,777,898
Brazil	2,649,246	1,952,117	35.70%	697,129
Sri Lanka	2,520,095	2,353,000	7.10%	167,095
Viet Nam	1,469,960	884,800	66.10%	585,160
Sub-total	49,314,708	41,774,571	18.00%	7,540,137
World	59,012,652	51,225,627	15.20%	7,787,025

Source: FAOSTAT 2016/ACAL

Amongst the wider data, those for Thailand (see Table 1) were surprising with negative growth of nearly 55%: 2016 production of 815,000 MT contrasts with more than 1.8 million MT in 2000. Coconut is grown mainly in the southern and central plain part of Thailand. The production area in Thailand has declined mainly due to a growing shift to oil palm cultivation, which gives better yield and higher farm gate price. Approximately 60% of coconuts produced are sold in the domestic market. There is limited data on how these nuts are utilized. Around 25% of total nuts are sold to factories for processing. There is limited information to identify the volumes of final products and utilization of these products – although most are understood to be processed by integrated food processors as an ingredient into a wide array of food products as well as some specific coconut products. The remaining 15% are processed into coconut milk. Some estimates suggest that Thailand may account for 20%-40% of global coconut milk production.

Along with Thailand, Viet Nam also deserves a mention, for the opposite reason. The country has recorded the highest expansion rate within the top 10 producer countries this century, and warrants being taken seriously as a new producer. Vietnamese farmers have a reputation for entrepreneurial drive, as demonstrated by their success in the global coffee and black pepper (33% of the global production of black pepper 2014) sectors. Vietnam, was the second largest coffee producer in 2017, accounting for roughly 20% of the world production, behind Brazil with 36%. In the context of the coconut sector however, the structure of the Vietnamese sector is small farmer focused, and distinctly different from the Brazilian model.

According to a 2009 report by the Prosperity Initiative: 'Coconuts in the Mekong Delta', the Mekong Delta is the centre for the coconut industry in Vietnam, and Tinh Ben Tre is the hub for the industry in the Mekong Delta. The total production area in the Mekong Delta stood at some 110,000 ha in 2009 and was then, more than 75% of the total coconut area of 130,000 ha. Today, Tinh Ben Tre is reported to have some 72,000 hectares of coconut plantations with an annual production volume of 600 million coconuts. The report indicates that the development of the coconut industry was targeted as a major priority by the provincial authorities in the Mekong Delta, resulting in the establishment of an industry association and a multi-stakeholder industry strategy development process including farmer outreach and sector research. Reports confirm that Chinese demand for Viet Nam's coconuts has been a major influence on the pricing and structure of the domestic industry, with a number of processors being put out of business, unable to pay the prices offered by Chinese traders. Reports from mid-2018 (Fresh Plaza, the leading portal for the fruit sector) suggest that a hiatus in Chinese buying has disrupted pricing; then around US$0.145 per nut whereas as high as US$0.25 earlier in the year.

An Informal Smallholder Dominated Sector

The relative stagnation of coconut productivity and expansion across much of Asia-Pacific and the African tropical belt, reflects the informal and unreformed nature of this crop: more than 96% of coconut farmers are smallholders tending 0.5-4.0 (at most) hectares. These farmers are thought to earn circa USD500/ha/yr.

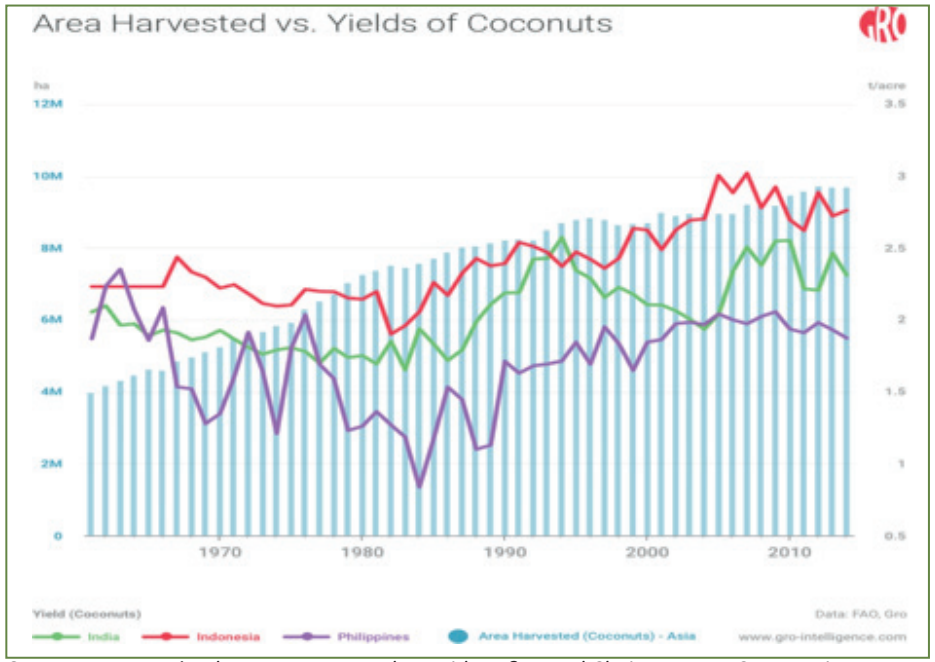
Data for farmgate prices (largely informal data) indicate:

- US$0.071 - 0.21 Indonesia
  - October average price APCC website: US$0.14
- US$0.18 Philippines
  - October average price APCC website: US$0.149
- US$0.145 – 0.25 Viet Nam
- US$0.30 India
  - October/Kerala average price APCC website: US$0.597
  - Prices at all time high due to cost increases being passed on
- US$0.15-0.30 Brazil.

Smallholder farmers typically do not have access to investment capital, nor to the planting materials, technologies and mechanization, to optimize productivity. This sector frequently lacks managerial skills and has effectively, no direct access to markets for value-added products. Despite the potential uses of the coconut and production and use of high-value products in the food, non-food, nutraceutical, cosmeceutical, pharmaceutical and biofuel industries, smallholder coconut farmers generally do not benefit proportionally from these opportunities, as upstream, small-scale suppliers of raw materials to aggregators and or processors. Although such farmers may live below the poverty line, they are not incentivised to invest in planting more coconuts. Dr Ponciano Batugal, Chairman, Technical Working Group, Asian and Pacific Coconut Community (APCC) argues that "*If farmers do not earn more, they will not plant more coconuts…over 50% of the coconuts in the world are senile and unproductive and about 700 million coconut trees need to be replanted urgently*".

The data presented in Chart 1, below, show sluggish progress in the case of Indonesia and India over the period under review, but decline in the case of the Philippines. These yield data for the world's three largest producers of coconuts have significance for the supply outlook, and they are in sharp contrast to the reported yield profile for the very much smaller, fourth placed producer, Brazil.

Chart 1



Source: Presentation by Dr Pons Batugal, President & Board Chair, Farmers Community Development Foundation International, National Coconut Conference, August 2018, Ipoh,

Consider the relative performance of Brazil to the big three producers in the Table below, which compares FAOSTAT coconut production data for 1961 with 2016. Over the intervening 55 years Brazil has achieved a truly massive increase in production on a very much smaller area expansion (than any of its peers), for yield gains of nearly 500%. Indonesia, the world's largest producer of coconuts, at 30% of the global crop, has like India (18.9% of global crop), increased its planted area by more than 200%, but yield gains have been modest at 14% and 12% for Indonesia and India respectively. The Philippines, however, which produced 23.4% of the global crop in 2016, has seen a decline in coconuts per hectare output, of 7.4% over the period, notwithstanding an increase of almost 200% in planted area.

Table 3

1961 Data	Element	Unit	Value	1961 Data Source	FAOSTAT 2016 Data	Change (%)
Brazil	Area harvested	Ha	143,000	FAO estimate	234,012	63.60%
Brazil	Production	tonnes	271,737	Official data	2,649,246	874.90%
Brazil	Yield	MT/Ha	1.9		11.3	495.80%
India	Area harvested	ha	723,000	Official data	2,155,749	198.20%
India	Production	tonnes	3,328,000	Official data	11,127,898	234.40%
India	Yield	MT/Ha	4.6		5.2	12.10%
Indonesia	Area harvested	ha	1,130,000	FAO estimate	3,105,259	174.80%
Indonesia	Production	tonnes	5,650,000	FAO estimate	17,722,429	213.70%
Indonesia	Yield	MT/Ha	5		5.7	14.10%
Philippines	Area harvested	ha	1,199,880	Official data	3,565,059	197.10%
Philippines	Production	tonnes	5,023,200	Official data	13,825,080	175.20%
Philippines	Yield	MT/Ha	4.2		3.9	-7.40%

Source: FAOSTAT/ACAL

Indonesia – An Informal Producer Sector Blessed By Climate

Indonesia produces some 30% of the global harvest of coconuts, yet the production of the crop is perhaps best described as 'informal'. The coconut production sector in Indonesia is almost exclusively the province of smallholder farmers, accounting for 99% of the area harvested in Indonesia, and 98.9% of the national production (on a copra basis).

In some areas, the production of coconuts is a secondary activity, defined not so much by area planted as by palms per household. An Australia Aid review of the Coconut Sub-Sector in East Java and West Nusa Tenggara (October 2015) noted that: "*Coconut plays a role as a secondary income source for farmers. Tree ownership is low, with typically only 23-46 trees per household. Production is affected by seasonal variation, climate conditions, and stability of the water supply…Management practices are generally poor, and farmers rarely make efforts to improve productivity.*" The review, which was conducted under the umbrella of Australia-Indonesia Partnership for Promoting Rural Income through Support for Markets in Agriculture (AIP-PRISMA), concluded that "*Coconut is often cultivated as a supplementary income source to more traditional crops and is not prioritized by farmers*". Coconuts may be planted along farm boundaries and around homesteads, rather than in formal cultivations. There is also a pattern of intercropping with cash crops such as sugar cane, cacao and cassava. With farm gate prices low: from IDR 1,500-3,500 (US$0.15-21), there is little incentive for farmers to focus on the crop, so that palms are not fertilised or routinely protected from pest and disease. Without support from government or other agencies, (a recurring theme across Asia) and extension services largely being absent, farmers are neither incentivized financially, nor equipped technically, to prioritize coconut production. The production of coconuts in Riau Province is different however. While still a small holder crop, the industrialised processing of much of the region's production by the Sambu Group, in three plants in Eastern Sumatra, there is a clearly defined 'coconut economy'. With the Sambu Group processing some 5 million nuts daily, it is a reliable off-taker for the production of the region's farmers, making the production of coconuts an economically important and reliable revenue source for the farmers.

The data in Table 4 illustrates dramatically the scale of the smallholder segment across Indonesia's national coconut production platform, with the commercial producer segment, at just 1% of area harvested and national crop. Readers will note that there are significant differences between data sources in respect of area specified: the Directorate General of Estate Crops for Indonesia assessed 2016 production area at 3,566,103 Ha, whereas FAOSTAT lists the harvested area at 3,105,259 Ha, the difference perhaps being immature area.

Table 4

Production Area (Ha) By Estate Category	2017 Estimate	Production Area As % Of Total	Harvest MT (Copra Basis) 2017 Estimate; Director General of Estate Crops	Harvest By Producer Category As % of National Harvest
Smallholder	3,507,764	99.00%	2,839,426	98.90%
Government	3,874	0.10%	2,584	0.10%
Private Commercial	32,755	0.90%	29,271	1.00%
Total Production Area (Ha) & Production (MT Copra basis)	**3,544,393**	**100.00%**	**2,871,281**	**100.00%**

Source: Estate Crops Report December 2016, Director General of Estate Crops

The Indonesian production area is spread across the length of the archipelago (it all being well-positioned within the Equatorial belt suitable for coconuts 5 degrees north, 10 degrees south), but with the largest single concentration of 515,130 Ha in Riau Province, Sumatra from whence the Sambu Group, the largest processor of coconuts in Indonesia and the World, sources coconuts from smallholders across the region. Sambu Group also has a significant proprietary estate running to some 45,000 hectares, planted in one contiguous parcel on peat land, and marine soils include clay and mud.

Source: PT. Riau Sakti United Plantations

The estate, planted some 30 years ago, is almost certainly the largest in the world, but only contributes some 10% of Sambu Group's daily intake, with 90% deriving from small holder farmers across Riau Province. Combined with its processing plant activities, the Sambu Group provides direct employment for some 21,000 people in the region.

The climate in Riau is tropical, with 109 mm of rainfall even in the driest month (August) when rainfall typically occurs in 17 days of the month. The wettest months, like May, can record 500 mm of rainfall, with precipitation every day. This climate is considered to be Af according to the Köppen-Geiger climate classification. Sunshine hours per month range from 137 in November to as much as 288 hours in August, with temperatures in a range of 28 Celsius to 37 Celsius across the year, for an average annual temperature of circa 26.9 °C. In a year, the average rainfall is 2361 mm. These are pretty much ideal climatic conditions for coconuts, and this will be a major factor in Indonesia's ranking above the average for productivity per hectare.

The Köppen climate classification divides climates into five main climate groups, with each group being divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). Each group and subgroup is represented by a letter. All climates are assigned a main group (the first letter). All climates except for those in the E group are assigned a seasonal precipitation subgroup (the second letter). For example, Af indicates a tropical rainforest climate. The system assigns a temperature subgroup for all groups other than those in the A group, indicated by the third letter for climates in B, C, and D, and the second letter for climates in E. For example, Cfb indicates an oceanic climate with warm summers as indicated by the ending b. Climates are classified based on specific criteria unique to each climate type.

Table 5

Production Area (Ha) by Province	2017 Estimate	Production Area As % Of Total
Sumatera	1,122,314	31.70%
Jawa	813,289	22.90%
Nusa Tenggara + Bali	269,862	7.60%
Kalimantan	199,537	5.60%
Sulawesi	766,796	21.60%
Maluku + Papua	372,595	10.50%
Total Area Harvested	**3,544,393**	**100.00%**

Source: Estate Crops Report December 2016, Director General of Estate Crops (Indonesia)/ACAL

Table 6

Yield MT / Ha (Copra Basis) By Province	2017 Estimate	MT Nuts / Ha @ 14.5% Copra
Sumatera	0.8	5.8
Jawa	0.8	5.4
Nusa Tenggara + Bali	0.7	4.8
Kalimantan	0.7	4.7
Sulawesi	0.8	5.6
Maluku + Papua	0.9	6.5
Average National Yield / Ha (MT)	**0.8**	**5.6**

Source: Estate Crops Report December 2016, Director General of Estate Crops (Indonesia)/ACAL

Three Limiting Factors

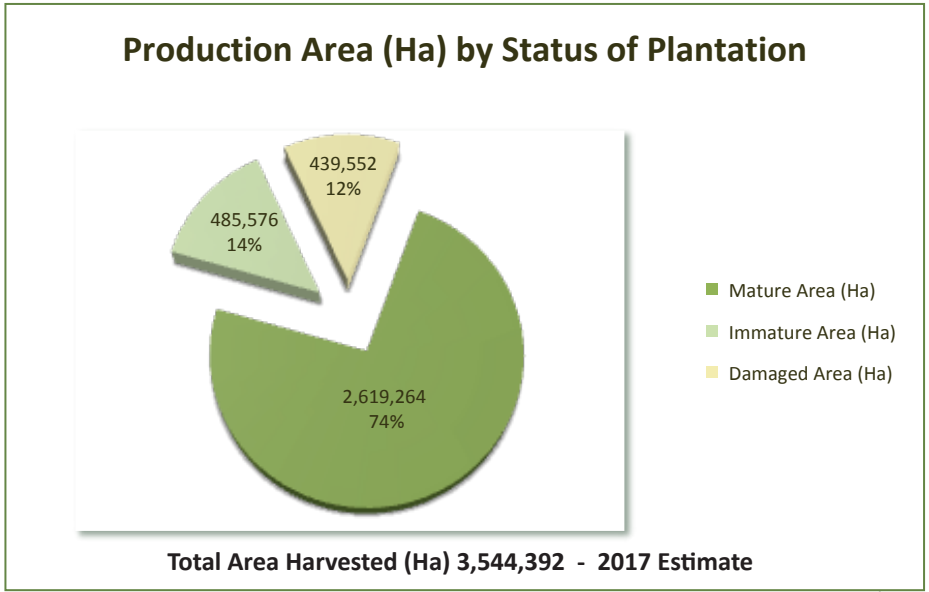
Sources within the coconut value chain in Indonesia describe three determining factors bearing on the development and the performance of the national coconut production platform:

1. <u>99% of coconut palms belong to smallholder farmers</u> who are extremely limited in their ability to invest in their coconut orchards

   a. While the smallholder farmers may have been farming the same land for centuries, observers note that these farms are frequently poorly managed. Moreover, palm age and productivity may vary significantly.

   b. The limited access to capital, that is the reality for smallholder farmers then reflects in maturity profile of the national production platform in Indonesia, with nearly 74% of the production area mature, and more than 12% of the area damaged, thus likely to experience declining yields.

Chart 2

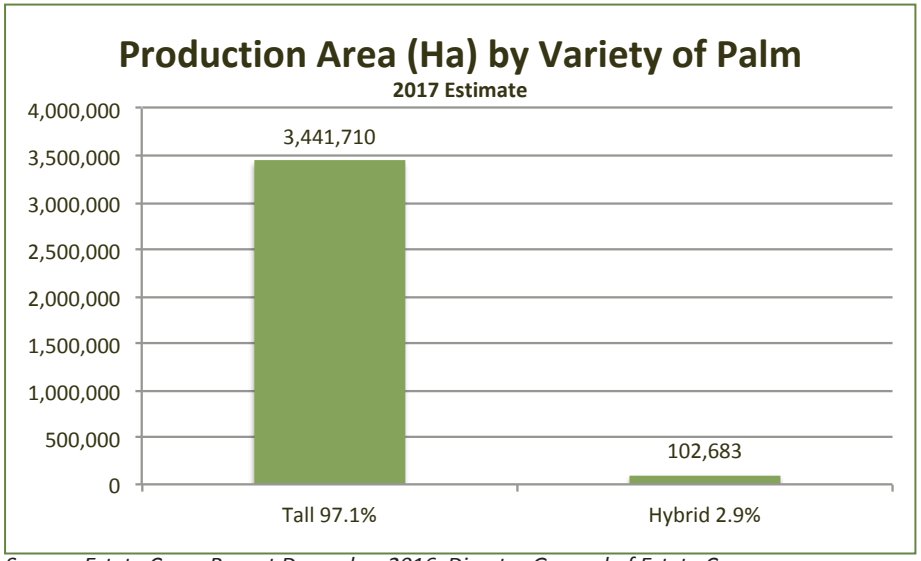


Source: Estate Crops Report December 2016, Director General of Estate Crops (Indonesia)/ ACAL

2 Government support for the agriculture sector in Indonesia is focused on the production of food crops such as rice, corn and soya, and on oil palm, in respect of estate crops. Government support for the coconut segment is directed only to the annual replanting of a limited area.

3 The Production Area is dominated by Tall populations at 97%.

Chart 3



Source: Estate Crops Report December 2016, Director General of Estate Crops (Indonesia)/ACAL

Planting Material – a Recurring Theme Across Asia

The AIP-PRISMA report referred to above, notes that in East Java and West Nusa Tenggara, cultivation is dominated by local varieties: "*Farmers typically conduct seed propagation themselves with more knowledgeable farmers selecting seed nuts based on fruit size*". While local government departments reportedly make occasional and small-scale distributions of hybrid materials, uptake is not thought to be significant.

Indonesian sector sources advise that the best performing national Tall variety, produces at most only some 15,000 nuts/ha/year, whereas the MATAG hybrid can produced 30,000-35,000 nuts/ha/year. Readers can get a sense for the difference made by improved planting materials and superior agronomic management, by comparing the Indonesian national data with the reported 10-year performance history of United Plantations Limited (UPL) coconut plantations in Malaysia. Over the period 2008-2017, UPL's 3,000 ha coconut plantations have averaged more than 26,000 nuts per hectare annually, in a range from 23,000 nuts per Ha to 30,000 nuts per Ha.

Table 7

Reported Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average Over Period
Nuts Produced (millions)	83.655	75.541	83.331	71.763	74.11	74.678	68.424	77.501	86.052	75.252	
Hectares Implied by Average Yield/ha	3,341	3,340	2,962	2,897	2,842	2,780	2,731	2,793	2,840	2,969	
Total Planted Area Reported (ha)						3,090					
Average Yield (Nuts) per ha (as reported)	25,037	22,616	28,135	24,771	26,080	26,858	25,056	27,747	30,305	25,345	**26,117**
Comment on Yield	Biological Boom	Removed 317 ha to plant Oil Palm		Biological Resting Phase	Biological Recovery	Biological Recovery & Intensive Harvesting to Meet Demand Surge	Drought impacted bud formation and pollination	Biological Recovery & Favourable Climatic Conditions incl abundant rainfall	Biological Recovery but nut size small due to drought	Biological Rest After 2016 Abundance	

Source UPL Report & Accounts 2008-2017/ACAL

UPL observes that its plantations "*…are pioneers in the production and cultivation of the MAWA (Malaysia Yellow Dwarf x West African Tall) and MATAG (Malaysia Yellow Dwarf or Malaysia Red Dwarf with Tagnanan Tall coconut from the Philippines) hybrids*". At maturity the two hybrid lines can be expected to produce up to 29,000 nuts per Ha, while the Malayan Tall is limited to peak productions of circa 9,000 nuts per Ha.

While the three limiting factors on Indonesian coconut production (listed above) are dominant themes, sector sources indicate other negative moderating factors, which impact on the dominant smallholder sector in particular:

1. The involvement of middle-men
    - o Farmers tend to sell their nuts to 'collectors' who inevitably pay a discount to prevailing market prices
2. The majority of the smallholder farms are located within the inter-tidal zone and are vulnerable to climate change effects
3. Both palms and farmers are ageing
    - o It is reportedly common for labourers to be hired to harvest and de-husk coconuts, for which they receive payment worth around 10%-20% of the harvest value.
4. Inflation
5. Urbanization.

Limited Private Investment In Upstream Production

There are very few professional plantations in Indonesia, the largest (according to ACAL data) is owned by the Sambu Group at some 45,000 Ha. Other industrialised processors and integrated coconut value chain businesses in Indonesia include Cocomas, which reportedly owns a proprietary plantation extending to between 8,000-10,000 hectares, Rose Brand, a producer of a range of consumer products including coconut oil and milk, and Freeman Carbon Indonesia PT, a producer of coconut shell activated carbon since 2002, and based in Bandar Lampung, Southern Sumatra.

See the image below for pineapple intercropping (1,000 Ha) under hybrid (MAWA) coconut palms on the Sambu plantation at Pulau Burung in Riau Province. The use of pineapples was first adopted by the company when its plantations were premature, to provide a cash crop. Today, the company has developed an important business in the supply of pineapple products, including pineapple juice for the flavouring of OEM brands of packaged coconut water.

Source: PT. Riau Sakti United Plantations

A Sambu Group spokesperson notes that "*The difference between our plantation and the typical smallholder farm, is that the Sambu Group plantation employs a water management system that is able to provide the required /optimal moisture levels to the palms all year round, irrespective of weather patterns*". Excess rain, flooding, drought and rising sea-levels are all addressed. Established on peat land, the Sambu Group's plantation is intersected by deep canals for water logistics, water management (including reservoir), fire breaks and conservation of the original peat land water table.

The Sambu Group provides the economies of scale at the processing and distribution end of the value chain for a significant portion of Indonesian production (estimated at 8%-9%). But for Indonesia as for the Philippines, the issue of micro-farms, without access to capital, and staffed by ageing farmers who are not incentivised to scale up their operations, or to boost efficiencies, is a problem without any easy solutions. While these are issues which the Sambu Group is addressing in Riau Province, Sumatra, the contrast between the Asian producer sector (ex Sambu Group) and the developing agro-industrial producers in Brazil, could not be more striking.

Profile of The Sambu Group

The Sambu Group is unique within the global coconut economy for aggregating the production from perhaps 500,000 hectares of small farms, and industrialising the processing of this production to best global practice. The creation of one Indonesian family over three generations, it is a globally scaled and vertically integrated whole value chain coconut products business established around a partnership with some 400,000 small farmers in Eastern Sumatra.

Origins

Escaping from the war in the Pacific, in 1942 the Tay family from Singapore, arrived in Riau Province in Eastern Sumatra. There the family began to trade copra. Mr Tay Juhana, the second-generation head of the Tay family, progressively established the modern Sambu Group during the second half of the 20th Century. PT PULAU SAMBU was incorporated in 1967. Mr Tay Juhanna, determined to establish a socially inclusive business model centred on the coconut economy in Jambi and Riau provinces. Today the Sambu Group processes some 5 million coconuts per day at three processing plants in Eastern Sumatra, employing more than 21,000 people directly, and providing a secure sales outlet for over 400,000 smallholder farmers across the region, farming more than 500,000 Ha.

Over more than six decades the Sambu Group has developed to become a processor and manufacturer of a wide variety of value-added coconut products, both for domestic consumption and for sale to circa 150 international markets. The group's revenues are derived evenly between the domestic market and international markets. Western Europe is an important market for packaged coconut water and coconut cream. The North American market, and the USA in particular, is a focus for packaged coconut water. China is a significant and growing market for coconut milk and coconut milk powder, while Australia and New Zealand are outlets for both coconut cream and packaged coconut water.

Ecosystem

Motivated by a desire to develop a set of commercial operations that delivered economic and social benefits for the communities surrounding the Sambu Group facilities, the Tay family view the Sambu Group both as an ecosystem, and a business. The Tay family and the Sambu Group have contributed extensively to the communities of the

region, including the provision of schools, classroom materials, clinics, mosques, churches, temples, bridges and roads. The Sambu Group supports community projects including sports events, educational competitions, religious festivals, community security and policing, and climate change mitigation.

Proprietary Plantations

Planted during the 1980s, Sambu Group owns and manages some 45,000 hectares of coconut plantations on Riau Island. In total the group has a concession over some 96,000 hectares of peat and marine land. In addition to the coconut plantations, the group farms circa 1,000 hectares of pineapple and runs an experimental farm which is an initiative to bolster food security for Indonesia by demonstrating the productive potential of peat land.

Source: PT. Riau Sakti United Plantations

Sambu Group has maintained the water table in its peatland concessions, an important asset in the cultivation of coconuts, with coconut palms requiring up to 200 litres of water a day and more, if producing heavy crops. The Sambu Group plantations are mainly planted to AfricanTalls and hybrids of West African Talls and Malayan Dwarf varieties. While the Tall varieties are reported to produce circa 100 nuts annually per palm, the Hybrids are producing circa 120 nuts per palm.

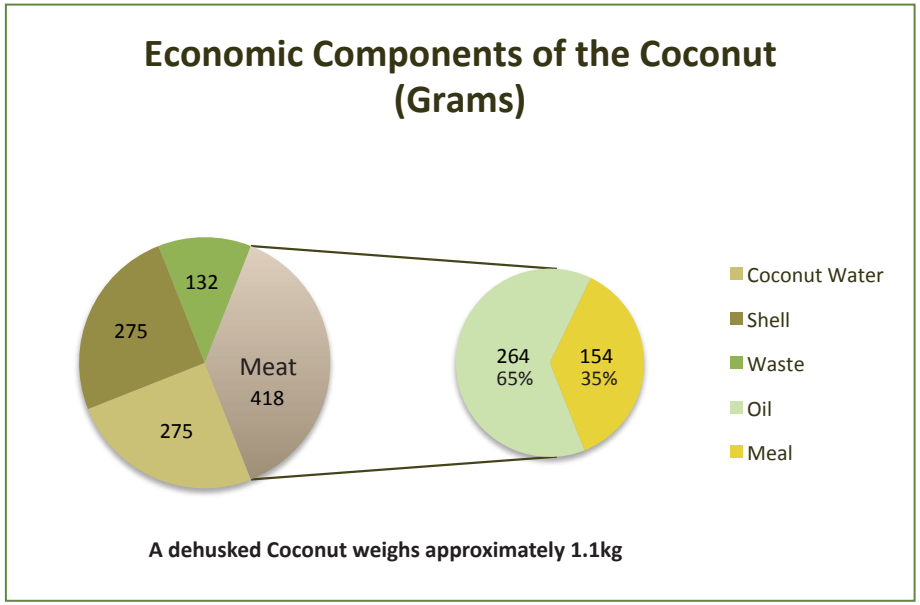
Harvested at circa 9 months old, the nuts are used primarily for the production of coconut milk, coconut milk powder, coconut cream, desiccated coconut and coconut oil. Sambu Group notes that typically more than 80% if its production is food grade, with the residue utilized for the production of crude coconut oil.

Processing

The Sambu Group has three processing plants along the coast in Riau Province. In total the group processes some 5 million nuts per day, the bulk of which – perhaps as much as 90% - are sourced from independent farmers throughout the region. The three processing plants receive nuts from supplying farmers every day of the year, with processing across its facilities running for 24 hours per day across three shifts, operating for up to 340 days annually.

Zero Waste

Every part of the coconut is used: flesh that is not used for food products, is pressed for oil, and the residual meal pelletised for animal feed. Husks are used for the manufacture of particle board, fertiliser and coir, or burned to generate steam. Shells are burned in the boilers for the production of steam, or are used to create charcoal and activated carbon.



PT Pulau Sambu (Kuala Enok)

Established in 1967, PT Pulau Sambu is located on the Nyiur Island, in the Indragiri district of Riau province, and produces crude coconut oil, cooking oil and copra extraction pellets. These products are exported to Asia, Europe, USA and Australia. The company has established a close and mutually beneficial relationship with the coconut farmers in its surrounding regions for the supply of fresh nuts. The plant combines, milling, extraction, refinery and storage. PT Pulau Sambu (Kuala Enok) is a self-contained and self-sufficient production complex, with its own power plant with steam generators heated by coconut shells, modern telecommunications facilities, jetties that allow vessels of up to 30,000 dwt to berth and load, a multi-purpose training centre, housing for over 2,000 employees, more than a hundred boats to transport raw copra and coconuts, and a storage facility with capacity for 21,000 MT of coconut oil. Kuala Enok processes 1 million nuts per day and work has recently begun to increase the plant's capacity to process another 4 million nuts. The new facility is expected to come on stream in 2021, when it will produce coconut milk and desiccated coconut, employing up to 30,000 staff. Its impact on the regional economy will be considerable.

PT Pulau Sambu (Guntung)

PT Pulau Sambu (Guntung) was founded in 1983 in Guntung, in Riau Province, to produce coconut cream and desiccated coconut. Today the company is a supplier of desiccated coconut to well-known confectioners and chocolate manufacturers in Europe, North America, Australia, Middle East and China. Its coconut cream, under the Kara brand name, is now popular across Asia, Australasia, Europe.

Coconuts are screened and selected on a size and quality basis, in order to produce high quality coconut cream and desiccated coconut. In the production of desiccated coconut, the Guntung plant uses a Proctor & Schwartz three stage dryer, built for the company's particular production processes. The production line, supplied by Alfal-Laval, has been tailored to the requirements of Sambu's processing technology to produce a market leading coconut cream. The company's Kara brand is the leading coconut brand in the Indonesian market, providing a strong base for a number of coconut product categories including nata de coco, virgin coconut oil for pharmaceutical industry, charcoal from coconut shell, coconut water and drinking water. In 2001, PT

Pulau Sambu (Guntung) started commercial production of spray dried Coconut Cream Powder.

Like PT Pulau Sambu (Kuala Enok), PT Pulau Sambu (Guntung) is also a fully self-sufficient and self-supporting complex. The facility boasts satellite communications, proprietary electricity generation capacity sufficient to provide electricity for the entire complex as well as for domestic use by the employees. The port, which was built in 1989, is equipped with two 40-foot heavy container cranes for the efficient loading of large ocean-going vessels. Strategically located near Singapore, all cargoes are exported via Singapore's efficient and world class seaport. The plant is able to process up to 2 million nuts per day, but can receive up to 4 million nuts per day. Typically, it processes between 1.5 million and 1.7 million nuts per day. The site includes 8 warehouses and can hold 10,000 MT of finished goods. Some 9,000 staff are employed on the site.

PT Riau Sakti United Plantations

Founded in 1993, the processing plant at PT Riau Sakti United Plantations was established to increase total processing capacity of desiccated coconut, but in 1996 it also began to produce canned coconut milk. From its proprietary 45,000 ha plantation, the processing plant enjoys a consistent supply of fresh coconuts throughout the year, all of which are processed within 24 hours of harvest, for freshness and quality. In addition, the PT Riau Sakti facilities also receive nuts from independent farmers. In total the plant processes some 1 million nuts per day.

Dating from 1995 the plant also boasts five high capacity canned pineapple production lines, for the estate's own production from 1,000 ha of pineapples. It also produces pineapple concentrate and coconut water concentrate UHT processing lines produce ambient shelf-stable coconut milk and cream. The processing plant employs over 6,000 people, most of whom come from the neighbouring areas; many are provided with company housing. The Sambu Group is highly focused on the welfare of its employees, providing clinics, schools, places of worship and recreational facilities.

A Focus On Small Farmer Supply

The processing operations at PT Riau Sakti United Plantations have evolved with a critical raw material sourcing programme from independent small holding farmers. This means that PT Riau Sakti United Plantations has become a critical contributor to the regional economy.

Staff and Staff Management

Today the company employs some 21,000 staff, split 60% male to 40% female and trending towards 50/50 distribution. The workforce is mostly unionised and the company reports that it has a positive relationship with the unions, meeting biennially to agree working conditions including health care provision, staff welfare and disciplinary procedures. Wage increases are set by government mandate.

Source: the Sambu Group

Products & Brands

The Sambu Group name has become synonymous with coconut cream, especially as sold under the Kara (people's coconut) brand, the market leader in Indonesia. Sambu Group was the first company in Indonesia to produce aseptic packaged coconut cream – a staple in the Indonesian diet. The company is also a leader in the manufacture and supply of packaged coconut water under its own label and that of other leading brands in Indonesia. Packaged coconut water is a global good for Sambu, with sales outside Indonesia, all on an business to business supply basis.

Postscript: Peat Land Agriculture

Peat land in Indonesia, extends to perhaps 22.5 million ha (more than 11% of total land mass) according to a February 2018 report from CIFOR[10]. This is significantly larger than the area reported in the official government map (14.9 million ha; Haryono et al. 2011), due to previously unaccounted peat deposits in Indonesian Papua (according to CIFOR). Farming peat land is not without controversy, as detailed in the CIFOR report:

"*Indonesian peat swamp forests cycle and store globally significant amounts of carbon. They provide essential ecosystem services, including regulating water across the landscape and buffering salt/freshwater transitions in coastal areas. They host unique and often endangered species such as orangutans, and provide critical habitats for migratory birds….Peat forests and the ecosystem services they provide are being transformed at a critical rate - between 2007 and 2015 the rate of loss was 2.6% per year in Sumatra and Kalimantan (Miettinen et al. 2016). Growing demand for arable land, in particular for palm oil production, lack of suitable unused uplands, and the attractiveness of peatlands' availability and flat topography (as opposed to alternative upland steep hills that present erosion risks), have all led to intense conversion and drainage of peatlands in recent decades…With a mean peat depth of 5.5 m, pristine peat forests in Indonesia store on average about 12 times more carbon than tropical rainforests on mineral soil in insular Asia, according to the Intergovernmental Panel on Climate Change (IPCC) default values*".

According to The Peat Society website: "*In the late 1980s 3.7 million hectares of Indonesian peat swamp forest were taken for agriculture… The development of palm oil and timber plantations, which require intensive drainage and cause the highest CO2 emissions of all land uses, are major drivers of peatland deforestation and increases in CO2 emissions*".[11]

It is the drainage of peatlands that causes peat decomposition and carbon and methane gas release. Notably, the Sambu Group has maintained the water table on its peatland concessions. The Peat Society states that: "The total current CO2 emissions from tropical peatland of approximately 2000 Mt yr-1 equal almost 8% of global emissions from fossil fuel burning. Emissions are likely to increase every year for the first decades after 2000". The Peat Society also notes that methane emissions from tropical peatland are very low irrespective of whether it is natural peat swamp forest or drained and degraded or used for agriculture. N2O emissions from natural tropical peatlands are low but evidence is emerging that suggests that these increase following land use change and fire.

10 http://www.cifor.org/publications/pdf_files/infobrief/6449-infobrief.pdf

11 http://www.peatsociety.org/peatlands-and-peat/peatlands-and-climate-change

The Philippines – A Dysfunctional Supply Chain

The Philippines has the largest area under cultivation for coconuts in the world, but it is within the bottom quartile of producers on the basis of yield per hectare. FAO data indicate that whereas Brazilian productivity has increased by nearly 500%, 1961 to 2016, the Philippines data indicate a productivity decline of 7.4%. The Philippines coconut production sector was ranked fourth in its contribution to the national economy in 2013, behind rice, bananas and corn, according to Dr Emil Q Javier, Chairman for the Coalition for Agriculture Modernisation in the Philippines (CAMP). Severino S Magat, formerly of the Department of Agriculture and the PCA, notes that "…at least 50% of the country's populace, directly or indirectly depend on the coconut industry for business or livelihood".[12]

While coconuts have an important role in the national diet (5% of national production is estimated to be used in homes), the sector is geared to the export market with some 75% of the national crop being processed for export led products – and in particular, coconut oil (more than 7 billion nuts annually) and desiccated coconut. The remaining 20% of national production is utilized in local processing for the domestic market. The export dominated profile of the processing sector is part of its DNA. Both Franklin Baker and Peter Paul, the two largest processors of coconuts in the Philippines, together processing between 2.6 million and 2.8 million coconuts per day, were established in the first half of the 20th Century by US consumer goods focused corporations.

Farmgate price data from 2009 indicated that coconuts were achieving US$0.10 each, implying low income for producers. The Philippines has become an important supplier to the global packaged coconut water segment, with a number of brands (including Jax Coco) sourcing coconut water from the country. The Grocer, reporting on the coconut water market in August 2016[13] cited the United Coconut Association of the Philippines, when noting that the Philippines exported 71.7 million litres of coconut water in 2015, an increase of nearly forty-fold in five years. In respect of the fast-growing international market for virgin coconut oil, a number of new product formats are being developed, with one report by Research and Markets concluding that processors in the Philippines were adding 60%-70% value to coconut oil as compared with a little as 8% for Indian processors.[14]

The fragmented nature of the sector in the Philippines (mills are thought to operate at or below 50% of capacity), coupled with logistical challenges, reportedly gives world number one producer, Indonesia a logistics advantage equal to US$20-40 per MT of coconut oil, over the Philippines. In the analysis for the coconut regions of the Philippines (see Table 8 below), the weak performance levels for the sector contrast vividly with the achieved yields of progressive producer countries such as Brazil. The national average of 34 nuts per palm, contrasts with the achievement of as many as 300 nuts per palm on leading modern Brazilian plantations (senior Brazilian coconut agronomist Luiz Mirisola Filho: 43,000 fruits per hectare for hybrids and over 75,000 fruits per hectare for BGD). The national average yield for the Philippines of 3.89 MT nuts per hectare, derives from a regional range of 5.97 MT/Ha to 2.37 MT/Ha, with nuts per palm ranging from 23 to 47, also on a regional basis. Only the top quartile of four regions, representing 24% of the national production area and 34% of the national crop, achieves a yield above the global average, but at 5.47 MT nuts /Ha, even this top quartile of producer regions in the Philippines, achieves only 48% of the Brazilian national yield of 11.3 MT nuts / Ha.

12 http://www.pca.da.gov.ph/coconutrde/images/yield.pdf

13 25th August; Julia Glotz, 'Coconut Water: a fair target'

14 reported 13th January by PRNewswire

Table 8

Regional Analysis	Production (in MT)	Area (hectares)	Bearing (Trees)	MT/Ha	Nuts Produced /Assume average coconut 1.2kg	Nuts per Palm	% Of National Crop	% Of National Planted Area	% of Bearing Palms
Northern Mindanao	1,807,046	302,816.00	31,828,598	**5.97**	1,505,871,198	**47.3**	12.86%	8.38%	9.28%
Davao Region	1,886,600	357,890.00	34,092,713	**5.27**	1,572,165,929	**46.1**	13.43%	9.91%	9.94%
SOCCSKSARGEN	938,162	192,721.00	16,678,818	**4.87**	781,801,612	**46.9**	6.68%	5.34%	4.86%
Cagayan Valley	73,795	15,189.00	1,409,325	**4.86**	61,495,450	**43.6**	0.53%	0.42%	0.41%
These 4 regions represent the top quartile with an average yield / Ha some 13% above the world average. The regions represent only 33.5% of national crop and 24% of production area									
Western Visayas	467,671	110,442.00	8,971,080	**4.23**	389,725,961	**43.4**	3.33%	3.06%	2.62%
ARMM	1,324,069	331,634.00	34,445,616	**3.99**	1,103,390,317	**32**	9.42%	9.18%	10.04%
Caraga	781,615	196,774.00	17,918,789	**3.97**	651,345,889	**36.3**	5.56%	5.45%	5.22%
Central Luzon	106,524	28,126.00	3,170,144	**3.79**	88,769,631	**28**	0.76%	0.78%	0.92%
Zamboanga Peninsula	1,700,250	453,994.00	38,309,693	**3.75**	1,416,874,075	**37**	12.10%	12.57%	11.17%
These 5 regions represent 32% of the national crop and 31% of production area. Average yield/Ha for this quartile is some 18% below world average									
MIMAROPA	772,479	216,939.00	17,641,397	**3.56**	643,731,868	**36.5**	5.50%	6.01%	5.14%
Ilocos Region	43,625	12,498.17	896,808	**3.49**	36,353,985	**40.5**	0.31%	0.35%	0.26%
Central Visayas	433,182	124,940.00	12,420,964	**3.47**	360,985,206	**29.1**	3.08%	3.46%	3.62%
Eastern Visayas	1,087,567	328,777.00	35,218,387	**3.31**	906,305,362	**25.7**	7.74%	9.10%	10.27%
These 4 regions represent only 16.6% of the national crop and 19% of the national production area. Average yield/Ha is some 29% below the world average									
CALABARZON	1,549,308	485,211.00	54,255,254	**3.19**	1,291,089,500	**23.8**	11.03%	13.43%	15.82%
CAR	981	333.12	35,329	**2.95**	817,841	**23.1**	0.01%	0.01%	0.01%
Bicol Region	1,076,257	454,020.00	35,755,759	**2.37**	896,880,716	**25.1**	7.66%	12.57%	10.42%
These 3 regions represent the bottom performance quartile, making up 26% of the production area and 19% of the national crop. MT/Ha is nearly 42% below the world average									
Total Data For Philippines	**14,049,131**	**3,612,304.29**	**343,048,674**	**3.89**	**11,707,604,534**	**34.1**	**100.00%**	**100.00%**	**100.00%**

Source: Coconut Statistics 2017; Oil Palm & Other Special Concerns & Project Division, Philippine Coconut Authority

Regional Analysis

The regional yield patterns are significantly influenced by the adequacy and distribution of rainfall over the cropping year and by the Philippines' vulnerability to powerful typhoons. Coconut is basically a rainfed crop and rainfall of 1500 -2500 mm is considered adequate, to highly adequate for a profitable annual crop, which in the Philippines is defined as 10,500 nuts/Ha plus. According to Magat, this is achievable with at least at 120 mm rainfall per month. Across the Philippines the growing zones are classified as:

- HIGHLY SUITABLE/WET ZONE (rainfall highly adequate, usually areas in eastern side of the country)
- SUITABLE/ INTERMEDIATE ZONE (rainfall adequate)
- FAIRLY SUITABLE/ DRY ZONE (rainfall, below adequate with only 4-5 rainy months, located in the western side of the country)
- UNSUITABLE/ARID ZONE (rainfall very inadequate, with only 3 rainy months and/or high altitudes of above 700 m above sea level, massive poorly drained, alluvial clayey soils planted to paddy rice).

Northern Mindanao – Upper Quartile

The highest quartile performance regions, enjoy a climate advantage: Davao has a tropical rainforest climate (Köppen climate classification Af), with little seasonal variation in temperature. Average monthly temperatures are always above 26 °C (78.8 °F), and average monthly rainfall is above 77 millimetres (3.03 in). For the highest performing region, Northern Mindanao, annual rainfall is circa 2,000 mm, with the wettest month (July) averaging some 250 mm. Temperatures vary little between 28 °C average in May to 25 °C in January.

Bicol – Bottom Quartile

By contrast the climate for Bicol, the worst performing region, while also tropical with an average temperature of 27 °C, is more diverse across its various provinces, and being located in the typhoon belt, the region is often the victim of strong and powerful typhoons. The western and southern parts of the Bicol Region along Camarines Sur and Camarines Norte and Albay do not have pronounced dry and wet seasons. Rainfall in these areas is evenly distributed throughout the year, which makes the area well suited to agriculture. The eastern and northern portions of the region however, are characterized by a very pronounced maximum rain period from November to January. The locally known cadang-cadang viroid disease in the Bicol Region, has impacted now for 2 decades, significantly impairing yields.

Luzon

Infestation by the coconut scale insect (CSI) of bearing trees in Southern Luzon has reduced yields in that part of the region, with an impact across the whole. The yield range for the provinces of the region is 1.64 MT/Ha to 5.32 MT/Ha

ARMM

CSI has established across Basilan Island province, with yields down to 1 MT/Ha.

Table 9

REGION/PROVINCE	Production (in MT)	Area (hectares)	Bearing (Trees)	MT/Ha
ARMM	**1,324,069**	**331,634.00**	**34,445,616**	**3.99**
Basilan	64,446	64,400.00	6,414,791	1
Lanao del Sur	186,574	46,381.00	4,598,300	4.02
Maguindanao	716,753	113,046.00	10,436,325	6.34
Sulu	214,231	67,750.00	8,350,000	3.16
Tawi-Tawi	142,064	40,057.00	4,646,200	3.55

Source: Oil Palm & Other Special Concerns & Project Division, Philippine Coconut Authority

South West Mindanao

The bearing capacity of coconut trees has been reduced to 9 nuts/palm/pa), due to “extreme ecological imbalance killing the biological agents in the islands” (Severino Magat) and many years of relative aridity.

Eastern Visayas

Five years from the devastation of Typhoon Yolanda, Eastern Visayas with 6 provinces is reported to have:

- 68,842,649 coconut palms
- 25,514,609 bearing coconut palms (37%)
- 8,108,483 – senile palms (12%)
- 267,234 coconut farmers
- 616,500 Hectares of planted coconut (2.3 Ha average farm size)
- Annual Nut yield per tree - 42 nuts

The region is largely (90%) planted with local coconut Tall varieties, but Severino Magat reports that field surveys have revealed:

- widespread deficiencies in nutrients including:
    - nitrogen, chloride, sulphur, potassium, boron and to a limited extent, phosphorus and magnesium
    - Leaf Analysis (foliar diagnostic techniques introduced by French agronomists), revealed applying fertilizers judiciously doubled, then tripled nut yields in 2-3 years of regular application (average of 2- 3 kg fertilizers/tree/yr, supplying at least N, Cl, and S).

Top Quartile of Regions

Sultant Kudarat province in SOCCSKSARGEN achieves 7.6 MT/Ha, being situated in a Highly Suitable Area. ACAL is advised that its average nut weight of 1.2 kg/nut and annual yield of 79 nuts/tree should at least improve to 1.4 kg/nut and an annual yield of 90 nuts/tree even with moderate fertilization per tree of 1kg A S + 2 kg NaCl (common sea salt).

2nd Quartile Regions

Among the provinces in Central Luzon region, only the province of Aurora (3.8 MT/Ha) is a major coconut producing province located in a highly Suitable zone, with adequate rainfall, located on the eastern side of the country, which receives intense rainfall from the Pacific Ocean yearly.

3rd Quartile Regions

MIMAROPA Region (covering provinces of Mindoro, Marinduque, Romblon, and Palawan), all of these provinces falling under Suitable/intermediate growing zone. The Ilocos Region with very limited coconut plantings falls under
fairly suitable, dry growing zone in the western side of the country. Because of the very limited rainfall (there is a 6-month dry season), only the narrow coastal areas grow coconuts successfully. Central Visayas is widely under the intermediate to dry growing zones. The Eastern Visayas, occupying the highly suitable wet growing zones in the eastern side of the country, albeit devastated by "super typhoon YOLANDA" 5 years ago, is reported to be very much on the road to full recovery to pre-Yolanda coconut crop output. With a current average annual yield of 42 nuts per palm, this is expected to increase to 65-75 nuts/palm, if judicious moderate levels of mineral fertilizer are applied in at least 3 consecutive years. In this region, the new plantings/replanting of coconut areas had started to follow a new planting

system that could withstand super typhoons (120 KPH) passing over the country, referring to the planting in group of 3 palms spaced 2m apart in triangular system or in short G3PH planting, giving about 300 palms per ha, 0.75 ha spaces in between rows to grow diverse food crops attractive to coconut farmers. The new plantings apparently include tall, dwarfs and hybrids.

Bottom Quartile Regions

Except for the Cordillera Autonomous Region (CAR) which is generally not suitable for commercial planting of coconut mainly due to the limiting low temperature for flowering and fruit development of coconut palms existing naturally in mountainous high altitude crop environments, the CALABARZON Region (also called the Southern Tagalog provinces, are considered the traditional coconut producing areas of Luzon main Islands, falling largely under the suitable / intermediate growing zone, where most of the coconut oil mills and coconut oil refining plants are located, coconut desiccated plants, coconut water processing factories and Coco methyl ester plants for Biodiesel fuel.

While the Bicol region is classed in the Philippines as a major coconut producing region, it falls largely under the highly suitable, highly adequate rainfall zone. The region comprises a peninsula with two island provinces of Catanduanes and Masbate, in which 75% of storms that entered the country pass through the region. The supply of coconuts in the region has "valleys and peaks", due to these natural calamities, and due to traditional farming methods, which pay too little attention to fertilization.

Ageing Palms

Dr E Q Javier, Chairman for Coalition for Agriculture Modernisation in The Philippines (CAMP), writing in the National Academy of Science and Technology Philippines Bulletin No. 8 (February 2015), recommended the replanting of some 44 million senile palms, equivalent to 12.8% of the bearing trees detailed in Table 8 above. Dr William Dar (see below) echoes the same sentiment "…the low yields are caused by poor genetics, nil fertilisation and limited replanting of tree stocks. Also 20% of coconut trees are already senile while most trees are planted on marginal lands that also affects yield. Meanwhile, large lands planted to the crop, have low genetic potential…". [15] Dr William Dar specialised originally in horticulture, receiving his doctoral degree from the University of the Philippines at Los Banos. After serving on the faculty of the Benguet State University in the northern Philippines, he became the first director of the Philippine Bureau of Agricultural Research (BAR) in 1988. Dr Dar was designated the executive director of the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD) and served on the governing boards of international research bodies such as the IRRI and CIMMYT and at ICRISAT. He also served for a brief while as Acting Secretary of Agriculture and as Presidential Adviser on Rural Development during the Presidency of Joseph Estrada. He was selected as Director General of ICRISAT in the year 1999.

15 Manila Times (August 25th, 2017)

Table 10 shows the year-by-year yield data for the MAWA and MATAG hybrids. Plots evaluated for each hybrid were planted with 131 palms per hectare. While the MAWA produces 4.5% more nuts per palm compared to the MATAG, its smaller nut size results in it producing 17.2% less copra. The contrasting yield curve of these varieties, with typical per palm outcomes at maturity across Asia, is striking. Under professional, but traditional estate management, as demonstrated by UPL in Malaysia, consistent yields of 26,000 nuts per hectare are achievable, using superior high yield varietals. Under the modern, high-tech farming model being practised by the leading producers in Brazil (including Aurantiaca Agricola), it is logical that even higher performances are possible.

Table 10

Fruits Per Palm (1987-2007)	MATAG	MAWA
1987	81	90
1988	108	137
1989	155	159
1990	167	152
1991	123	140
1992	175	182
1993	186	180
1994	192	192
1995	190	184
1996	163	155
1997	200	189
1998	235	218
1999	223	238
2000	256	283
2001	245	292
2002	212	242
2003	219	244
2004	152	174
2005	175	173
2006	194	193
2007	182	187
MEAN	**183**	**191**

Source: http://traineeagriculturist.blogspot.com/2015/05/mawa-vs-matag-review-of-21-year-study.html

Dr Javier observed that while the Philippine Coconut Authority (PCA) could produce hundreds of thousands of replacement hybrid varieties in its nurseries, this was insufficient to meet the needs the sector, which required urgent replanting following the damage wrought by super-typhoon Yolanda (November 2013). Dr Javier recommended providing incentives to coconut farmers' co-operatives and commercial farmers in all the major coconut producing regions of the country to produce hybrid planting materials. While Dr Javier recommended that these independent hybrid seed gardens should be closely supervised by the PCA to guarantee that only true hybrids were sold to farmers, the risks of sub-standard materials 'leaking' into farms would be very real in our view.

Absent Economies of Scale and Dysfunctional Supply Chain

Dr Javier also noted that production of coconuts in remote locations meant that transporting nuts to processing facilities racked up high logistics costs. His suggestion was to increase village processing facilities, pointing to village-level wet processing of coconuts to produce virgin coconut oil and coconut flour, but he noted that notwithstanding considerable promotion of the concept by the national authorities, very few such developments had materialised. The achievement of scaled efficiencies is challenging, not just in the Philippines, when faced with a fragmented, remotely located smallholder production sector. A fragmented processing link in the Philippines coconut value chain, would likely only compound capital and quality efficiencies. Economically scaled processing facilities with strong quality control systems would support the production of competitive products for domestic and international growth markets. What Dr Javier does not address however, are the problems with quality control and production efficiency, when processing is fragmented in remote locations, without professional process management controls.

Other voices in the Philippines have articulated near identical views to those of Dr Javier. Dr William Dar, writing in the Manila Times (August 25th, 2017) observed that "*…Besides low yield per tree and ageing trees, the supply chain is largely unorganised and made up of dispersed smallholdings that affects economies of scale in input supply, primary processing and marketing*".

Table 11

Coconut Productivity Scenarios The Philippines	Tall Varieties (Laguna)	Dwarf Varieties	PCA Hybrids	Source of Data
Palms per hectare	143	180	143	
Fruits per hectare	14,600	21,200	18,900	Philippines research stations
Fruits per palm	102	118	132	
Fruits per palm without use of fertilisers	63			Philippines research stations
Fruits per palm after 3 years of prescribed fertiliser applications		97		Philippines research stations
Fruits per palm without use of fertilisers	35			Small Coconut Farms Development Project; World Bank Assisted
Fruits per palm after 3 years of prescribed fertiliser applications		83		Small Coconut Farms Development Project; World Bank Assisted

Source: PCA - Zamboanga Research Center (Breeding & Genetics 2005); Good Agricultural Practices- Coconut (Magat, 2006 & 2008)

The issue of scale, or rather the lack of scale at the farmer end of the supply chain, is not just a reflection of the evolution over centuries, of the Philippines agricultural economy, it has been influenced by the posture of the processors and also by government policies. One influential source remarked to ACAL "*In the Philippines, we had the agrarian reform where no farmer could own more than 5 ha of plantation*". Also, unlike the palm oil sector in Malaysia and Indonesia, the processing sector in the Philippines has not, historically, involved itself in upstream production. The fragmented nature of the farming landscape that has developed over the centuries means that "all or many Philippine 'manufactories' buy from traders and consolidators".

While sparse, the data in Table 11 (attributable to Severino Magat) reveal the impact on productivity when fertiliser is not used. Against the potential to produce more than 100 fruits per palm, the example provided of small farmer programmes where fertilisers are not used, indicates the yield per palm falling to 35 fruits, which accords with the national average in the regional analysis in Table 8.
Noting his background in research, it is not surprising that Dr William Dar recommends that the Philippines coconut sector "*ramps up research and development efforts to improve the productivity of coconut lands*". He strongly advocates a "science-based solution". Dr Dar has exhorted the national authorities to:

- Ramp up R&D
- Establish processing centres
- Establish post-harvest facilities
- Soil Mapping
- Farm to market roads
- Irrigation
- Credit & risk management tools for farmers
- Increased use of high yield hybrid varieties of coconut.

Questionable Leadership and Political Support

In August (18th) 2018, Dr Javier wrote in the Manila Bulletin Business, "*…the PCA, sadly has been chronically suffering from organisational instability and alleged mismanagement and misdirection…Worse its ability to fully utilize its appropriations, the budget of the PCA was humiliatingly slashed by Congress from P3 billion to P1.5 billion*". In the face of a weak commodity price for coconut oil, Dr Javier recommends that the Philippine sector "*should reduce dependence on coconut oil as a commodity export…should aggressively diversify into other higher-value products like VCO, coconut water and direct exports of young coconuts…*". However, while Dr Javier was advocating that the production sector refocuses on higher value coconut products, some strands within the political arena appear to have adopted a harsher view. Severino Magat, in his paper on the sector, republished comments attributed to Finance Secretary, Cesar Purisima by the Manila Times in February 2014 "*…the government is no longer keen on replanting coconut trees in the area hit by Yolanda because earnings from coconut is no longer profitable*".[16]

Industrial Processing

As noted above, the processing sector in the Philippines has established important market shares in coconut product segments including desiccated coconut, coconut oil and coconut virgin oil and packaged coconut water. Detailed below are the two largest processors in the Philippines, both of which originated in the 20th Century to produce desiccated coconut for US parent companies in the bakery and confectionery sectors. Both have subsequently developed to become processors of a wide variety of value-added coconut products. As in Indonesia, industrially scaled and internationally focused processors draw raw materials from an unsophisticated, fragmented small farmer dominated supply base. Neither of the companies described below appears to have the same scale as the Sambu Group of Indonesia.

16 http://www.pca.da.gov.ph/coconutrde/images/yield.pdf

Franklin Baker

Franklin Baker is a privately-held company owned by Andorra Investments Corporation, which serves as the vehicle for the Philippine investments of Andorra Services Limited, Hong Kong. Andorra acquired Franklin Baker in 2004, from Kraft Food Ingredients Corporation.
The business is one of the largest global suppliers of desiccated coconut products with plants located at San Pablo, Laguna and Davao, Mindanao. Franklin Baker processes some 1.4 million to 1.6 million coconuts per day, all sourced from smallholder farmers. The company's products are shipped to over 50 countries worldwide across the US, South America, Europe, Middle East, Africa and Asia Pacific. Franklin Baker claims to be "*the leading and preferred supplier of desiccated coconut to major food manufacturers in the U.S accounting for close to a 50% share of total Philippine coconut exports to the USA*". Franklin Baker offers a broad product range as indicated below.

Franklin Baker is concerned about the state of the supply segment in the Philippines, noting on its website that "*the supply chain is declining*". The company notes that Filipino coconut farmers are amongst the poorest in their country, with around 50% living with less than US$ 2 per day. It notes that the majority of farmers lack technical support, access to market and financing. Franklin Baker is now

organizing farmers into co-operatives and 'farmer clusters' in order to introduce good farming practices and technologies including irrigation. The 'farmer clusters' seek to bring economic and logistic benefits of scale to what are otherwise simply fragmented small farms.

To address the spectre of a declining supply chain, the Livelihoods Fund was established to support a 10-year project to mobilize stakeholders in the coconut value chain in Mindanao. Some 5,000 smallholder farmers, the Integrated Rural Development Foundation (IRDF), an experienced Filipino NGO; Franklin Baker, and Mars, Inc which uses coconut for its Bounty® bars, are all contributing to this initiative. According to the Franklin Baker Website: "*In Mindanao, coconut farmers are mostly aged between 40 to 60 years old in a region where 70% of the population is under 35. Farmers have an average of 2 ha with around 200 trees. This planting density therefore leaves large spaces which are generally underutilized*". Franklin Baker's website further notes "*Although coconut accounts for 70% of the people's income in the project zone, ageing farmers do not see it as a business but as a side activity. Farms are not adequately managed… With no appropriate training, Filipino coconut farmers are not able to optimize their production to make a decent living and invest in coconut replanting, maintaining them in a poverty trap*".

The Livelihoods-Coconut (L3F) project has as one of its objectives to promote sustainable practices to better manage coconut farms and increase yields. IRDF proposes to train farmers on practical, efficient methods to enhance productivity including trimming old leaves, cleaning crowns and around the bottom of the palm and composting. The project, further proposes to replace around 30% of senile coconut trees per farm with high-yielding varieties.

The project also proposes to implement a direct sourcing scheme: the 5,000 smallholders participating in the Livelihoods programme will sell their crop directly to Franklin Baker through farmer-owned cooperatives. The cooperatives will rely on networks of village-level farmers' associations to collect the production and to bulk it to Franklin Baker, which in turn will sell the processed coconut to Mars. In this way, Mars and Franklin Baker will have access to a fully transparent coconut supply chain up to farm level. A transparent price mechanism is to be defined in order to give more visibility to farmers and Franklin Baker, thus ensuring the long-term stability of the supply chain. By selling their coconuts directly to Franklin Baker, farmers are expected to retain a bigger share of the coconut's market value. Mars and Franklin Baker are committed to buying the coconut production from this project for the next 10 years.

Table 12

L3F Project Objectives	Weight (kg)	Average Weight per nut Philippines (kg)	L3F Target Implied Nuts Per Palm	Average Density/ Palms per Ha Philippines	Implied Nuts per Ha	Implied Weight of Nuts Per Ha (MT)
Nuts per palm target	65	1.2	54.2	95	5,146	6.2

Source: ACAL/L3F Program

Unsurprisingly, given the below sector average productivity levels across the Philippines, the project has realistic goals; it is targeting a 50% increase in productivity with farmers progressively producing 65kg of coconuts per palm annually. This equates to circa 54 nuts per palm at an average Philippines weight of 1.2kg per nut. Bearing in mind that the average planting density across the country is 95 palms per hectare, this would equate to a yield of 6.2MT/Ha. Well above the national average 3.89MT/Ha and also above the World Average of 4.86MT/Ha.

Peter Paul Philippines Corporation

Processing an estimated 1.2 million coconuts per day, Peter Paul is thought to be the second largest industrial integrated coconut processing plant in the Philippines, after Franklin Baker. Located in Luzon, some 100 kilometres south of Manila, the company's processing operations draw coconuts from plantations across the region. Spread over 13-hectares, the Peter Paul processing facility includes managers' residences, a hospital, and recreational facilities for the company's staff. Peter Paul processes coconuts for a wide variety of products including: coconut milk and cream, coconut water, virgin coconut oil, coconut flour, copra, copra cake, coconut oil and other residual products.

Peter Paul advertises the following product categories:

1. Desiccated Coconut Products
    a. Regular Desiccated Coconut
    b. Sweetened Desiccated Coconut
    c. Toasted Desiccated Coconut
        i. Assorted cuts of coconut, golden brown, free from any extraneous foreign matter. With crunchy, natural coconut taste.

2. Specialty Coconut Products
    a. Organic Virgin Coconut Oil
    b. Coconut Flour
        i. a high-fibre, high protein, low fat, glu ten-free product. A substitute to wheat flour (10-40%) in making bakery prod-ucts, pastas, chips, etc
    c. Coconut Water
    d. Coconut Water Concentrate
        i. an electrolyte drink, a natural source of potassium and magnesium. Described as nutritious, low in fat and low in calo-ries with no cholesterol. The average brix content of coconut water is 5.2+/-.2 but Peter Paul coconut water concen trate brix content is detailed at 60. Water can be added until the average brix content of the coconut water is reached, thus bringing it to its original taste.
    e. Coconut Milk and Coconut Cream
        i. Cream or coconut milk is the pure and natural extract of fresh, mature coconut meat at a certain fat matter content (FMC) combined with natural stabilizers. The process used is intended to preserve the freshness, natural flavour, aroma and quality of coconut cream of fresh coconuts. It is a smooth-flowing liquid and creamy white in colour.
    f. Creamed Coconut/Coconut Butter
        i. Creamed coconut butter is the pure and natural extract of fresh, mature coconut meat at a certain fat content combined with natural stabilizers.

History & Origins

In 1946, the year of independence for the Philippines, The Peter Paul Philippine Corporation was established in Barrio Pahinga, Candelaria, Quezon Province to manufacture desiccated coconut. The company's production was then supplied to its US parent, Peter Paul Inc the manufacturer and owner of the then popular 'Almond Joy' and 'Mounds' chocolate bars. In 1962, control of the company was sold to Filipino interests, which have remained in control.

Conclusion

In all, the picture presented of the Philippines coconut production sector is one lacking broad political support, a forceful lobby group, or an empowered producer sector. It is difficult to form a positive view of its future without a fundamental revision of policy and practice in that country. In the context of the forward-looking picture for international demand growth, it is concerning to recall that the Philippines produces more than 23% of the global crop and that it accounts for more than 29% of the global coconut orchard. Moreover, with 75% of the national crop exported, the declining pattern of productivity across the Philippines sector, implies a risk of disruption to the international market in traditional coconut products. However, significant processors within the country observe that not all nuts are presently harvested or if harvested, successfully shipped for processing. This may imply that the cost of sourcing these nuts (given the complex logistics of certain regions of the country) is prohibitive, but it also suggests that the supply of nuts in the Philippines is still in excess of commercial demand.

MODERNIZATION OF THE COCONUT INDUSTRY

Emil Q. Javier
Academician, National Academy of Science and Technology Philippines (NAST PHL);
Chair, Coalition for Agriculture Modernization in the Philippines (CAMP)

The value of coconut to the Philippine economy is captured by the following statistics: Coconut contributed PhP77.4 billion to the national economy in 2013, ranked fourth among crops after rice, banana and corn. It is planted on 3.56 million hectares, about one-fourth of the total land area devoted to agriculture. An estimated 3 million farmers are primarily engaged in coconut cultivation. We are the world's largest coconut producer and coconut oil exporter.

We are the global leader in coconut production. How do we keep that dominant position and at the same time generate greater value out of that comparative advantage? In other words, how do we modernize the Philippine coconut industry to make it more productive, globally competitive but environmentally sustainable and equitable, particularly to the small farmers who can be and are often short-changed in the rush toward agriculture modernization?

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About the Author:
Dr. Emil Q. Javier is an Academician, former President of the National Academy of Science and Technology (Philippines) and the University of the Philippines System, and Director General of the National Science and Technology Authority, now Department of Science and Technology. He is the chair of the Coalition of Agriculture Modernization in the Philippines (CAMP). A plant breeder, farmer- entrepreneur, and internationally recognized agricultural scientist and research administrator, Dr. Javier led the extensive studies that resulted in the **Philippine Agriculture 2020 (PA 2020)**. This Bulletin on the coconut industry is part of PA 2020.

The National Academy of Science and Technology Philippines (NAST PHL) is the country's premier advisory and recognition body on science and technology. NAST PHL is an attached agency to the Department of Science and Technology.

India – A Complex Jigsaw

ACAL's research indicates a greater degree of official support for the Indian producer sector, than its peer in the Philippines. The profile of the sector, across the relevant Indian states is minutely detailed by various national and regional agricultural agencies of government.

Indian coconut production is, as in Indonesia and the Philippines, still a smallholder occupation. Farm sizes are small by any standard, frequently below one hectare. While production occurs principally across four states, all in Southern India, the climatic differences are diverse, from wet tropical to arid. It is interesting to note therefore that India has some pattern of irrigation and water management, with up to 26.5% of the production area irrigated in the driest major producer state, Karnataka. There is active supply of superior planting materials available to Indian farmers, but as in Indonesia and the Philippines, there is little incentive for farmers to replant their orchards. With coconut production important for local consumption and rural employment, the sector can be expected to continue to grow with demand, having achieved the best production increase (33%) amongst the top three producers this century, but our research suggests that the Indian coconut production sector is focused domestically, not internationally. Perhaps for this reason we have been unable to identify very large scale processors in the model of Sambu, Franklin Baker or Peter Paul.

An Agricultural Economy

According to diverse sources including the CIA Fact Book, India ranks second worldwide in farm outputs, with agriculture and allied sectors like forestry and fisheries, accounting for 13%-14% of national GDP, and accounting for some 50% of the work force.

Data for the coconut economy of India sometimes present as highly variable from one year, and one source to the next, and should perhaps, be treated as indicative. In general, the official statistics for harvested or cultivated area, and for production data, are provided by the state directorates for economics and statistics in Kerala, Tamil Nadu, Karnataka and Andra Pradesh, the four states that make up some 90% of the country's coconut production.

In other states, these data were (until 2009-10) more likely to be provided by their respective departments for agriculture or horticulture. Whereas the All India data were collected and or estimated by the Directorate of Economics & Statistics (DES) under the Ministry of Agriculture and Co-operation. Since 2009-10, the Advisor for Horticulture, Horticulture Division under the Ministry of Agriculture for India, has had responsibility. It is easy to see why the data might therefore throw out anomalies. Moreover, there is gap of some 24 months between the release of regional data by the DES. And since late 2012, the Coconut Development Board has undertaken to estimate forward crop production across the four key states. Readers are advised to keep these factors in mind, when reviewing the data for the Indian coconut economy.

'Tree of Heaven', Central To Farming In Peninsular India

Coconut farming in India has a documented history of some 3,000 years[17] and it is overwhelmingly, a smallholder crop. According to the Coconut Development Board of Ministry of Agriculture (CDB), agriculture represents the way of life for 66% of the country's population. The CDB is a statutory body established under the Ministry of Agriculture, for the integrated development of coconut cultivation and industry in the country with focus on productivity increase and product diversification. The CDB estimates that some 12 million people

17 Ind. Jn. Of Agri. Econ. Vol. 60. No. 4, October – December 2005

in India are dependent on coconut cultivation, processing and trading. The coconut has a central position in the very culture of farming populations in peninsular India, who refer to the palm as Kalpavriksha or 'Tree of Heaven'.

Four States Produce 90% of National Coconut Crop

The data in Table 13 below are somewhat aged, relating to the period 2010-12, for the four big coconut producer states in India. The key references for readers should be the importance of these four states to the production of coconuts in India. Kerala dominates in terms of area (more than 40%) and production (near 37%). Tamil Nadu follows closely in terms of production (circa 34%), but for a smaller land area given over to coconuts (only 20%+ of the national coconut area). So, these two states, represented more than 70% of the national crop in the review period above, and a little more than 60% of the crop area. In reviewing the fundamentals for the Indian coconut sector, this report focuses on these four states.

Not surprisingly, these states are all in South India, sometimes referred to as Peninsular India, an area encompassing the Indian states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Telangana as well

Table 13

Production By State	Production Area (Ha) 2010-11	Production Area (Ha) 2011-12	Change (%)	Nuts Produced (Millions) 2010-11	Nuts Produced (Millions) 2011-12	Change (%)	Production MT 2010-11	Production MT 2011-12	Nuts/Ha 2010-11	Nuts/Ha (2011-12)	MT/Ha 2010-11	MT/Ha 2011-12
Kerala	788,000	766,000	-2.8%	6,239,000,000	6,211,000,000	-0.4%	3,992,000	3,973,900	7,918	8,108	5.1	5.2
Tamil Nadu	390,000	506,800	29.9%	5,771,000,000	5,893,000,000	2.1%	3,692,000	3,770,000	14,797	11,628	9.5	7.4
Karnataka	419,000	420,700	0.4%	2,340,000,000	5,771,000,000	146.6%	1,497,000	3,692,000	5,585	13,718	3.6	8.8
Andhra Pradesh	104,000	142,000	36.5%	1,043,000,000	1,985,000,000	90.3%	667,000	1,270,000	10,029	13,979	6.4	8.9
Totals	1,701,000	1,835,500	7.9%	15,393,000,000	19,860,000,000	29.0%	9,848,000	12,705,900	9,049	10,820	5.8	6.9
All India	**1,895,900**	**2,039,100**	**7.6%**	**16,943,000,000**	**21,892,000,000**	**29.2%**	**10,840,000**	**13,898,500**	**8,937**	**10,736**	**5.7**	**6.8**
As % of All India	89.7%	90.0%	na	90.9%	90.7%	na	90.8%	91.4%	101%	101%	101%	102%

Source: Horticulture Division, Ministry of Agriculture, India

Table 14

Coconut Production India	2016	2015	2014	2013	2012	2011	2010
MT Coconuts	11,127,898	11,209,641	11,078,873	11,930,000	10,560,000	10,280,000	10,840,000
Harvested Area (Hectares)	2,155,749	2,164,000	2,140,000	2,159,000	2,137,000	2,070,820	1,895,900
MT/Ha	5.2	5.2	5.2	5.5	4.9	5	5.7

Source: FAOSTAT

as the union territories of Andaman and Nicobar, Lakshadweep and Puducherry, occupying 19.31% of India's area (635,780 km2 or 245,480 sq mi). Between 8 and 12 degrees north of the Equator, the states are flanked to the West by the Arabian Sea, and to the East by Indian Ocean. Sri Lanka, the 5th largest producer (2.5 million MT annually), lies marginally to the South and East of India, at some 9 to 5 degrees north of the Equator, its most southerly tip, due West of the Northern

Table 15

Coconut Production Data	2016	2000	Change (%)	Increase (MT)
Nuts Produced (MT)	11,127,898	8,350,000	33.30%	2,777,898
Harvested Area (Hectares)	2,155,749	1,770,000	21.80%	385,749
Yield (MT/Ha)	5.2	4.7	9.40%	0.4

Source: FAOSTAT

tip of Sumatera, Indonesia's most westerly and northern island.
The national data for India, for the years subsequent to 2010, drawn from the FAO, indicate that productivity has slipped, notwithstanding the considerable gains made since the turn of the century. Notably, India has achieved a 33% gain in tonnage produced 2000-2016, while area expansion has been lower, at 22%, over the same period.

Constraints On Productivity

The CDB lists the following constraints on productivity for Kerala state, but many of the constraints will apply across the other producer regions.

- Crop management is not approached scientifically
- Modern technological tools and practices are not rou tinely or widely utilised
- Farm holdings are uneconomic in size; A survey of the coconut sector in the four leading producer states iden tified an average holding size of:
  - Kerala 0.53 Ha
    - This is considered to be the Kerala sector's greatest disadvantage
  - Tamil Nadu 2.19 Ha
  - Karnataka 1.13 Ha
  - Andhra Pradesh 1.6 Ha
- Planting materials are sub-standard
- Disease impacts (root disease singled out in Kerala)
- Climate change impact
- High input costs
- Achieved prices for coconut production are not suffi ciently attractive to increase production.

These are constraints which resonate with observations made regarding both the Indonesian and Philippines coconut sectors.

Climatic Zones in India; The Köppen Classification System

As detailed in the Climate Zone map, right, the Indian coconut regions occupy very different climate zones from Wet Tropical (Kerala 38% of production area and 28% of national crop), to Tropical Wet and Dry (Tamil Nadu, Karnataka and Andhra Pradesh), but with some of these important regions straddling the semi-arid zone. But taking Kerala as an example, it has a mix of Koppen classifications:

- Tropical monsoon climate (Am)
- Tropical savanna climate (Aw)
- Subtropical highland oceanic climate (Cwb).

These variations across the country and the coconut growing regions, will be one factor in the varying productivity across locations. Noting that Karnataka straddles the Wet & Dry Tropical and Arid zones in the map below, it is not surprising that more than 26% of the cultivated area is irrigated. This marks a distinct difference between India and the other two big Asian producers, from which climatic conditions are Wet Tropical.

Source: https://en.wikipedia.org/wiki/Climatic_regions_of_India#/media/File:India_climatic_zone_map_en.svg

Sub-optimal Planting Densities

A further factor with potential to impact on productivity, is planting density, especially as defined by yielding palms. The CDB indicates that 175 palms per Ha is considered to be the optimum palm density for coconut production, but within Tamil Nadu for example, a survey revealed a range of densities extending from 122 Palms/Ha to 248 Palms/Ha. However, the production data across the period 2010-2012 (as presented above) especially for Karnataka and Andhra Pradesh, would tend to confirm that planting densities within a range of 20% from target or agronomically ideal, are not the deciding factor in yield outcomes.

East Godavari in Andhra Pradesh featured the highest planting

densities of 151 bearing palms per hectare (for 37 nuts per palm pa), compared with only 95 bearing palms /Ha in the worst performing district of Srikakulam, where surveys revealed average palm productivity of only 17 nuts; worse even than the bottom quartile regions in the Philippines (23 nuts per palm).

Table 16

Production By State	Non Yielding Palms (%)	Palm Density per Ha	Yielding Palm Density per Ha
Kerala	18%	174	142
Tamil Nadu	4%	176	169
Karnataka	10%	131	118
Andhra Pradesh	14%	160	138

Source: Horticulture Division, Ministry of Agriculture, India

Rainfed versus Irrigated

Karnataka, with the lowest density (amongst the four lead states) of yielding palms per hectare, produced one of the top MT/Ha outcomes in 2011-12 at 8.8 MT/Ha. There is a high proportion of Tall varieties growing across the coconut districts of Karnataka, with a wide age profile of 15 to 60 years according to the CDB. The state can suffer from drought, but in certain districts (Mysore and Mandya), the coconut plantations are commonly irrigated. Yields in these districts were reported by the DES at 12,925 nuts per Ha Mandya, and 9,085 nuts per Ha, Mysore. Rainfall in Mysore averages some 782 mm annually and Mandya circa 700 mm. For contrast, consider that the district of Dakshina Kannada, bordered by the Arabian Sea, enjoys 3559 mm of annual rainfall; in 2011-12, the district achieved yields of 13,414 nuts per Ha. Udupi, which also benefits from high annual rainfall (3,728 mm), but with a bearing palm density of 136 palms per Ha, the district was reported to have achieved a production yield of 9,807 nuts per Ha in 2011-12.

Meteorologically, Karnataka is divided into three zones — coastal, north interior and south interior. Of these, the coastal zone receives the heaviest rainfall with an average annual rainfall of about 3,638.5 mm per annum, far in excess of the state average of 1,139 mm. Much of the agricultural output of the state is dependent on the southwest monsoon as only 26.5% of the cultivated area is irrigated. See Table 17 for agronomic conditions across Karnataka's 7 major producer districts.

Table 17

Agronomic Conditions in Major Coconut Producer Districts of Karnataka State	Average Annual Rainfall (mm)	Soil Type	Risks	Nuts/Ha (2011-12)
Chikkamagaluru	1,903	Red sandy loam, Laterite, Alluvial, Red clay, Deep black	Drought, occasional cold	5,453
Dakshina Kannada	3,559	Red laterite, sandy loam	Drought, Flood, Cyclone, occasional sea water intrusion	13,414
Hassan	1,031	Very deep red, medium deep red, gravelly	Drought, Occasional Pest & Disesase	9,943
Mandya	700	Red gravelly, red sandy loam, red sandy	Drought, Flood & Cyclone, regular Pest & Disease	12,925
Mysore	782	Deep red loamy, red sandy loam, black	Drought, flood, regular Pest & Disease	9,085
Tumkur	593	Red, sandy, sandy loam, black	Drought	9,446
Udupi	3,728	Red laterite, sandy loam, alluvial	Drought, Flood and regular sea water intrusion	9,807

Source: Coconut Development Board of India

Compare per hectare productivity with the data for the leading producer districts of Tamil Nadu.

Table 18

Yield per Bearing Palm In Lead Producer Districts of Tamil Nadu (2011-12)	Nuts per palm	Nuts per Ha
Coimbatore	42	6,783
Tiruppur	90	16.682
Thanjavur	87	16,530
Dindigul	79	15,488
Kanyakumari	49	10,055
Theni	74	15,891
Krishnagiri	61	11,651
Dharmapuri	63	7,686
Tamil Nadu	**68**	**12,196**

Source: Coconut Development Board of India

Uneconomic Producer Units

In Kerala by contrast, average nuts per palm is estimated at 58, for some 8,114 nuts per hectare. The range of productivity per palm across 12 districts was 42 – 77, and in terms of nuts/Ha, the range was 12,551 to 5,520. In Kerala the crop is grown on small and marginal holdings. Recall that Kerala has the smallest holding size of the four main producer states at a 0.53 Ha. Economic utilisation of the Kerala crop is traditionally for coir and oil, lower value products. The holding sizes are considered to be uneconomic. The productivity profile for the three leading producer districts of Andhra Pradesh are lower again, ranging from 17 nuts per palm to 37, for nuts per hectare ranging from 1,615 to 5,587. The best performing district is East Godavari which occupies the largest part of the rich Godavari delta. East Godavari featured the highest planting densities of 151 bearing palms per hectare, compared with only 95 in the worst performing district of Srikakulam.

Progressive Replanting – Perspective of Deejay Farms

"*The traditional thinking in India, is that coconut orchards will remain commercially productive for a minimum of 40 years, but the problem with this approach is that there will be zero replanting within a farmer's lifetime*". The potential for greater productivity per palm and per hectare has been established through scientific breeding programmes, with new material becoming available perhaps every ten years; Deejay argues that progressive replanting with new, improved materials would lead to higher per hectare returns. However, the problem with Deejay's perspective, (as ever with a smallholder dominated crop), is capital for investment in new plantings and the cash flow resilience to survive the pre-cropping phase.

A Focus on Breeding

Deejay Farms is focusing on the development of varieties for specific end markets:

- The Deejay Pushkala produces over 250 tender nuts per year, each with more than 600 ml for sweet coconut water
- The Sampoorna is a general-purpose hybrid
  - The Indian Tall produces 12 leaves a year which implies the development of 12 bunches of nuts per year
- The Sampoorna has 18 -22 leaves per year, implying significantly greater productivity
  - The Indian Tall's leaves have a breadth of about 3.5 to 4.5 cm, but the breadth of the Sampoorna leaf is 4.5 to 6.5 cm, with some reported at 7 cm
- The Sampoorna also has more and longer leaves implying (claims the breeder) more than three times the photosynthesis compared to local Talls. (See photo on Page 58)

The stronger performance of India relative to either of the Philippines or Indonesia in terms of increased production since the turn of the 21st century, has been attributed to a variety of factors including:

- Soils
- Palm varieties
- Some pattern of irrigation to offset rainfall patterns
- Wider provision of extension services to farmers.

Processing Sector

The data in the Table 19 sourced from the website of the Coconut Board of India, implies a relatively fragmented coconut processing and manufacturing sector. Many of the enterprises are relatively small, many are centred on farmer co-operatives and very few are incorporated. Without access to published operational and financial data, we cannot confirm if any of the names listed in the table below operate with significant scale, but our sense from the data, is that they do not. Not surprisingly there is a concentration of enterprises in the more traditional product areas of Coconut Oil (62/249); Desiccated Coconut (36/249); and Copra/Ball Copra (30/249). Virgin Coconut Oil (35/249), is what we describe as a modern product, and this is strongly represented. Also deemed to be a modern product, 14 enterprises are focused on the production of Activated Carbon, of which 9 are private limited companies. Packaged Tender Coconut Water also features 9 private limited company producers for a total of 12 producers. The impression conveyed in various dialogues with coconut sector actors in India, is that there are few scaled enterprises. One source commented "*…we know only of one big factory in Andhra Pradesh which is Vijayanagar Food & Nutraceuticals, a modern factory set up with Philippines technology to process 200,000 coconuts per shift to produce VCO, coconut water, coconut milk and milk powder. We understand this is the biggest unit in India today*". If the reference to Philippines processing technology is correct, this would confirm that indeed the coconut economy in India, has not developed the critical scale at the processing and manufacturing level, to support production systems innovation.

Table 19

Coconut Product Manufactured	Number of Projects	Of Which Public Limited Companies	Of Which Private Limited Companies	Of Which Proprietor
Acid Wash Activated Carbon	1	1	0	0
Activated Carbon	14	0	9	3
Ball Copra	16	0	0	13
Coconut Chips	11	0	2	3
Coconut Oil	62	1	5	22
Coconut Shell Powder	13	0	1	6
Coconut Vinegar	22	0	2	5
Copra	14	0	0	6
Desiccated Coconut	36	0	2	17
Milk Powder	1	0	0	1
Packed Tender Coconut Water	12	0	9	1
Coconut Shell Charcoal	12	0	4	6
Virgin Coconut Oil	35	0	4	15
Total	**249**	**2**	**38**	**98**

Source: www.coconutboard.gov.in

Brazil – "Invented Here"

According to Paulo Roberto, CEO of Sococo "*…Brazil is at the forefront of global coconut production…We can't import technology from Asia or copy competitors because they're far behind us*..." Brazil has a rich agricultural history, developed and preserved perhaps by its landed families over centuries. Within the 20th and 21st centuries, this culture has been benefitted by the focus on productivity and technological innovation by the state research organisation, EMBRAPA. While large-scale sections of the agri-economy of Brazil have benefitted from the emergence of China as a global power, as so well exampled by soya, the coconut sector has thrived on the native demand for advanced coconut products within Brazil itself. Paulo Roberto's title claim is not an exaggeration: Brazil has designed, and is implementing a coconut production value chain unlike any other across the tropical belt. However, despite the significant technological advances achieved by the best farms in Brazil, the leading Brazilian coconut agronomist, Luiz Mirisola Filho advises that the majority of coconuts produced in Brazil, are produced by smallholders, without technological aids. As detailed further herein, ACAL estimates that there are some 22,000 hectares planted in agro-industrial plantations or planted to supply agro-industrial processors. If we assume that these achieve a mixed productivity from 30,000 to 15,000 nuts per hectare, for an average of 22,500 nuts per hectare, this area would produce a notional annual crop of some 495 million nuts, or circa 0.5 million tonnes of nuts out of a national harvest of 2.65 million tonnes, for a percentage share of circa 18%. This would imply that national productivity, as indicated by FAOSTAT data, out turns at some 10.3 MT/Ha if adjusted for the agro-industrial element. This would still be greater than 2x the world average.

Brazilian Coconut Sector Origins

It is widely believed that populations of 'Talls' (coconut palms) were introduced to the north-eastern coastal zone of Brazil, focused on Bahia, by the Portuguese in the 16th century (coco-da-Bahia). The palms then spread along the north-eastern coastal zone, and waterways, adapting over time to various environmental conditions to create different regional ecotypes (Ribeiro et al. 1995). The Brazilian Agricultural Research Corporation (EMBRAPA) collected, characterized and conserved the genetic variability of these populations, and used them for developing reportedly superior hybrids with better production traits and quality, adapted to different Brazilian agro-ecological zones.

Brazil has established a coconut gene bank in the State of Sergipe to serve EMBRAPA´s coconut improvement programme. There is now a commitment to upgrade this gene bank to become an International Coconut Gene Bank for Latin America and the Caribbean (ICGLAC), with the support of the Bioversity International and the International Coconut Genetic Resources Network. Reports suggest that today the north-eastern costal region of Brazil, is responsible for more than 80% of national production. FAO data for 2016 suggest that Brazil was the fourth largest producer of coconuts in the world, but at some distance from the top three producer countries, except in terms of productivity per palm and per hectare.

Table 20

Coconut Production	MT	% of Global Crop	Area Harvested (Ha)	MT/Ha
Indonesia	17,722,429	30.00%	3,105,259	5.7
Philippines	13,825,080	23.40%	3,565,059	3.9
India	11,127,898	18.90%	2,155,749	5.2
Brazil	2,649,246	4.50%	234,012	11.3

Source: FAOSTAT/ACAL 2016

Research indicates that within Brazil:

- production is concentrated in the coastal region of the country, in the states of Bahia, Sergipe and Ceará
- the highest productivity recorded is in the region of the São Francisco Valley, in the back-lands of Pernambuco state, with irrigated plantations and intensive use of technology.

Table 21

Coconut Producing Regions of Brazil	Estimated Planted Area (Ha 000)	Köppen-Geiger Climate Classification (Symbol)	Description
Bahia	80	Aw	Tropical Savanna
Sergipe	42	Aw	Tropical Savanna
Ceará	43	As	Tropical Savanna
Pará	25	Af	Tropical Rainforest
Espírito Santo	11	Aw	Tropical Savanna
Pernambuco	14	Am	Tropical Monsoon
Rio de Janeiro	5	Aw	Tropical Savanna
Paraíba	12	Aw	Tropical Savanna
Rio Grande do Norte	22	As	Tropical Savanna
Alagoas	13	Am	Tropical Monsoon
All Regions	267		

Source: ACAL/Luis Mirisola Filho

The extraordinary leap in productivity over the past 55 years, by Brazil has been attributed to two significant developments: a focus on dwarf coconut varieties, and the Brazilian Green Dwarf in particular, (for the production of fresh coconut water), and the use of technologically advanced irrigation and fertigation systems. According to Paulo Roberto, CEO of Sococo "*…Brazil is at the forefront of global coconut production…We can't import technology from Asia or copy competitors because they're far behind us*..."

Growth Driven By Domestic Market

Industrialised processing of coconuts to produce products for the domestic market began to gather pace during the 1960s. This process of industrialisation soon spread also to the upstream sector with a number of major integrated value chain operators, establishing state-of-the-art coconut plantations.

This pattern marks a point of real difference between Brazil and the other major producer countries: it is the only producer country to see the development of an integrated industrialised value chain. In Indonesia, the Sambu Group comes closest to this model, but it relies substantially for its feedstock from smallholder farmers. In Brazil, by contrast, the processors determined to have control over the entire length of the value chain to ensure security of supplies and to guarantee quality. For Sambu the calculus was different: a cohort of some 400,000 smallholder farmers with 500,000 hectares of palms planted across the Sumatran provinces of Riau, Jambi and South Sumatra, some of the most ideal locations in the world for coconuts, provides the source of feedstock for a globally scaled processing and distribution business model.

Brazil has been served well by its domestic market: the growth in global demand for packaged coconut water has its origins in Brazil. It is not an exaggeration to state that the modern Brazilian coconut production value chain has been designed around domestic demand for value added coconut products.

Productivity

While we have been able to access ten-year production data for the United Plantations Limited (UPL) coconut operations in Malaysia, we have not been able to publish production data for the Brazilian peer group. The data available on the Sococo website imply it is achieving yields per palm in the region of 228 nuts, for per hectare yields in excess of 33,000 nuts. Given Sococo's focus on dwarf and hybrid planting materials, the results implied may be possible. Compare with the UPL 10-year history below: the Malaysian operator, which supports its operations with a scientifically focused in-house breeding programme, has demonstrated capacity to produce more than 30,000 nuts /Ha, and average in excess of 26,000 nuts / Ha over a ten-year period.

As noted elsewhere in this report, the price received by producer in the major producer countries ranges from US$0.071 cents to US$0.30 cents (in tight market conditions). The data are informal, and many farmers likely achieve the lower side pricing, but the price for processors, courtesy of the collectors and aggregators will be higher, perhaps double the farmgate price, and perhaps calibrated at this rate, for size and quality. ACAL is advised that the average price per nut, received by small farmers in Brazil, ranges from US$0.15 to US$0.30, selling to farm gate aggregators, who sell on to processors, or in the local market. The data, if correct, are remarkably consistent with the Asian data, and this may not be too surprising if Brazilian processors are importing Asian coconut products for reprocessing.

Table 22

Reported Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average Over Period
Nuts Produced (millions)	83.655	75.541	83.331	71.763	74.11	74.678	68.424	77.501	86.052	75.252	
Hectares Implied by Average Yield/ha	3,341	3,340	2,962	2,897	2,842	2,780	2,731	2,793	2,840	2,969	
Total Planted Area Reported (ha)						3,090					
Average Yield (Nuts) per ha (as reported)	25,037	22,616	28,135	24,771	26,080	26,858	25,056	27,747	30,305	25,345	**26,117**
Comment on Yield	Biological Boom	Removed 317 ha to plant Oil Palm		Biological Resting Phase	Biological Recovery	Biological Recovery & Intensive Harvesting to Meet Demand Surge	Drought impacted bud formation and pollination	Biological Recovery & Favourable Climatic Conditions incl abundant rainfall	Biological Recovery but nut size small due to drought	Biological Rest After 2016 Abundance	

Source: United Plantations Report & Accounts 2006-2017/Website/ACAL

The Brazilian Agro-Industrial Producer Group

The descriptive data have been substantially collected from the company websites; most names were not prepared to provide additional data. Despite the significant technological advances achieved by the best farms in Brazil, the leading Brazilian coconut agronomist, Luiz Mirisola Filho (LMF), advises that the majority of coconuts produced in Brazil, are produced by smallholders, without technological aids.

LMF has provided a local expert perspective, and he notes that amongst the peer group, Sococo and Ducoco are noted for their upstream production assets. ACAL's research indicates that Sococo has not installed irrigation systems across its farms, while Ducoco apparently has a focus on Tall varieties. Whereas Sococo processes only what it produces with no third-party supply, LMF advises that some Brazilian integrated value chain operators, may purchase domestically produced nuts, and / or import dried coconut from Asia, for processing. This presumably, is a cost / price driven strategy.

Table 23

Brazilian Agro-Industrial Producers	Proprietary Farms	State	Hectares Planted	Palms Planted	Implied Palms / Ha	Total Nuts Implied Produced /Palm	Total Nuts Implied Produced per Ha	Planting Material
Aurantiaca	Yes	Bahia	1,706	0	na	na	na	BGD and Hybrids
Coco do Vale		Paraíba	2,000	320,000	160			na
CocoSamba		Paraiba	2,000					Ivory Coast Hybrids/Embrapa Lines
Ducoco * (Estimate)	Yes	Ceará	4,900	784000				Talls (LMF)
Sococo	Yes	Para	11,000		145	228	33,182	Hybrids (including Ivorian material)
Peer Group Area Planted (Ha)			**21,606**					

Source: ACAL/Company Websites/Luiz Mirisola Filho

Table 24

Brazil Agro-Industrial Cost Per Nut	Optimal Growing Locations	Standard Growing Locations	Sub-Optimal Growing Locations	Costs per Ha (US$)
Dwarf Palms / Ha	205	205	205	3,792.50
Fruits per Palm	350	250	100	
Fruit / Ha	71,750	51,250	30,750	
Cost Production per Fruit (US$)	0.053	0.074	0.123	
Hybrid Palms / Ha	160	160	160	3,368.00
Fruits per Palm	250	150	100	
Fruit / Ha	40,000	24,000	16,000	
Cost Production per Fruit (US$)	0.084	0.14	0.211	

Source: Luiz Mirisola Filho

Aurantiaca

The Aurantiaca Group initiated its activities in Conde in the state of Bahia, in 2006, when it acquired two farms, Fazenda Bu and Sao Bento da Barra. The planting of both properties, with a mix of dwarf and hybrid material, was completed at 1,706 Ha in 2015. The regional climate in which Conde is located, is classified as tropical. The summers are much rainier than the winters and our reading of the Köppen Geiger index, suggests that this climate would be classified as Aw. The average annual temperature is 23.0 °C, and some 888 mm of precipitation falls annually. This environment will certainly require irrigation, to achieve high yields. In India, for example, the region

compares with Mysore (782 mm annually) where average nut yield per hectare in 2011-12 was 9,446.

The group was founded with two stated objectives:

1. to redefine the coconut value chain by becoming the leading producer and innovator in the coconut farming sector
    a. a demanding challenge when a number of Brazilian companies had laid claim to this mantel already, including Sococo and Ducoco
    b. to develop a culture of operational excellence as a means of guaranteeing the management of resources in a responsible, sustainable and profitable manner.

Source: Aurantiaca Agricola Brazilian Green Dwarf Plantation

Aurantiaca set out with the objective of raising the level of productivity for coconut palms and plantations, and the quality of the coconuts produced. The farms were fitted with state-of-the-art irrigation systems which enable the collection of real time analytical data to optimise water and energy usage on the farms.

The processing facility for the Aurantiaca farms is located within 30 kilometres from the plantations, thus permitting 'nuts on tree', to export of processed nuts or nut products, within 24 hours. The integration of production and processing, both at scale, strikes a vivid contrast with the coconut sector in the three big Asian producer countries.

Compared to the mindset (coconut production is a secondary, supplemental activity) and culture (zero inputs, no mechanisation, local planting materials) of subsistence farmers in Indonesia, the Philippines and India, many of whom live below the poverty line, the environment on the Aurantiaca farms (and others like them in Brazil) is quite literally, a 'world apart'.

Coco do Vale

The Vale do Coco, known as the coconut grove of Coco do Vale, is located in Lucena, Paraíba, a coastal region, with reportedly superior soils, highly suitable for coconut cultivation. The orchards containing some 320,000 palms, are an estimated 2,000 Ha in area, and are irrigated by 7 rivers and by waters from the Beberibe Aquifer, reportedly at a rate of 200 litres per day per palm. This rate of water use compares with traditional guidance that bearing palms require 100-150 litres of moisture per day, perhaps indicating a greater requirement for higher yielding, water nuts.

CocoSamba

CocoSamba, is another company that has grown on the back of internal demand for traditional Brazilian coconut products. Fazenda Vale do Mangereba, located in Paraiba, comprises some 2,700 hectares, of which some 1,500 hectares were planted with hybrid material imported from Ivory Coast (reportedly under the influence of CIRAD). Another 500 hectares have been planted with Brazilian materials. In the model of Sococo and Aurantiaca, the processing facilities have been located in close proximity to the plantations with the coconuts processed (reportedly) immediately after harvesting. The plantation operates on a continuous irrigation basis.

Ducoco

Ducoco has been producing coconuts for 35 years on the Ceará Coast. The company boasts 7 farms, 2 factories, 3 distribution centres, and 1,500 employees. Ducoco claims to have established a sales network across Brazil, and to being today "one of the largest coconut water exporters" in Brazil. In the Brazilian industrial tradition, the processing facilities are located close to the plantations, for fast processing after harvesting, and the preservation of nutritional values and quality of product. The company's website states that it has "the world's largest coconut farm certified by the Rainforest Alliance" and the first one in Brazil.

Sococo

The Brazilian company Sococo was founded in 1966 in the state of Alagoas, with a mission to produce packaged grated coconut and coconut milk, both ingredients which had come to form staple components of the Brazilian national diet.

Sococo went on to establish its own plantations (8,500 hectares) in the state of Para, where today it has some 1.6 million trees planted. With a second farm of 2,500 hectares (also in Para), Sococo now claims to harvest 1 million coconuts per day. With some 11,000 hectares planted, for a total of 1.6m trees, the plantations appear to be planted at a lower density of 145 palms per hectare. However, if the bulk of the 1 million nuts per day derive from the proprietary plantations, then the company is achieving yields in the region of 228 nuts per palm, for more than 33,000 nuts per hectare.

The decision to plant within the Amazon rainforest was considered to be ground-breaking as a strategy as formerly, coconuts had only been cultivated along the coastal regions of Northeast Brazil. In 1979, working with the French Institut de Recherches pour les Huiles e Oléagineaux (IRHO), now more commonly known as CIRAD, the company decided that the Amazon's soil and climatic conditions made it agronomically ideal for the cultivation of high yielding hybrid coconuts. The resulting farm in Mojú, 110 km from Pará's capital of Belém, reportedly became the largest, most productive and most sustainable coconut plantation in Brazil, with 8,500-hectares of coconuts set amid 12,000 hectares of preserved Amazonian rainforest. In so doing, Sococo set a precedent for other Brazilian coconut value chain operators to establish proprietary farms also, and thereby gaining control over the entire production process from farm to fridge. Today Sococo branded coconut products are reportedly in stock with more than 90% of retail channels handling the category.

Sococo has been selling coconut water since the 1990s. According to Paulo Roberto, current managing director of Sococo, Sococo is ideally poised to take advantage of an imminent coconut water boom: he predicts the market will expand by more than 10% a year, and he attributes Sococo's 14% growth in revenues over the last three years to the success of its popular lines of coconut water, which include a diet version as well as beverages that combine coconut water with fruit juice.

Government Backed Research Support for Brazilian Coconut Sector

Thanks to the development by Embrapa Food Agroindustry of an edible food coating, the shelf life of fresh green coconuts can be extended by up to four times (normally no more than 10 days); this in response to demands from consumers relayed back to Embrapa by the Brazilian producer sector. The entrepreneur Edivânio Domingos, from the Coco do Vale estate, states that he had been searching for years for a technology that was able to guarantee the quality of fresh green coconuts while increasing their shelf life. This revolutionary material is expected to allow significant shipments of fresh coconuts from Brazil to markets around the world. Reportedly, the use of this technology is able to preserve the integrity of the nutritional characteristics of the fresh coconuts and the water within them, without changing their colour or flavour. "The coating works as a physical barrier and reduces the fruit metabolism by decreasing respiration, enzymatic activity, and the degradation of sugars, minerals and vitamins, while maintaining sensorial characteristics and ensuring the microbiological quality of the fruit and of the water, that is, conserving it for longer", reports Josane Resende, a professor from the Federal Rural University of Rio de Janeiro (UFRRJ), who conducted the pioneering study in 2007 while advised by the researchers Antonio Gomes Embrapa Food Agroindustry, and Neide Bottel, from Embrapa Vegetables.

"This Embrapa technology is spectacular, because it is low cost and requires little manpower. There are only three stages: cleaning, immersion in the film solution, and drying. Thus, we can extend the shelf life of green coconut to over 40 days, making it possible to export it to European countries such as Portugal, Belgium and the Netherlands", Domingos states.

In order to obtain this result, Coco do Vale also follows Embrapa Food Agroindustry's technical guidelines on the best way to store the fruits, and on regulating the temperature, humidity and ventilation of containers in the export process. During the application of the technology, the fruits are cleaned and then immersed in a filmogenic solution based on polysaccharides and other composites, which contribute to reducing microbial activity and maintaining nutritional value. After the coating is dry, the product is ready to be packed and stored for export or trade in the national market.

The composition of the filmogenic solution can vary according to the physiological characteristics of the fruit, and it does not cause changes to colour or flavour. "The coating can be used in different fruits, such as coconuts, melons, papayas, mangoes, watermelons and guavas. It is a simple technology that farmers themselves can apply in their property" according to Antonio Gomes, a researcher from Embrapa Food Agroindustry. For over twenty years, the post-harvest team of Embrapa Food Agroindustry has conducted research with the aim of increasing shelf life and reducing food loss. The studies into biodegradable and edible fruit coating, were begun some ten years ago.

The Importance of Embrapa

Brazil has been transformed from a food importer to one of the world's largest agricultural producers over the past several decades, catching up with developed countries that have historically dominated the global markets for grains. The Brazilian Agricultural Research Corporation (Embrapa) is thought to be one of the principal drivers behind this transformation, "literally changing the landscape of Brazil to increase the cultivation of the cerrado, Brazil's savannah".[18] According to Embrapa, which receives most of its funding from the federal government, every R$ 1 invested in Embrapa generates an average return of R$ 13.20 for Brazilian society.

18 CREMAQ, PIAUÍ. "The miracle of the cerrado". The Economist. 26 August, 2010

Source: Brazlilian Green Dwarf, 18 months, under irrigation, fully mechanised in Tourus, Rio Grande do Norte. Luiz Mirisola Filho

Although it is connected to the Brazilian Ministry of Agriculture, Livestock and Supply, Embrapa was established in 1973 as a public company. Its mission to "provide feasible solutions for the sustainable development of the agricultural sector through knowledge and technology". [19]

Embrapa comprises a broad network of research and service centres across the country, and is engaged in a wide variety of activity in agro-energy, agribusiness, food technology, biotechnology, nanotechnology, animal production and forestry. It is present in all states of Brazil, and employs over 9,000 people including over 2,000 researchers, three-fourths of whom have doctoral degrees. The organization has created and recommended more than 9,000 technologies for Brazilian agriculture since its inception.[20] Innovations include new seeds, edible wrapping paper for foodstuffs, and biodegradable fabrics and bandages, among other highly sophisticated product and process improvements in the agricultural sector.

Innovations include new seeds, edible wrapping paper for foodstuffs, and biodegradable fabrics and bandages, among other highly sophisticated product and process improvements in the agricultural sector.

19 International Society for Horticultural Science. (2012). EMBRAPA and ISHS: sign a partnership agreement. Available at: http://www.ishs.org/partners/embrapa/

20 Brazilian Agricultural Research Corporation. (2012) Embrapa. 10 December

Conclusion

According to Mike Foale of the Australian Centre for International Agricultural Research (ACIAR), "*Humans have probably been using the coconut for around half a million years…the story of the coconut and its presence around the globe is one in which evolution, immigration, trade, other cultural practices and the forces of nature all play a part*".[21]

A traditional crop of the tropics, before the beginning of this century most western consumers knew the coconut best from holidays in the Tropics and from such traditional desiccated coconut-based bakery items as macaroons and lamingtons, or from well-known confectionery brands like Bounty® bars. At the start of the 21st Century however, coconut products embarked on a renaissance with consumers around the world, and especially in the West. A surge of popularity in 'modern' coconut consumer goods has been led by packaged coconut water, with strong growth in consumption of coconut milk and virgin coconut oil following in its wake. Depending on definitions, and varying from one consumer products researcher to another, a consensus total for the market in 'modern' coconut consumer products implies a global sales value of some $9bn circa 2017, rising to $19bn in the mid-late 2020s, led by packaged coconut water at a projected $13bn from $6bn, coconut milk sales values growing from $1bn to $2bn, and VCO sales topping $4bn, as compared with circa $2bn in 2017. These data exclude traditional coconut product segments such as crude coconut oil, with a value of perhaps $3bn annually depending on prices (some 3.5 million MT produced annually), desiccated coconut, generating another $1bn or thereabouts annually, and then a miscellany of other coconut products including coir, generating perhaps another $1bn in sales. These data suggest a global coconut consumer goods market with a sales value in the order of $14bn annually in 2017/18, rising to a possible $24bn in the middle of the next decade. To put these data in context, the global sales value of cocoa based consumer products has been estimated at $120bn annually.[22]

Like the cocoa value chain, the coconut value chain is also dependent on the smallholder farmers of the tropical belt. More than 90% of both crops is produced by some of the poorest farmers on the planet, following agricultural models that have not changed in centuries. Surging global demand for modern coconut consumer products, contrasts with a structurally constrained upstream producer sector as described in this report. In this context, as the title of this report implies, Brazil stands out amongst the larger producer countries. Between 1961 and 2016, FAO production data indicate that productivity per hectare in Brazil has expanded by nearly 500% to reach more than 11 tonnes of coconuts per hectare. The Philippines on the other hand has seen per sector productivity shrink by more than 7% over the same period, to less than 4 tonnes of coconuts per hectare. Brazil's success has been based on the use of advanced breeding materials (like the Brazilian Green Dwarf) giving yields as high as 400 nuts per palm, and the employment of leading-edge technologies for irrigation and analysis of farm data, on modern, industrially scaled farms. Professional farms in Asia, producing over 20 MT of coconuts per hectare, are being challenged by Brazilian peers capable of producing more than 30 MT per hectare and potentially more than 40 MT.

The challenge for the global majors in the supply of processed coconut consumer goods, led by private interests such as Sambu Group in Indonesia, Franklin Baker and Peter Paul in the Philippines, is to improve the efficiency and sustainability of the critical cohort

21 Foale, M. 2003. The coconut odyssey: the bounteous possibilities of the tree of life. ACIAR Monograph No. 101, 132p.

22 Destruction By Chocolate, Hardman Agribusiness, February 2016

of smallholder farmers supplying their globally scaled processing plants. While today not all coconuts produced are either harvested or transported for processing, in the future the sustainability of supply will depend on making the production of coconuts sufficiently attractive economically for a generation of younger farmers to replant the ageing plantations of Asia with higher yielding materials, and to invest in modern farming methods.

The Stoll Estate, a 700 acre traditional coconut plantation under rehabilitation on the Pomeroon River, Guyana. (August 2018)

Appendix 1

Agronomic Requirements

A brief description of the agronomic conditions required by coconuts with a focus on Dwarf varieties and Brazilian conditions. Substantially drawn from: https://www.ipipotash.org/udocs/5_Coconut-Green_Dwarf_Variety.pdf

Climatic Requirements

As a species, the coconut requires annual temperatures around 27ºC, without great variation. Temperatures less than 15ºC may cause flower abortion, with negative effects on yield. Temperature, as a function of latitude, influences the altitude tolerance of the coconut. Close to the Equator, the plant may be cultivated up to 750 m, but with increasing distance from the Equator, the plant is grown at lower altitudes. The air relative humidity may influence plant development when it is lower than 60%. On the other hand, very high humidity may favour the development of diseases, as well as diminish the absorption of nutrients because of decreased transpiration. Not only the amount of rain, but more so its distribution has a strong influence on the growth of the plant. Total annual rainfall of around 1,500 mm, with a minimum of 125 mm rain each month, is satisfactory. Lack of rain may be compensated either by water within the soil but the depth of water table should not exceed 3 m, or by irrigation. The plant does not develop in low light intensities. Annual irradiation of 2,000 hours, with a monthly minimum of 120 hours is considered adequate (Fremond et al., 1966). Weak to moderate winds may positively influence growth because of its effects on transpiration and nutrient absorption (Passos, 1998), but winds during drought periods may aggravate water deficit.

Soil Preferences

Coconuts do not tolerate soils high in clay, nor do they appreciate soils that have compacted and impermeable layers, which impede root penetration or create poor aeration conditions (Fremond et al., 1966). The root system develops best in sandy soils where it can exploit a greater volume of soil. Soils across the growing regions of India, are mostly highly suitable for coconut cultivation.

Water Requirement

Of the coconut varieties, the dwarf coconut is the most sensitive to water deficit. In regions where there is a defined dry season, irrigation where water is available is required to produce large yields. Amongst the methods of irrigation, jet and surface dripping are the most appropriate (Nogueira et al., 1998). Jets are placed in the region of greatest root growth, which occurs in a radius of up to 1.80 m from the plant (Cintra et al., 1992). For dripping, a hose is connected to a lateral line around the trunk, with the drip also placed in the region of greatest root growth.

The amount of water required is estimated to be between 100 and 150 L/tree. However, the actual amount depends on climatic factors so that local adjustments should be made. It is notable that Coco do Vale in Brazil states that the palms supplying its processing unit are receiving up to 200 litres per day. Higher productivity, especially for coconut water, could be expected to increase the moisture requirement.

Where the fruits are produced for coconut water they are collected between six and seven months old. At this stage of maturity, the fruit weighs about 2.4 kg with approximately 600 ml of water, with a pH around 5.0, and Brix value at 20º about 5.8. Variations in fruit weight and water volume may be associated with nutritional problems and water deficiency which, when severe, may cause a change in the fruit's shape, which becomes oblong.

Mineral Nutrition: Uptake and Export of Nutrients

The amount of nutrients in dwarf coconut fruits were estimated using data from Ouvrier (1984) and recalculated according to Sobral (1998). For a yield of 200 fruits/plant/yr, the offtake of N, P, K, Ca, Mg, S and Cl, are approximately:
87.71; 12.44; 169.77; 6.02; 9.48; 7.85 and 92.0 kg/ha/yr, respectively. The largest offtakes are of N, K and Cl. Uexkull (1972) demonstrated the importance of Cl in coconut nutrition. By virtue of the quantity of Cl removed, the authors propose that this nutrient be considered a macro-nutrient for coconut. The demand for P, Ca Mg and S is less than that for N, K and Cl.

Functions and Importance of Nutrients

Nitrogen (N): Lack of N causes gradual yellowing of the leaves and a reduction of the number of female flowers. With acute deficiency, there is a decrease in the number and size of the leaves and a narrowing of the stalk, causing what is called a “pencil tip”. Sobral and Leal (1999) observed that N influenced the number of fruits of the giant coconut and considered that 17.18 g/kg as the critical N level in leaf 14. Sobral (2004) observed an increase in the number of green dwarf coconut fruits when the plant was fertigated with N as urea.
Phosphorus (P): Phosphorus deficiency causes reduced growth and darker green leaves caused by a greater relative concentration of chlorophyll. The removal of P in the harvested fruits is small, but in soils with very low levels of plant-available P the nutrient becomes limiting.
Potassium (K): The symptoms of K deficiency are characterized by the appearance of rust coloured stains on both sides of the leaves that become more intense at the extremities, and eventually developing into necrosis. For the plant as a whole, yellowing of the leaves in the middle of the crown may indicate K deficiency, followed later by the drying of the oldest leaves. The younger leaves remain green (Manciot et al., 1980). Potassium is exported in large quantities in the fruits. Occasionally an apparent anomaly may be seen with K. Analysis may show large amounts of K in the leaves but this does not signify good K nutrition. Potassium can accumulate in the leaves when other factors cause poor fruit yields and hence transfer of K to the fruits is limited.
Chlorine (Cl): Uexkull (1972) demonstrated the importance of the nutrient Cl for coconut when the application of KCl increased the weight of albumen, from 117 to 216g, and the composition of Cl, from 0.40 to 2.33 g/kg in leaf number 14. The composition of K in the same leaf varied only from 10.9 to 11.7 g/kg, i.e. K was not increased by the addition of more K. The symptoms of K deficiency appear first in the oldest leaves, which yellow and have orange spots. The leaflets dry along the edges and extremities, and the fruits are smaller.
Calcium (Ca): The first symptoms of Ca deficiency appear on leaf numbers 1, 2 and 3 and they become yellow and rounded, turning brown at the centre. The spots are isolated in the early stages, joining and drying later on. In young leaves, the spots are uniformly distributed, however starting from leaf number 4 the spots are concentrated at the base of the leaf. Plants with such symptoms contained only 0.85 g/kg Ca in leaf number 4 (Dufour et al., 1984).
Magnesium (Mg): The symptoms of Mg deficiency appear first in the old leaves. At the extremities of the leaflets and the parts exposed to the sun, the yellowing is more intense, while the leaves close to the trunk remain green. When the deficiency becomes severe, there is a necrosis on the extremities of the leaflets, which become dark yellow. At this stage translucent spots become visible.
Sulphur (S): When S is deficient it is not translocated from the older to the newer leaves (Mengel and Kirkby, 1978). In young coconuts, when there is a deficiency of S the new leaves become yellowish and orangey, with necrosis on the extremities of the leaflets. In the adult coconut there is a reduction of the number of living leaves, which become yellow. In the oldest leaves the stalk becomes weak and it bends around the stem. The number of fruits is small and approaches zero when the deficiency is serious. The albumen, after drying (copra),

becomes thin and elastic and contains little oil (Southern, 1969).
Boron (B): B deficiency is manifest in the leaflets, which are joined at the extremities. In severe cases the leaflets at the base of the stem are smaller, crest, and may even disappear. When B deficiency is very severe the point of growth completely deforms, preventing the development of the plant. In young coconuts, deficiency may be corrected by applying 30 g of borax at the axial of leaf number 4. In adult coconuts, B can be added as borax mixed with other fertilizers and added to the soil. Because the limits of deficiency and toxicity are very close, elevated doses of B may cause toxicity in the plant.
Copper (Cu): Deficiency of Cu in coconuts was described by Ochs et al. (1993) when the plants were grown in peat soils in Indonesia. Firstly, the stems of the new leaves become flaccid and later bend. Almost simultaneously, the extremities of the leaflets start to dry, going from green to yellow, and finally, to brown – appearing burnt. When the deficiency is serious new leaves are small and chlorotic and the plant may dry completely. In Brazil, Cu deficiency was found in coconuts planted in Quartz Neosols (Sandy Quartz). Iron (Fe): The symptoms of Fe deficiency were described by Pomier (1969) when found on the Pacific Coralline Islands where the high levels of calcium carbonate render the iron unavailable. It is important to remember that in tropical soils, the presence of iron oxides is substantial.
Manganese (Mn): Mn deficiency is characterized by generalized chlorosis. For coconuts grown in north-eastern Brazil, analysis of leaf number 14 showed great variability in the Mn composition. Sobral (1989), studying the nutritional state of coconuts in Sergipe, showed no direct relationship between Mn in leaves and the burned leaf symptom. It was observed, however, that there is a significant relationship between the composition of Mn in the soil and the leaf.

Source: Deejay Group. Deejay Sampoorna Hybrid Coconut (Dwarf x Tall). Maturity at 5 years. Yield projected at 250 mature nuts/annum

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