Malaysian Palm Oil Industry: Moving towards the Future

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INTRODUCTION

Over the last forty years, the Malaysian palm oil industry has grown by leaps and bounds to become the world's largest producer and exporter of palm oil and its products. The planted acreage has increased from a mere 55 000 ha in 1960 to 3.3 million hectares in 1999 (*Figure 1*). Since 1997, oil palm cultivation has occupied more than 50% of the total planted areas under major agriculture crops – oil palm, rubber, cocoa, coconut, pepper, pineapple, tobacco, paddy, coffee, tea and sugar cane (Ministry of Primary Industries Malaysia, 1998). In 1999, there were 334 operating palm oil mills, 43 palm kernel crushing plants, 46 refineries and 14 oleochemical companies producing crude palm oil (CPO) and crude palm kernel oil (CPKO), refined oils and oleochemicals respectively (PORLA, 1999). In the same year, Malaysia produced 10.55, 1.34 and 1.62 million tonnes of CPO, CPKO and palm kernel cake (PKC) respectively. State wise, Johor and Sabah were the largest CPO producers accounting for 2.43 and 2.67 million tonnes respectively. Sabah is poised to become the largest CPO producer state in the country in the very near future. Though Sarawak produced only 0.46 million tonnes of CPO in 1999, in view of the vast land areas available, it will be the Focus State for oil palm cultivation in future.

Over 96% of the palm oil exported from Malaysia are in the refined form. In 1999, Malaysia was the largest exporter of refined palm oil, accounting for 8.53 million tonnes. Most of the palm kernel oil and its deriva-

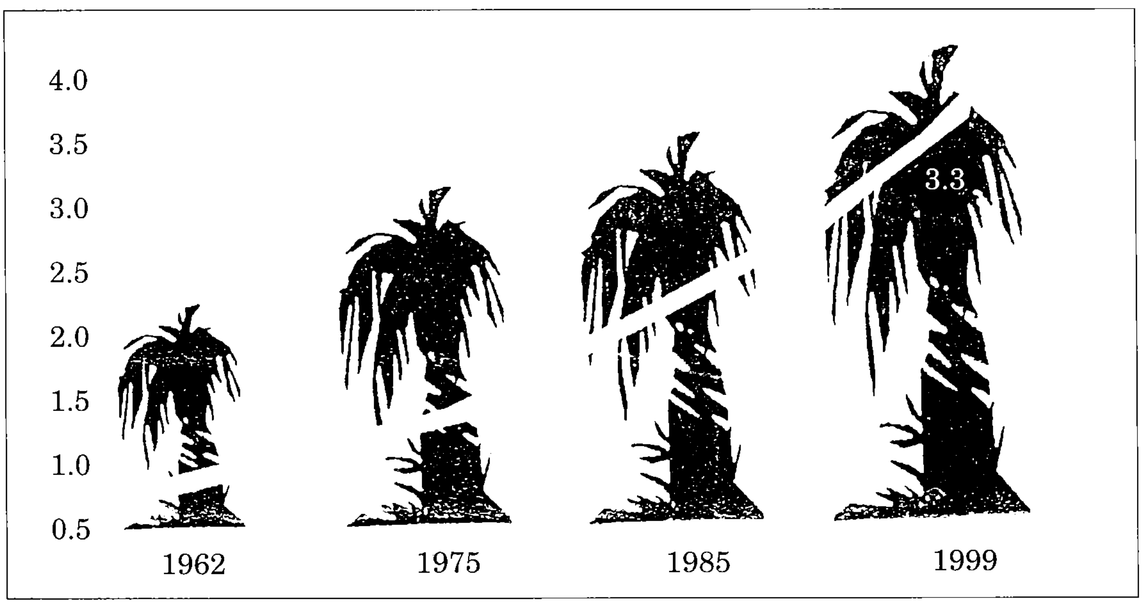

Figure 1. Malaysia: cultivated area under oil palm (million hectares).

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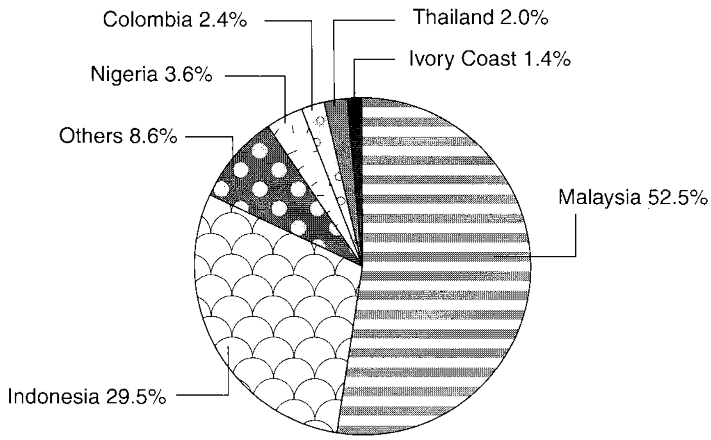


Source: Oil World Weekly (January 7, 2000).

Figure 2. World share production of palm oil by major producing countries - 1999.

tives, including oleochemicals are exported. The export earnings from palm-based products in 1999 amounted to RM 17.74 billion. It was the largest foreign exchange earner of the country and undoubtedly it had brought a positive effect on the country's balance of payment.

In the world oils and fats scenario, Malaysia's production of 10.55 million tonnes of CPO accounted for 52.5% of the total palm oil produced in 1999 (*Figure 2*) and contributed to 9.9% of the world oils and fats production. Indonesia was the second largest palm oil producing country. Its production in 1999 was 5.9 million tonnes. The other countries like Nigeria, Colombia, Thailand, Ivory Coast, Papua New Guinea and others produced about 3.58 million tonnes of palm oil.

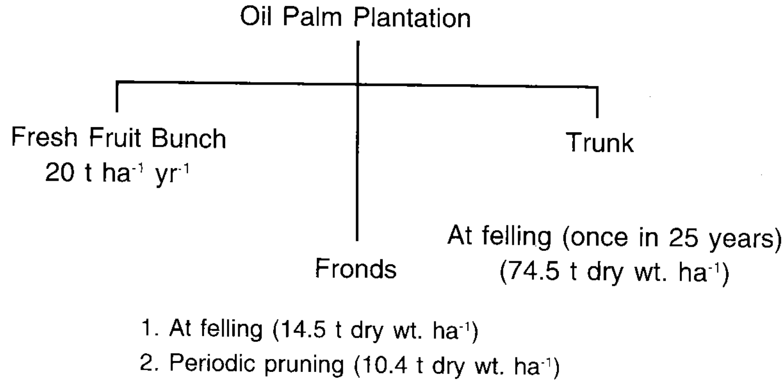
The world demand for oils and fats is expected to increase from the present 100 million tonnes to 125 million tonnes in 2005, due to increasing world population and increase in per capita consumption of oils and fats. Palm oil is poised to contribute significantly to meet this demand in view of its high yield of 4-5 t ha^{-1} yr^{-1} compared to only 0.4 and 0.6 t ha^{-1} yr^{-1} for soyabean and rapeseed oils respectively, the two major competitors to palm oil.

PRODUCTS FROM OIL PALM CULTIVATION

Oil palm is a perennial crop that has an economic life span of about 25 years. An oil palm estate produces fresh fruit bunches (daily production), fronds (daily production) and trunks and fronds (during replanting). The quantities of these products obtainable from the estates are shown in *Figure 3*. It must be mentioned here that the oil palm is grown, to date, for its fruits (or fresh fruit bunches), that yield two distinct oils (namely CPO and CPKO) and PKC. These are presently the main commercial products of oil palm industry.

Fresh fruit bunches (FFB), after harvesting, are transported to palm oil mills for processing into CPO and palm kernels – the main commercial products, and fibre, shell and empty fruit bunch (EFB) – the non-commercial products (*Figure 4*).

Oil palm is a unique crop in that its fruits yield two types of oils, palm oil from the mesocarp and palm kernel oil from the seed or kernel. These two oils have very different physical and chemical properties as shown in *Table 1*. Their processing and applications also differ to a great extent.



Source: Chan *et al.* (1981).

Figure 3. Products from oil palm estates.

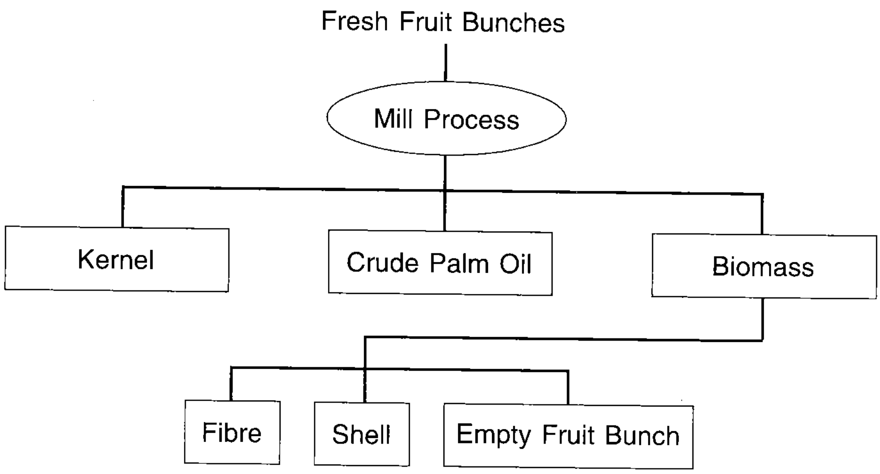


Figure 4. Products from palm oil mill.

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF PALM OIL AND PALM KERNEL OIL

	Palm oil	Palm kernel oil
Melting point (°C)	**36**	**27.3**
Iodine value	**53**	**17.8**
Fatty acid composition		
C6:0		0.3
C8:0		4.4
C10:0		3.7
C12:0	0.2	48.3
C14:0	1.1	15.6
C16:0	44.0	7.8
C18:0	4.5	2.0
C18:1	39.2	15.1
C18:2	10.1	2.7
C18:3	0.4	-
C20:0	0.4	-

Sources: Tan and Oh (1981).
Siew and Berger (1981).

RESEARCH AND DEVELOPMENT - MPOB's ROLE

The oil palm industry is expected to continue to be an important contributor of foreign exchange earnings and employment in the Malaysian economy in the foreseeable future. However, it has to overcome keen competition from 16 other oils and fats in the world market. In addition, it also has to face the challenges from palm oil producing countries, particularly Indonesia, for the palm oil markets.

The Malaysian palm oil industry emphasizes on strong R&D support in order to face the challenges. The sustainability of the oil palm industry can be enhanced through vigorous and well strategized R&D programmes. Palm Oil Research Institute of Malaysia (PORIM) was entrusted to discharge this responsibility dutifully. Since its inception in 1979, PORIM has bean well equipped and staffed with qualified scientists to conduct research to meet the industry's need. With the merging of PORIM and the Palm Oil Registration and Licensing Authority (PORLA) as the Malaysian Palm Oil Board (MPOB) effective 1 May 2000, this R&D function shall continue to be carried out by the MPOB. The Research Divisions at MPOB have programmes aimed at increasing yields of planting materials and enhancing the marketability of palm oil by expanding its food and non-food uses, improving production efficiency and quality and promoting palm oil products.

Besides the laboratory and pilot plant facilities, MPOB has established an experimental palm oil mill to evaluate new milling technologies and an Advanced Oleochemical Technology Centre to spearhead research in production and applications of palm-based oleochemicals. MPOB also collaborates with well-known research institutions locally and overseas to complement its research efforts where necessary. Thus, the industry is most welcome to conduct collaborative research with MPOB. To date, MPOB has signed many Memoranda of Understanding (MoU) with numerous organizations to conduct joint research in many areas beneficial to the industry.

Oil Palm Cultivation

Land has become a scarce resource especially in Peninsular Malaysia. The industry is also facing acute labour shortage. In order to maintain its competitiveness, the industry has to increase the productivity per unit land area of oil palm products. Intensive and extensive R&D efforts are being directed towards developing high yielding and slow growing planting materials as well as planting materials that can produce specialty products that can command high premium prices.

There is an urgent need to increase the yield of the planting material. The current national yield is averaged at 3.7 t oil ha^{-1} yr^{-1} as compared to the theoretical maximum of 17 t oil ha^{-1} yr^{-1} (cited in Chan and Yusof, 1999). This is a challenge to the researchers to narrow this (yield) gap.

Over the last 20 years, PORIM had collected extensive germplasm materials from Africa and Latin America. Through intensive breeding programmes, PORIM had succeeded in developing the dwarf palm variety, the PS1 and palm with high liquid oil, the PS2 and high kernel content variety, the PS3. Other palm varieties that yield oil with high carotene and vitamin E contents are being developed.

With the advent of genetic engineering techniques, it will be possible in future to channel the inherent high productivity of the palm towards the production of high value products such as nutraceuticals and pharmaceuticals. Given the impediments of labour and land scarcity, the powerful tools of gene technology could be harnessed to produce high yielding and high value products so that the industry will continue to prosper into the next millennium. In future, it is likely that we have a plantation supermarket where consumers can choose their preferred oils.

Notwithstanding the above developments, the industry still depends heavily on labour in many aspects of the plantation operations. It remains a major challenge to mechanize operations such as harvesting of FFB and collection of loose fruits. More innovations and commitments are necessary.

Palm Oil Milling Technology

It has often been said and is true that there has been no dramatic change in the overall palm oil milling technology since it was introduced to Malaysia some fifty years ago. But over the years, there have been much incremental improvements in various unit operations in the mills. These developments or improvements may be mill- or site-specific.

It is our opinion that if the palm oil mills continue to receive and process the FFB in the present forms, it is unlikely that there will be dramatic change in the overall palm oil milling processes, especially in the front line - starting from the FFB ramp to stripper or thresher. Much man power and attention are required in loading of FFB into cages, sterilization of FFB and conveying 'cooked' FFB into thresher. These operations will be revolutionized if the mills receive and process only loose fruits!

MPOB is focusing its efforts in developing a continuous sterilization process. Very promising results have been obtained from our studies. The process is being scaled up and will be installed at MPOB's experimental palm oil mill for commercial evaluation.

It is fair to say that after the thresher, the milling processes are fully automated or mechanized. But all the processes are not centrally controlled. Millers are still skeptical about the benefits of such a central control system though it has been implemented at the refineries. We believe that a fully automated palm oil will make the milling operation less labour intensive and more productive.

The palm oil mills are suffering from low oil extraction rate (OER). The national OER is hovering at about 18% as compared to above 20% in the pre-weevil era. The industry has lost billions of ringgit and is still looking for the cause of the decline in OER! No answers seem to be forthcoming as fingers are being pointed at both the mills and plantations. There will be no simple answer until and unless we can establish how much oil received by the respective mills is in the FFB. This is another challenge to all scientists and technologists to come out with an instrument that can measure the oil content in a bunch.

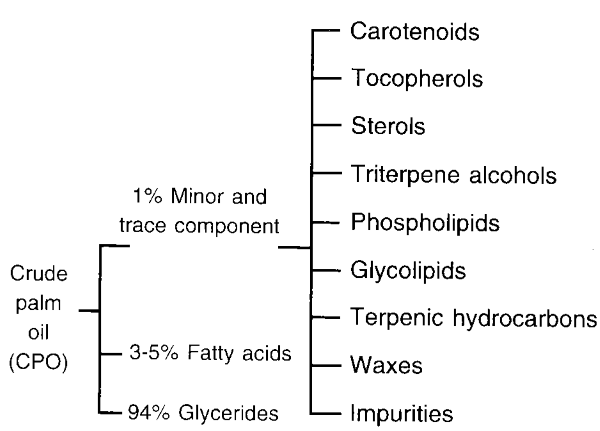
Palm Oil Refining Technology

Up to the early 1970s, Malaysia exported only CPO. Malaysia's first palm oil refinery was set up in early 1970s against all odds! Since then and encouraged by Government incentives, more than 50 refineries were set up in the last 30 years. But some have ceased operations due to one reason or another. The refineries are all equipped with the latest refining technologies including fractionation, hydrogenation and specialty fats processing equipment. Though all these technologies were imported, much fine tuning and in-house improvements have been developed locally. Today, Malaysian refineries are capable of producing a wide range of high quality palm-based products to meet consumers' requirements all over the world. With a refining capacity of 12 million tonnes per annum and a fractionation capacity of 10.5 million tonnes per annum, Malaysia is reputed to be the largest edible oil – processing centre in the world. Malaysian palm oil is exported to more than 130 countries. This underscores our capabilities.

Chemical refining was the general order of the day in the early stage of refining industry. With the trend to build bigger refining capacities to cater for greater availability of CPO, coupled with the tight control on environmental pollution, the industry shifted to physical refining in early 1980s. Existing chemical refining plants were either scrapped or mothballed and only operated when there is request for chemically refined oils (Yusof and Thiagarajan, 1998).

Very often, the on–going pressure of reducing processing costs has produced some unhealthy practices – cutting corners at the expense of quality (stability) of the refined products. Cost-saving processing conditions are introduced without thorough understanding of their effects on the quality of the finished products.

There is a need to review the palm oil refining technologies. It is now well established from our numerous nutrition studies that some of the minor components like carotenes and tocopherols (*Figure 5*) in palm oil are beneficial to our health (Choo, 1995; Yusof and Sundram, 1999). But they are destroyed or removed by the current refining technology. For example in 1998, the refineries destroyed about 4000 t of high value carotenes through bleaching and deodorization (8.0 million tonnes of CPO containing 500 ppm of carotenes). The industry had lost billions of ringgit without realizing it!



Source: Goh *et al.* (1987).

Figure 5. Constituents of crude palm oil.

PORIM had developed and commercialized a process to produce a refined oil rich in natural carotenes. In this PORIM patented technology, the CPO is deacidified and deodorized at low temperature (<180°C) by means of short-path-distillation (Choo *et al.*, 1996). Under such conditions, the carotenes are retained intact. Conventionally, the same process is carried out at higher temperature (>240°C) that destroys the heat-sensitive carotenes.

PORIM had also developed a process to recover vitamin E (tocopherols) from palm fatty acid distillates (PFAD), a by-product from physical refining of CPO. Processes to recover pure carotenes, sterols, squalene and other minor valuable components are being investigated. CPO has been recognized as a good source for these substances. It is possible that one day in the near future, these substances will become the major commercial products and palm oil, the co-product.

Food Uses of Palm Oil and Palm Kernel Oil

Palm oil and palm kernel oil are important raw materials in food applications. This is due to their unique fatty acid and triglycerides compositions as well as thermal properties. About 80% of the oils are used in food applications. Common products made from palm oil and palm kernel oil, wholly or blended with other oils include frying and cooking oils, shortenings, vanaspati, margarines, confectionery and non-dairy products (*Figures 6* and *7*). In many applications, palm oil or its more liquid fractions can be combined with harder fraction such as stearin to produce products of the required consistency without hydrogenation.

In certain applications, such as industrial frying, palm oil has built up a name for itself as among the most suitable frying oil. Furthermore, in the manufacturing of solid fat products, palm oil is an excellent source of raw material, being semi-solid with moderate level of saturation. It does not require hydrogenation; hence the products do not contain *trans* fatty acids which are considered harmful to health. Palm oil has been proven as healthy by many nutritional studies undertaken by many researchers worldwide.

Oleochemicals

Oleochemicals are chemicals derived from plant or animal oils and fats. They are analogous to petrochemicals derived from petroleum. Over the last twenty years, the Malaysian oleochemicals industry has developed to become an important industry in the palm oil sector. Palm oil and palm kernel oil have become the important raw materials

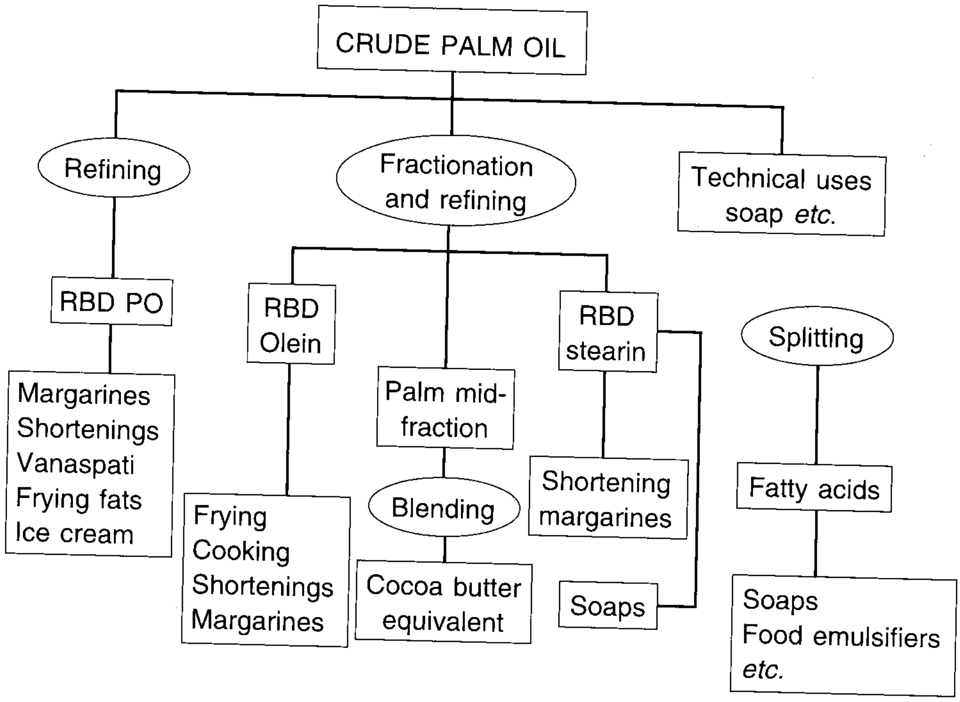


Figure 6. Uses of palm oil.

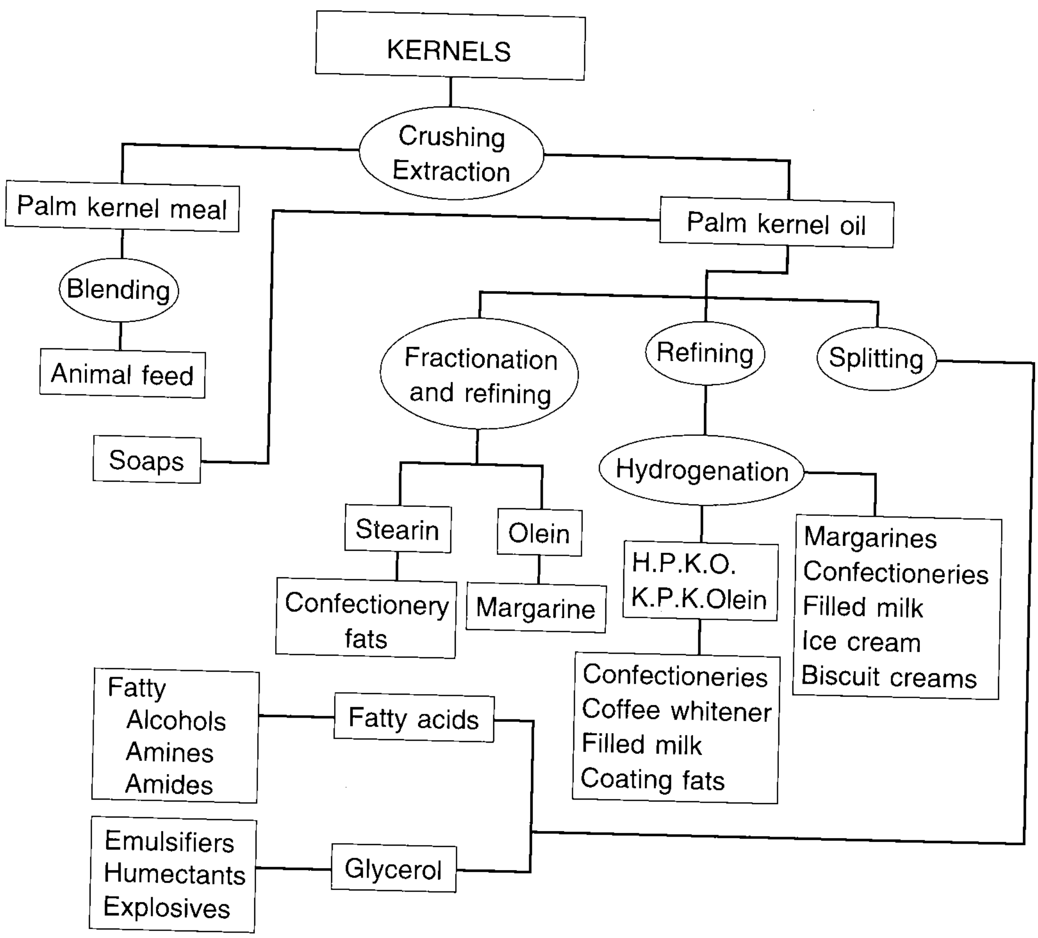


Figure 7. Uses of palm kernel oil.

for the production of such basic oleochemicals as fatty acids, fatty esters, fatty alcohols and glycerols. The major uses of oleochemicals are in the manufacture of non-food products like soaps, detergents, cosmetics and personal care products, lubricants and greases, printing ink and biodiesel.

Theoretically, oleochemicals are able to substitute petrochemicals in most areas of applications. The advantage of oleochemicals over the petrochemicals is that the former are renewable and more biodegradable. In other words, oleochemicals are more environmentally friendly.

It is clear that there are tremendous business opportunities in the more value-added downstream oleochemical industry and Malaysia being the largest producer of palm oil and palm kernel oil, is well positioned to become the leader in oleochemical industry (Salmiah, 1999).

Utilization of Oil Palm Biomass

It is estimated that in 1999, in tandem with CPO and CPKO, the palm oil industry also generated more than 30 million tonnes (dry weight) of biomass in the form of fibre, shell, EFB, fronds and trunks. These products are only commercially exploited to a very limited extent; *e.g.* fibre and shell are used as energy source in palm oil mills while EFB, fronds and trunks are used as mulch in estates. All the palm oil mills use fibre and shell as fuel to generate steam and electricity to meet their energy demands. It is estimated that in 1998, the palm oil mills generated and consumed about 800 million kWh of electricity from fibre and shell. It amounted to about 3%-4% of the national electricity demand. Being renewable, it is envisaged that oil palm biomass will play an important role in the national energy programme in the near future.

R&D efforts have found that these palm-based fibrous materials are suitable for the manufacture of a broad range of products – medium density fibre-board, pulp and paper, furniture, cushions and mattresses as well as chemicals like xylose and xylitol. Many of these studies are in advanced stages of development and expected to be commercially exploited in the near future. It is envisaged that utilization of palm-based biomass is a long term plan to sustain the viability of the Malaysian oil palm industry. It is highly possible that palm biomass will be the main product instead of the oils.

Environmental Protection

The palm oil industry is facing tremendous challenges to meet the increasingly stringent environmental regulations. Over the last thirty years, several cost-effective treatment technologies have been developed for palm oil mill effluent (POME). A growing awareness of the need not to pollute is forcing the industry to review its waste management strategy. The conventional treatment and disposal strategy is no longer justifiable. Environmental management is placing greater emphasis on waste minimization and utilization. Land application of POME is the most viable option if suitable land is available near the palm oil mill. Its application to land has been shown to be beneficial to soil and crop. Tremendous savings in fertilizer have been realized.

PORIM had developed a zero-waste process using evaporation technology to recover water and solids from POME (Ma, 1999). The water recovered is recycled as boiler feed-water or process water and the solids are converted to fertilizer. It is a closed-loop system. No treatment plant is required and therefore no liquid waste is discharged. Also no biogas, the greenhouse gas is generated. This innovative technology offers a long term solution to the pollution problem. The industry should adopt new green and clean technologies to reduce or prevent waste generation at source.

CONCLUSION

It is forecast that the demand for oils and fats will continue to exceed the supply. The Malaysian oil palm industry is projected to grow moderately in the next decade. In order to enjoy and maintain the dominant position in the international oils and fats market, the Malaysian palm oil industry should strive to improve its productivity and competitiveness through continuous technology innovation in processing of palm-based products including the utilization of biomass. It is also important to open new markets and consolidate existing markets. Concerted R&D efforts are required to produce new and innovative palm-based products for niche markets.

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