Palm Oil: Nature's Gift to Malaysia and Malaysia's Gift to the World**

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ABSTRACT

For Malaysia, oil palm is the golden crop that has helped to change the scenario of the Malaysia's agriculture and the Malaysian economy. In 2007 at 4.17 million hectares, the oil palm performance is compared over the last 90 years from 1917 to 2007 and some projections are made over the next 100 years to 2107. The various phases undergone by the oil palm industry from the pioneering work with the determination to nurture the plant into a crop and to create a home for it in Malaysia, have been marked with several important milestones such as diversification from the over dependence on rubber in the 1950s and 1960s, strong support from well thought-out policies involving use of palm oil as food, fuel, fibre and feed in the 1970s and 1980s, through R&D move into processing and value-adding activities to improve the health and food safety aspects and finally in the 1990s and 2000s to tackle the environmental and sustainability development. The broadening of the scope and horizon for export of oil palm and its products into 11 areas of food, oleochemicals, energy, biomass, biotechnologically improved products, nutraceutical, pharmaceutical, farm machinery, research and advisory services, processing, livestock integration and feed production will strengthen the competitiveness of the Malaysian oil palm products that will take centre-stage in international oils and fats businesses. In so doing, the impact of such massive development of the oil palm has helped uplift the rural poverty, enhance social and economic life, and yet protect the very environmental and ecological bases on which the oil palm thrives. Truly the oil palm is a crop that nature gives to Malaysia and now it has evolved into Malaysia's gift, thanks to continuous R&D with many innovations, to share the new discoveries on the uses of palm oil and its products with the whole world. In the future, the Malaysian oil palm industry will remain a major reliable supplier of vegetable oil for both food and non-food applications. It must be mentioned that the projections made here after deliberation are the views what the MPOB team members have wished for the industry. For a forecast of a hundred years, the reality will be dictated by events and the rate of progress of R&D.

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INTRODUCTION

The Malaysian oil palm industry has a long history of development and over the past 90 years from 1917 to 2007, it has achieved tremendous success and will continue to be one of the main pillars of the Malaysian economy when projected over the next 100 years to 2107. The industry is globalized and its palm oil production is recognized internationally as one of the major reliable suppliers of the major oils and fats in the world.

The Malaysian oil palm industry recorded an impressive performance in 2008 where the export earnings of the oil palm products rose to a record RM 65.2 billion despite the decline of a high price of RM 4179/t traded in early March to a low of RM 1403/t in late November 2008. Production of crude palm oil (CPO) increased to 17.73 million tonnes, an increase of 1.91 million tonnes or 12.1% over 2007 (MPOB, 2008). The total oil palm planted areas showed a small increase of 4.3% to 4.48 million hectares in 2008.

The national average FFB yield increased by 6% to 20.18 t/ha/yr as against 19.03 t/ha achieved in 2007 which is a record since 1994. In addition, the expansion in matured area by 151 534 ha coupled with the improvement in the national average oil extraction rate (OER) to 20.18% also contributed to the higher CPO production. The average oil yield/ha also posted a 6.5% year-on-year increase to 4.08 t/ha, the highest since 1987. The production of crude palm kernel oil (CPKO) also rose by 11.7% to 2.13 million tonnes. Thus, the impressive development of the Malaysian palm oil industry is traced through the snapshots over three dates comprising of:

- 1917 when oil palm was first planted;
- 2007 with an examination of the current status in 2007 after 100 years from 1907; and
- 2107 by doing scenario painting with projections of what it will likely be in the next 100 years.

Though oil palm was introduced into our Malaysian shores in 1875, it was only in 1917 that the first commercial planting of oil palm was started. The area was less than 3000 ha then and the main use of the palm oil was for food. In 2007, the area was 4.17 million hectares with 80% of the palm oil being used as food and the balance of 20% for non-food use. With the production target at 35 t fresh fruit bunches (FFB) and oil extraction rate (OER) at 25% which set in place a target of 8.75 t oil/ha since year 2000, the spin-off industries from palm oil and its related products would have grown and matured to take advantage of the yield increases. It is anticipated that by 2107, the area will reach 5.5 million hectares from the present 4.48 million hectares. In accounting for a slight increase in the projected planted area, it is due to the innovative technologies that push the projected yields to 40 t FFB and 30% OER thereby setting a target yield of 12 t oil/ha. As a result the increase of 3.25 t/ha in potential oil production coming from 12 t/ha over the present potential of 8.75 t/ha, it is expected by then that 50% of the production will be used for food use and the other half be used for non-food applications. The spill-off industries would have matured into respective competitive industries in their own right and some examples could be related to the biodiesel, flavonoid and pharmaceutical businesses. It must be mentioned here that the projection is what the MPOB team members have wished for the industry and in reality much will be dictated by actual events and the rate of progress of R&D.

The development of the oil palm industries will continue to be based on the well-established 'perseverance' and 'pioneering' spirit of the Malaysians. As the country practices free enterprise, innovative ideas will soon generate into new businesses. The urge to overcome global issues brought about by the difficulties in diversification into other crops will see the birth of new products through linkages with existing ones by tapping on the synergies of production and environment (Basri and Chan, 2008a). Looking back, indeed the oil palm tree has not only adapted well in Malaysia by making it its home but ever since then, the country has been sharing this gift of palm oil with the rest of the world. Currently, the overall importance of sustainability of the crop cannot be overemphasized enough and from now onwards, it is essential to recognize that sustainable development must be addressed and the best practices be implemented on a sector basis covering all its related industries. In other words, the oil palm industry has the potential to give birth to numerous palm oil related industries that have better leverage on the palm oil and oil palm itself. Each product will have to work with a different set of regulations and the necessary regulatory bodies to overcome each of the industries' own peculiarities. The oil palm industry indeed will then be most diversified and one size does not fit all in the food and non-food uses.

THE FUTURE OF THE PALM OIL INDUSTRY

In the next 100 years in 2107, there will likely be five major thrusts areas *viz*., i) products/ industry development, ii) process development, iii) nutritional aspects, iv) environment and sustainability concerns, and of course, lastly, v) market development.

Palm oil, a well balanced edible healthy oil, supplies an important energy source for mankind. Today, it is widely acknowledged as a versatile and nutritious vegetable oil, *trans* fat free oil with rich content of vitamins and antioxidants. A palm bears 8-12 bunches annually, each weighing 15-25 kg and containing 1000-3000 fruits. Two types of oil are derived *viz*., palm oil from the mesocarp and kernel oil from the seed and the ratio is 10 to one in terms of production. Palm oil being red in colour is fractionated into the liquid olein and the semi-solid stearin to improve the versatility in food applications. Olein is used mostly for cooking and frying while stearin finds applications in solid fat formulations and is extensively used in food processing. Palm kernel oil is used for making specialty fats for various food products. It is also an important raw material for oleochemicals. Under the product/industry clusters from the five thrust areas, there are 11 industries for which there is already some active transfer of technologies (TOT). The industry clusters are shown in *Table 1*.

The details of the 11 clusters and their potentials value are shown in *Table 2*.

From *Table 2*, the future looks bright. With continuous R&D into the innovation and looking at the industry components of being a reliable supplier, the sector has to look at the buyers both existing and new and also to look at threats from substitutes, and other low cost new entrants so that our new innovative products from R&D are to take a foothold in new emerging markets. The potential values from birth and enhancement of palm oil and its related industries - both macro and micro - are shown in *Figure 1*.

In *Figure 1*, we have added two more clusters consisting of the livestock integration, intercropping and also the inclusion of feed production from the biomass of the oil palm crop and the intercrops. Under biomass, the use of fibre for the automobile industry has prospects.

Food Industry

In 1907, the palm oil that was produced was used mainly in household frying and baking. However, in 2007, the palm oil has been used for performance food, health food, specialty fats and widely used in commercial frying and baking. In the future in 2107, palm oil will feature well in the designer-food to suit the hypermarket food and also the use of nano-technology to improve its bioavailability of nutrients, vitamins and phyto-nutrients. As the Malaysian palm oil is exported to over 150 countries globally, the research priority on food is on its application as 80% is used for

TABLE 1. PRODUCTS/INDUSTRY CLUSTERS AND THE TRANSFER OF TECHNOLOGY (TOT) DONE BY MPOB IN 2007

No.	Clusters	No. of TOT
1	Food	43
2	Oleochemicals	116
3	Energy	7
4	Biomass	18
5	Genetically modified (GM) derived products	3
6	Clonal industries	6
7	Pharmaceutical, nutraceutical, flavonoids	5
8	Farm machinery	23
9	Automotive industry	7
10	Processing	132
11	Services	58

TABLE 2. THE ESTIMATED AND POTENTIAL VALUE OF THE PALM OIL INDUSTRY CLUSTERS

No.	Industry cluster	Current estimated value (USD billion)	Future projected value (USD billion)
1	Food	20	100
2	Oleochemicals	25	100
3	Energy	20	130
4	Biomass	20	80
5	GM derived products	10	50
6	Clonal industries	<1	10
7	Pharmaceuticals, nutraceuticals, flavonoids	25	500
8	Farm machinery	2	10
9	Automobile industries	12	45
10	Processing	15	60
11	Services	5	20
	Total	155	1 165

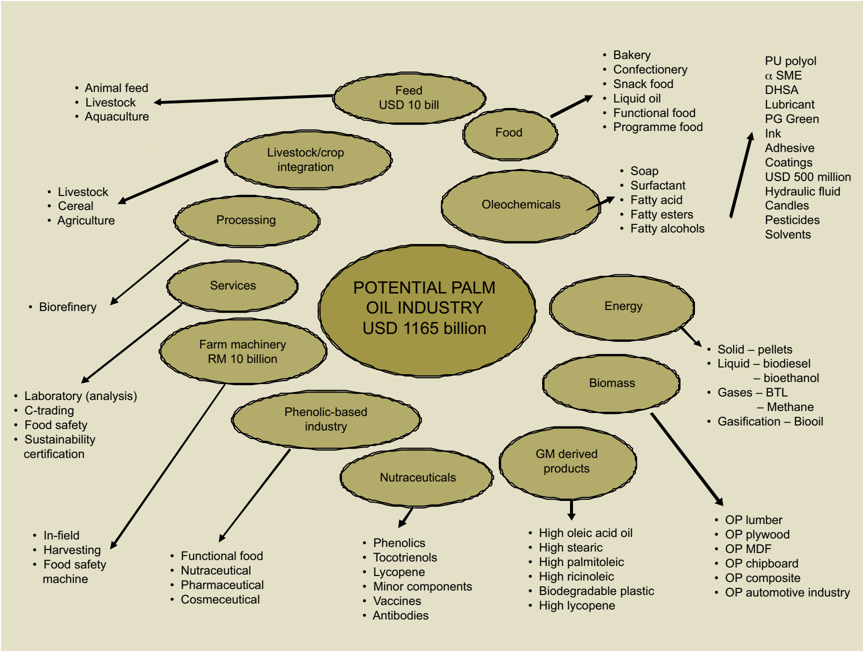

Figure 1. The potential values from birth and enhancement of palm oil and its related industries – both macro and micro.

food application. The palm oil as food serves as a source of energy for tissue replacement, a carrier of fat soluble vitamins and phyto-nutrients and also used as a heating medium since it has excellent oxidative stability.

In the food industries, palm oil is used in a variety of foods such as bakery fats, confectionaries, snack foods, imitation dairy, frozen foods, drinks and beverages, functional foods, specialized ingredients, food manufacturing, food catering, liquid oils and semi-solid fats. Based on the market trends, there is an increasing demand for low saturates requirements and the call for healthy fats and oils is a reflection of the consumers' preference for low fats and *trans*-free fats. This is due to the awareness by consumers who are more conscious on health and food safety (Ainie *et al.*, 2008) and discerning consumers are requiring more convenience foods and more designer foods. The changing lifestyle has therefore created demands for consumers products based on convenience. Thus, there are new opportunities for palm oil to branch into specialty ingredients, *e.g.* specialty animal fats replacers (SAFaR) and microencapsulated fats for premixes (Sundram, 2008). In the future, there will be designer foods where the fats are structured lipids with the Sn-2 position, confectionary with symmetrical tri-acyl-glycerol and oils with targeted characteristics of balanced fatty acid composition and high carotene. There are related industries such as the pet food industries that are valued over USD 10 billion. Globally, the animal feeds, livestock and poultry, and aquaculture industries from oil palm currently at USD 625 million is expected to be raised in the future to three to five times to USD 3 billion in 2107.

Oleochemicals

To date, there are 17 companies in the country involved in the production of the basic oleochemicals and together they have a combined capacity of 2 million tonnes. The potential for the oleochemical industries to venture into production of derivatives is great and already one company has already started producing polyols. Thus, looking back in 1907, the oleochemical industry even in European Union (EU) was at its infancy and only the soap industry was beginning to take root. Today, the oleochemical industry is worth USD 25 billion and the industry has gone beyond the production of basic oleochemicals. The surfactant industry alone is worth USD 28 billion (excluding soap). By 2107, the industry is expected to grow to USD 150 billion and by that time both basic and derivative oleochemicals will be produced. The surfactant industry is expected to expand even further.

Research at MPOB is on two focus areas, one on surfactant looking at the anionics (SME) and cationics (esterquats) and the other on polyols and polyurethanes (PU) (Razmah and Salmiah, 2008). The reason is simply that 70% of the world consumption on oleochemicals is on surfactants which are the main ingredient responsible for the cleaning action. Of the use of surfactants, the largest, close to 40%, is for making detergent, 10% for textiles, 9% for personal care, 6% for industrial use and 5% for oil field with the remaining 30% for other minor uses. In 2004, the world market consumed 12.5 million tonnes (excluding soap) worth USD 28 billion. The market growth is set at 4% per annum. The Asian market consumed about 4 million tonnes per year with China alone consuming 1.57 million tonnes and is the second largest consumer after USA. The global market for surfactants in 2004 comprised 64% anionic, 29% non-ionic, 5% cationic and 2% amphoteric types. Based on the surfactant usage of 12 million tonnes in 2003 worth Euro 13 billion, the projected demands in 2012 for EU, Americas and Asia Pacific are 20%, 20% and 70% respectively over their current usage in these three regions. As for global PU production, there is a steady increase rising from 9.92 million tonnes in 2000 to 13.75 million tonnes in 2005 and is expected to reach 16.91 million tonnes in 2010. On a regional basis, of the 13.75 million tonnes China consumed 21% after North American Free Trade Area (NAFTA) 28% and Western Europe at 24%. However, by 2010 of the 16.91 million tonnes projected, China will consume 26% outstripping NAFTA at 24% and Western Europe at 21%. Thus, there is a good potential for natural-based polyols and the demands are for rigid PU, semi-rigid, flexible such as those used for pillow and mattress, PU adhesive, PU coating for both exterior and interior coating.

Energy Industry

Palm oil as a source for energy production had seen a change from a complete reliance on fossil fuels in 1907 where almost 100% fossil fuel was used to generate energy. Plant-based fuel use was at minimal and even the little amount used was by direct burning. However, in 2007, there was the direct use of shell, mesocarp fibre as boiler fuels (Ma *et al.*, 2008) and R&D had resulted in the production of biodiesel, envo diesel and bioethanol. As there is a controversy between food and fuel demand from the same feedstock of palm oil, future R&D will look into the second generation biofuels involving pyrolysis to obtain biooils, cellulosic fermentation to obtain bioethanol from biomass, biomass to liquid (BtL), biodiesel to off-take any excess palm oil. Based on present value, the biodiesel will generate potentially about RM 20 billion worth of export.

In future, the avenues for both oil and biomass from the oil palm will be exploited. From palm oil, biodiesel can be produced for the biodiesel engines while there is also the possibility of straight burning of vegetable oils in the boilers and diesel engines. Alternatively, there is the possibility to look at the biomass as a source for the exploitation as boiler fuel, methane capture from the effluent ponds and the use of advanced technology to produce bioethanol, BtL fuels and producer gas. Palm oil, however, is traditionally used as food (80%) and non-food applications (20%).

For palm oil to be converted to palm biofuels, the framework document on the National Biofuel Policy was released in March 2006 (see http://www.mpob.gov.my). The Policy envisions a greater use of biofuels for environmental conservation and remunerative commodity prices. The MPOB/PETRONAS pilot plant was established in 1985 and the plant is also used to extract phyto-nutrients. The potential to commercialize the summer and winter grade formulations is being evaluated through the summer grade palm biodiesel plant of capacity 60 000 t/yr and the winter grade palm biodiesel plant of capacity 30 000 t/yr. In 100 years from now in 2107, it is probably that vegetable oil-based energy source will be the norm for use to generate energy and palm oil is anticipated to use about 50% of its production as food while the rest of the world's vegetable oils will use about 50% for biofuels.

As for biomass from the mills, the activities generate a lot of palm biomass comprising of fibre, shell and empty fruit bunches (Chan, 2008a). Palm biomass preferably a mixture of shell and fibre is used as fuels for generating steam and electricity for internal consumption. The renewable energy from palm biomass generated in 2005 is shown in *Table 3*.

Off-grid energy generated from palm oil mill based on 396 mills processing 84.11 million tonnes of FFB at 20 kWhr/t was 1682.2 million kWhr/t. At 400 hr/month, the total generating capacity was 350 MW. The present and future potential energy uses are:

- firstly, for direct usage where shell and mesocarp fibre are used as palm oil mill boiler fuels where the surplus of 20% is sold to other industries, *e.g.* cement and brick industries; secondly, for indirect usage where the EFB will require further treatment to reduce the size and moisture content;
- alternatively, the fibre and shell are upgraded to uniform solid fuels and made in pellets and briquettes. The pellets or briquettes have good potential value for export market when used for co-firing with coal; and
- thirdly, usage of lignocelluloses material as feedstocks for thermo-chemical energy conversion such as gasification, pyrolysis, carbonization and bioethanol.

The advantages of the lignocellulosic material are that it is grossly underutilized (Koh *et al.*, 2008), easily collected, available

TABLE 3. PALM BIOMASS GENERATED FROM PALM OIL MILLS IN 2005

Biomass	Quantity (million tonnes)	Moisture content (%)	Calorific value (kJ/kg)
Fibre	9.66	37.0	18 795
Shell	5.20	12.0	20 093
EFB	17.08	67.0	18 960

Note: EFB – empty fruit bunch.

throughout the year, cheaper compared to food-based bioethanol feedstocks. For example, 1 t dried EFB produced 388 litres bioethanol and based on EFB generated in 2005, direct potential of bioethanol was 2309 million litres. The contribution to the economy is about RM 6 billion (USD 1.7 billion) annually.

As for pyrolysis and the gasification technology for the oil palm industry, the producer gas obtained can be used for the boiler, heating process, IC engine, methanol/ethanol and hydrogen. Thus, MPOB has embarked on R&D on the long-term to look at converting biomass for transportation fuels through three processes of pyrolysis, cellulosic ethanol and biomass to liquid.

Thus, the R&D of biomass which in 1907 was concentrated on its use mainly for mulching and recycling in the fields (Singh *et al.*, 2008) and for direct burning in boilers in the mills has advanced in 2007 into biocomposite, medium density fibreboard (MDF) and energy generation and it is expected in 2107 that the biomass will become feedstocks for biocomposite, biooils, furniture, high quality oil palm lumber and high quality oil palm MDF. Some examples of current uses are paper pulp for moulded paper products (Kamaruddin *et al*., 2008), soil-less planting medium from oil palm biomass (Lim *et al*., 2008), oil palm trunk plywood, moulded school desks and chairs, coloured MDF and fibre reinforcing thermoplastics for automotive components.

Genetically Modified (GM) Products

In 1907, there was no research on this. In 2007, the R&D is on transgenic plastic, high oleic acid, high stearic acid, high lycopene, high ricinoleic acid and high palmitoleic acid (Parveez and Sharifah, 2008). It is anticipated that in 2107, there will be commercialization and commercial planting of these GM derived products.

The oil palm then will become a plant factory to produce designer products such as high oleic acid oil, high stearic acid oil, biodegradable plastics, lycopene-enriched oil, high palmitoleic acid oil and high ricinoleic oil. The potential values derived from the special qualities of GM products from oil palm are shown in *Table 4*.

The objectives of the GM research are to look at potential industrial feedstock for new products that are biodegradable and to expand into the liquid oil market with the high oleic oil. The aim is to look into easy processing with the oil palm as plant factory with potential feedstock for industrial products. Currently, the transgenic greenhouse on 1.2 ha is under construction for the large scale evaluation of transgenic oil palm. It is anticipated that the field planting under controlled conditions for high oleic transgenic will be done in late 2009, high stearate transgenic in 2009/2010 and transgenic producing bioplastics in 2011. The commercial GMO with special qualities will be planted in 2025.

At that time, the mesocarp oil will be a factory for producing various types of novel high value fatty acids and nutraceuticals while the kernel becomes a factory for producing high value pharmaceuticals such as vaccines and antibodies. Even the leaves will become a factory for producing novel high value products such as biodegradable plastics, vitamins and other high value metabolites, and the trunks and roots are a factory for producing woody biomass and high value fibres.

TABLE 4. POTENTIAL VALUES OF GENETICALLY MODIFIED (GM) DERIVED PRODUCTS WITH SPECIAL QUALITIES

Special qualities	Potential values (USD/ha/yr)
High oleic acid	2 422
High stearic acid	150
High lycopene	700
High ricinoleic acid	7 800
High palmitoleic acid	200
Biodegradable plastic	14 000

Clonal Industry

In 1907, there was none but in 2007 there had been active R&D on clonal palm propagation since the 1980s and field testing though on a limited scale had started. By 2107, it is expected that the commercial use of clones will be a norm and breeding material derived from clones will hasten and shorten the cycle of conventional breeding. Thus, inevitably clones will be the future planting material. The current high throughput technologies coupled with the biomarkers will enhance the production of better and better clones. Further, it is likely that future tissue culture laboratories will be semi or fully automated.

Pharmaceutical, Nutraceutical and Phenolic-based Industries

The palm-based pharmaceutical, nutraceutical and phenoloic-based industries in 1907 were not in existence and by 2007, there was extensive R&D on the application of the minor components, vitamin E, carotene and flavonoids. By

2107, it is expected that there will be commercialization of palm-based pharmaceuticals and nutraceutical products. The oil pharmaceutical products are phenolics, tocotrienols, lycopene, other minor components, growth hormones, vaccines and plant antibodies. The active research will enhance the oil palm industry as it is predicted that the world nutraceutical demands will reach USD 15.5 billion in 2010.

The world phenolics market will see Malaysia dominating it if the phenolics can be recovered from the palm oil mill effluent. However, there are strong intellectual properties (IP) to be protected in the world of phenolics. The phenolics-based industries are in the functional food industry, nutraceutical industry, pharmaceutical industry and cosmeceutical industry. For Malaysia to fulfil its role there must be a shift in paradigm where phenolics will be considered as the main products while oil is considered as co-products. This is similar to soyabean where the protein is the main product while the oil is the by-product. The potential market value in 2107 is at least USD 500 billion.

Farm Mechanization

In 1907, all the jobs in the oil palm industry were heavily labour intensive and by 2007 many plantations had introduced mechanization into their operations. It included use of Grabber for loading FFB onto trailer, motorcycle cart for FFB evacuation, motorized wheelbarrow. In fact, all operations in the field could be mechanized except the cutting operation during harvesting. Active R&D is in progress in this area with the objective of coming out with a harvesting machine. By 2107, it is expected that the plantation will be fully mechanized.

There may also be the use of robotics and at least 80% of the current labour will be replaced by mechanization. Farm mechanization a 100 years from now will see the use of remote control harvesting just like aerospace project at Atacama Desert in South America where the control of machine is in the USA. Bunches upon harvesting will be pre-processed in the field and only the oil is transported back for storage and further treatment. Likewise aerial application of fertilizers will be controlled with precision agriculture where the variable rates of nutrients will be applied. Similarly, for pest control, only the optimum amount will be applied. There will be greater use of bio-protection where natural predators will be emphasized.

Automobile Industry

In 1907, the automobile industry being at its infancy did not have any palm-based components but in 2007 with the R&D into palm-based products, many components such as sound damper, pad dash panel, carpet industry, rear shelf trim to replace plastic composites are made from biomass fibre. By 2107, it is expected that 70% of the non-metallic car components will be substituted with palm-based materials. The use of palm-based biofuels with potential to reduce greenhouse gases will also be a common occurrence.

Palm Oil Processes of the Future

This will be examined over the three phases of upstream, midstream and downstream. Land use, despite the country's emergence as the world's largest exporter of palm oil is at less than 19% of the country's landmass of 32 million hectares. This has been brought by palm oil cultivation on land previously occupied by the other agricultural crops like rubber, cocoa, and coconuts. The land use in Malaysia as of 2005 is shown in *Table 5*.

Upstream

In the upstream, the oil palm land use for intercropping and livestock integration is made possible with the development of the double avenue planting on relatively flat land. With the development of the double avenue, a total area over the next 100 years is expected to reach 2 220 000 ha. It is assumed that 50% is used for intercropping and another 50% for livestock integration. In 2107, the double avenue will have saved an equivalent of 333 000 ha of cleared forests for intercropping as shown in *Table 6*.

Besides half the area allocated for the double avenue palms at

TABLE 5. LAND USE IN MALAYSIA 2005

Type	Million ha	% Malaysia
Forest	20.90	63.60
Oil palm	4.05	12.33
Rubber	1.25	3.80
Cocoa and coconut	0.16	0.49
Total green cover	26.36	80.22
Other land use housing, infrastructure, other agriculture	6.50	19.70
Grand total	32.86	100.00

Source: FAO (2005), MPOB, MRB, MCB and Department of Agriculture for the year 2006.

1 110 000 ha for livestock integration, there is an estimated 740 000 ha of undulating area and another 1 752 000 ha of peat suitable for goat and sheep integration. Based on the projected holding capacity of the land for livestock integration, the total number of heads that can be produced is shown in *Table 7*.

The total production and income from intercropping and livestock integration is shown in *Table 8*.

What is important is not just the supply of animal protein from livestock integration and carbohydrate supply from crop intercropping, the productivity of the land is increased and at the same time, the food and related industries bring along the other benefits from the intercropping and livestock integration activities. What is important is not just the supply of animal protein from livestock integration and carbohydrate supply from crop intercropping, the productivity of the land is increased and at the same time, the food and related industries bring along the other benefits from the intercropping and livestock integration activities.

And they are the accompanying emerging meat processing, food processing industry, confectionary industry, snack food industry, canning industry, pharmaceutical industry, *halal* hub industry, herbal industry, cosmetics industry, animal feed industry, automation industry and retail agricultural industry.

TABLE 6. EXPECTED SAVINGS OF LAND USE CONVERTED FROM FOREST IF DOUBLE AVENUE IS USED FOR INTERCROPPING UP TO 2107

Crop	Double avenue (ha)	Equivalent mono crop (ha)
Soyabean	144 300	43 290
Banana	222 000	66 600
Bactris	88 800	26 640
Tongkat Ali	77 700	23 310
Ground nut	55 500	16 650
Cocoa	111 000	33 300
Pineapple	166 500	49 950
Sorghum	55 500	16 650
Hill paddy	77 700	23 310
Other crops	111 000	33 300
Total	1 110 000	333 000

TABLE 7. LIVESTOCK INTEGRATION WITH PROJECTED HOLDING CAPACITY

	Cattle	Goats	Total
No. of animals in double avenue area	5 994 000[a]	555 000[c]	6 549 000
No. of animals in undulating area	166 500[b]	370 000[d]	536 500
No. of animals in peat area	-	14 595 130[e]	14 595 130
Total	6 160 500	15 520 130	21 680 630

Note: [a]Cattle in intensive model (ratio 6 heads/ha); [b]Cattle in systematic rotational model (ratio 1 head /4 ha); [c,d,e]Goat in semi-intensive model (ratio 5 heads/ha).

TABLE 8. TOTAL PRODUCTION AND INCOME FROM INTERCROPPING AND LIVESTOCK INTEGRATION

Type of integration	Production (t)	Value (RM million)
Crops	4 432 163	7 486 703
Livestock	833 094	12 692 000
Total	5 265 257	20 178 703

Midstream

The midstream activities in the oil palm industry will include the following processes *viz*., palm oil milling, palm oil refining, palm oil kernel crushing, biodiesel plant and paper and pulp plant. The palm oil mills and refinery are equipped with the state of the art facilities for processing, handling and transportation of palm oil and its products. Dedicated clean system for bulk handling and transport of palm oil products will ensure that the superior quality products are delivered to the customers always. Having spearheaded the extensive R&D in oil palm cultivation, the country is now gathering the evidences to demonstrate the advocacy of sustainable farming practice, maintaining a balance between commercial and economic needs and preservation of the environment.

To this end, there is labour reduction through process automation, increase productivity, reduce downtime, improvement in maintenance programming and creating conducive work environment for operators. More importantly, is the implementation of the Codes of Practices (CoPs) required for all plantations and mills that are involved in the production of both palm oil and kernel oils. There are six codes of practices being developed and they are Good Nursery Practices, Good Agricultural Practices, Good Manufacturing Practices, Good Kernel Crushing Practice, Good Refining Practices and Good Handling and Storage Practices. Thus, starting from the use of superior planting material right from the nursery to increase productivity in the field with the implementation of good agricultural practices will ensure greater environmental sustainability. As environment is fast becoming a global concern which is in turn if not handled well is becoming a trade issue. The emphasis here is that the industry sees the environmental and social aspects of palm oil production to be opportunities to bring the industry to a higher achievement. Thus, the key is to optimize oil palm cultivation and palm oil production in a way to achieve sustainable conditions with minimum negative environmental effects.

The midstream processing is now playing and will in the future play its part by having:

- environmental-friendly practices with zero waste and biogas such as methane from the palm oil effluent ponds will be tapped and used as energy in the palm oil mill;
- process simplification where more effective and efficient plant that reduce processing stages will ultimately lead to reduction of processing costs;
- integrated palm oil plant where palm oil processing and refining are located together and also with kernel crushing facilities to make use of the excess energy from the mill. More recently the location of the biodiesel and paper and pulp plants are also within the mill complex; and
- dedicated plant where high value-added products are extracted such as carotene and vitamin E.

Downstream

In the global scenario, the harmonization for food policies by the CODEX and WHO in developing food standards, guidelines and other CoPs is an important element for international partnership between the regulatory authorities and the business. As the global level requirements filter down to the producer from the buyer, efforts must be made to the global system that will benefit both the producer and the seller. Malaysia should insist to be present at the forum of the global-minded oils and fats fraternity so that any misconception or false statement made by some bodies to mislead the truth about the palm oil as a food should be challenged.

Thus, for processing of oil palm for food application, there must always be green and clean technology being applied without any solvent. The enzymatic route must be taken to structure lipids and to tailor-made fats. Advanced technologies such as advance fractionation technology to produce a wide range of oils and fats should be applied. This includes the use of nano-technology to synthesize food at the molecular level to come out with new products. At all times, food safety must be guarded.

The use of enzymes in oil processing may cover five areas, *viz.*,

- enzymes in oil production such as the breaking of cells so as to assist in the release the oil;
- enzyme in oil refining where enzymes hydrolyze phospholipids to increase hydration and separation;
- enzymes in oil modification where TAG-TAG interesterfication for margarine fat processing;
- structured lipids from plant-based material; and
- deriving diglycerides oils.

The advantages of enzymatic process is that it is simple, cause less environmental problems, the SN-2 position can be kept unmoved so that the palm oil becomes more nutritious, to obtain better PUFA oils in the formulations, meeting the physical properties of the final products for margarine production and finally economical for the process to be competitive to the chemical randomization process.

With the advent of the nano-technology in the food processing things have improved where nano-technology has impacted the food industry by ensuring food safety and bioavailability by improving the molecular synthesis of new products and ingredients. The major areas in food production which have benefited from nano-technology are micro scale processing, nano scale processing, product development, methods and instrumentation, and design for improved safety and biosecurity. Finally, the potential use of nano-technology in the food sector is in the encapsulation and delivery mechanisms for the functional ingredients to specific site of action for better absorption. Nano-technology can help the industry to advance further in the food security of manufacturing, processing and shipping of the food products.

Nutritional Aspects

In 1907, little was known about the nutritional aspects of palm oil but by 2007, the industry is into designer oils, anti-cancer properties, antioxidant properties, flavonoids and minor components. By 2107, it is expected nutritional aspect of palm oil will play a greater role where its nutritional benefits will be a major contributor to the pharmaceutical and nutraceutical industries. Certainly it will help to solve some of the health problems of the world. One good example is the acceptance of the Sn-2 position hypothesis where palm oil will become a much sought after oil for the following reasons. Firstly, the oil is as good as olive oil and that the scope for palm oil to be labelled as an anti-obesity oil is increased.

A new research programme has been put in place by MPOB and the programme intends to have three focus areas. They are:

- study the effect of palm oil and its components on coronary heart disease (CHD) risk;
- study the effect of palm oil on carcinogenesis; and
- study nutritional effects of the micronutrients in palm oil, *i.e.* tocotrienols, carotenoids and palm water soluble flavanoids and phenolics.

There is a wealth of scientific evidence that supports palm oil as both a wholesome and nutritious edible oil and its consumption has a proven record of neutrality towards plasma lipids and cardio-vascular heart diseases. Perhaps one of the most debated issues in the dietary fats has been the role of *trans* fatty acids (TFA) and their implication on human health. It is an advantage of palm oil to have a natural solid to semi-solid fraction since FDA has legislated since 2006 that all food products are required to make declaration on TFA so that consumers are able to make the correct healthy choice. Other scientific issues will continue to be addressed where with new findings, the role played by palm oil in food nutrition will be strengthened. Through the many new areas of research, new areas of application are anticipated. They include firstly, use of palm oil for blending with other oils to meet dietary recommendation of 1:1:1 of saturated: polyunsaturated; monounsaturated fatty acids or functional characteristics, *e.g.* improve oxidative stability, and texture. Secondly, it can replace partially hydrogenated oils in formulation. Thirdly, it can be further processed to produce tailor-made products/designer's products.

Environment and Sustainability

The oil palm industry has all along been practicing sustainable best practices. They include water management, soil conservation biological control, reduction of waste wastes and creation of wealth by increasing productivity and increasing yield of existing plantation area with good agricultural practices. Sustainable agriculture is not just environmentally sound land management practices, but an integration of the three main goals of protecting environmental health, economic profitability and social responsibility. The industry does not have to look far for in the past the good old agricultural practices of soil conservation, water management, effluent treatment and oil mill waste recycling coupled with socio-economic provisions of utilities, housing, medical facilities and welfare in plantations have formed a very sound foundation for sustainability (Yusof and Chan, 2008). Further the Malaysian oil palm industry has been develo-ping plantations in a sustainable manner. These sustainable practices have led to the growth of the oil palm industry.

The sustainable practices are integrated pest management to cut down use of chemicals by decreasing the reliance on harmful chemical pesticides, increasing the use of biological control such as the microbial pathogen, use of barn owls to control rats, use of beneficial plants, *e.g. Cassia cobanensis* to control parasitoids and the monitoring of diseases by satellites. With the implementation of the zero burning policy and the use of biomass for mulching, the felled oil palm trunks are chipped and retained on the land without burning. The nutrient in this way is recycled when the trunk chips decompose. Fronds removed during harvesting are neatly stacked in the field along the contours to conserve water and nutrients likewise EFB are returned to the field for mulching. In instances where the individual independent mills have no land to recycle their EFB, they will use the EFB together with the effluent to make compost as a bio-fertilizer.

Sustainability would mean increasing the productivity and the first requirement is to improve the planting material. There are high yielding materials with oil to bunch ratio exceeding 31% and this raises the potential OER in the mill to exceed 25% in commercial mills. As for tissue culture, the technology will allow clones with 30% increase in yield over the DxP planting to be mass produced. By reducing waste and creating value like doing composting of EFB with palm oil mill effluent, the process will help to reduce greenhouse gases as the effluent will not undergo anaerobic fermentation. This revenue-generating process can be used to earn carbon emission credits under the clean development mechanism (CDM). As the custodian of the industry, MPOB has the mindset to enhance the biodiversity. For example on steep-land, the hilly outcrop is allowed to revert as a forest reserve. The forest trees in such hillocks are cleansing agents which convert atmospheric carbon dioxide into valuable carbonic material and at the same time release oxygen. The biodiversity is also raised through agroforestry like the planting of bamboo *Gigantochloa levis*, teak *Tectoa grandis,* sentang *Azadirachta excels* and rattan *Calamus* sp.

The ecosystem biodiversity has also to be improved and an example may be cited where in Lima Belas Estate in Perak, the 75 ha reserves, maintained for more than 50 years ago, have recorded six types of primates, seven frugivorous animals, one insectivore, four types of squirrels and five types of predators.

DISCUSSION

The projections over the next 100 years from 2007 to 2107 by the members of the MPOB team are what it wished for the industry. For a forecast of a 100 years invariably be dictated by events and the rate of progress of R&D. Nevertheless, the direction is set and the industry is aiming for sustainable development into the future.

When the Brundtland commission's report, *Our Common Future* was published in 1987, it defined sustainable development as 'meeting the needs of the present without compromising the ability of the future generations to meet their own.' At that time 'sustainable development' and 'sustainability' were far from being buzz words that they have become today. While sustainability is almost an universal concern and is closely linked to the viability of our planet yet there is no universal accepted definition. For us in the oil palm industry delay and inaction are not options. While the debate continues on sustainability and which model to use, there is a general agreement on a practical basis which address economic, environmental and societal spheres. Thus, sustainability for the oil palm industry involves the global challenges such as food, water, energy, the environment, renewable resources and the dissemination of innovation to benefit all peoples. Tackling these challenges at some point requires us getting down to the sort of fine details that have been outlined in this article (Yusof *et al*., 2008).

Looking ahead it is clear that much has to change in terms of how we live and do business in order to promote a truly sustainable world. The oil palm industry envisions the future as a partnership of Malaysia as a producer and the buyers of oil palm as a consumer. The type of partnership is an alliance that represents the mobility of capacity and know-how to provide better information, more pertinent analysis and better solutions in a world that is in search of solutions. Our shared responsibility is to provide solutions, to put in place the tools that will anchor the sustainable development in order to ensure the economic and social well being of our peoples and to secure the quality of our planet we share. Thus, the four quadrants in *Figure* 2 will form the elements of the competitive ability of the oil palm industry in the next 100 years.

The oil palm industry must continue to be a global player where the services of the industry, consultancy, certification, the Malaysian palm oil hub, enhanced off-shore investment, increased joint ventures and providers of technology must invariably touches on the 3 Ps of people, planet and profitability. It needs us to understand that the management of competitiveness and the sustainability of the industry or the corporations that run the industry must continue to rely on R&D investment to come out with innovation to address the challenges of quality, environment, occupational health and safety, bio-security, business continuity, social responsibility knowledge and risk management. As greenhouse gas emission is the root cause, we need to nail the real culprit of emissions to be from fossil fuels rather than going on a wild goose chase of blaming deforestation to plant oil palm plantations (Basri and Chan, 2008b).

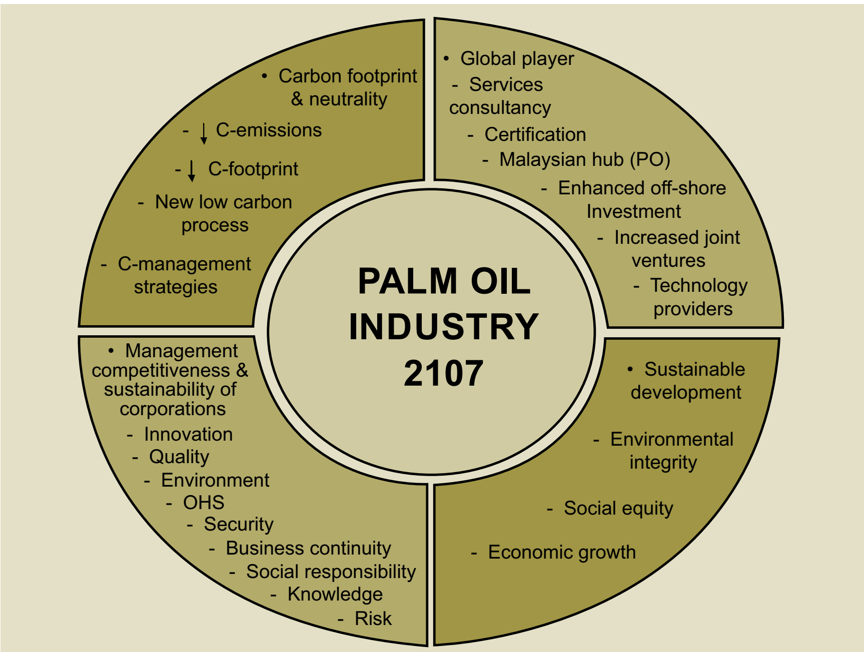

Figure 2. Elements of competitive ability of the oil palm industry in 100 years' time.

In Malaysia, the forest land remains intact at over 63% and therefore rather than blaming deforestation, it is good to remind ourselves that in EU every year it introduces 15 million new cars and this will emit greenhouse gas equivalent to 1.5 million hectares of deforestation. In 10 years' time, the deforestation equivalent of EU's new car population is estimated at 15 million hectares.

Thus, there is a need to look at the carbon footprint of the production of palm oil. Looking at the carbon emission, what are the strategies to reduce the carbon emissions? and are there carbon offsets from carbon sequestration in the above-ground biomass and below-ground in the roots and soils? Unless we trace the carbon footprint, we will not be able to go for carbon neutrality and ultimately to go for a low-carbon economy (Chan, 2008b).

CONCLUSION

From the projections which MPOB has wished for the industry over the next 100 years from 2007 to 2107, the oil palm industry must remain highly competitive. It must look carefully at its best sustainable practices, generate value-added products, and solve some of the health problems related to palm oil when supplying oils and fats to the world. For the progress to be accelerated and enhanced, continued sustained investment in R&D must be made to address the challenges raised through the various projections derived from consultation with the global partnership with the many stakeholders and consumers throughout the world.

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