Strengthening the Malaysian Palm Oil-based Biodiesel Industry: Solving Current Issues and Impact on CPO Prices

Ayat K Ab Rahman*;
Ramli Abdullah*;
Mohd Arif Simeh*;
Faizah Mohd Shariff*
and Hamid Jaafar**

ABSTRACT

The palm oil-based biodiesel industry can be considered as a 'golden egg' of the Malaysian palm oil supply chain. This is due to the role it plays in improving price scenario of crude palm oil (CPO) as well as creating value addition for palm oil products. This benefits all sub-sectors in the Malaysian palm oil supply chain. Based on the last four years scenario, total additional income received by oil palm growers was RM 20.835 billion. This scenario adds up another RM 61.50/t or 16% in support of fresh fruit bunch (FFB) prices. Meanwhile, under the Bx implementation programme, price of CPO is estimated to increase by RM 13/t if B1 programme implemented were to be. If the production of palm methyl ester (PME) increased to 0.3 million tonnes (B3) the price of CPO is expected to increase by RM 55/t. The aggressive implementation of biodiesel blending at 5% (B5) would result in the price of CPO to increase by RM 120/t.

However, although still at infancy stage, the palm oil-based biodiesel industry has already faced a few challenges. These challenges can be either within the oil palm industry itself or outside the industry. The analysis on cost of PME production in 2009 shows that biodiesel industry is still not viable as producers cannot fully recover depreciation in their operation due to the problem of overcapacity. Meanwhile, the main challenge is the implementation of the Bx programme for the local market. It can be a 'key' to the success of the Malaysian biodiesel industry in particular and the whole industry in general. Meanwhile, the challenge from outside the market is beyond the control of the industry as it is difficult to be solved. The challenge is related to rules and regulations from importing countries in order to protect their own products. Meanwhile, palm oil industry itself should always produce palm oil products in a sustainable manner at all levels of production to ensure this industry can sustain in the future.

* Malaysian Palm Oil Board, P. O. Box 10620, 50720 Kuala Lumpur, Malaysia.
** School of Economics, Faculty of Economics and Business, Universiti Kebangsaan Malaysia, 43650 UKM Bangi, Selangor, Malaysia.

BACKGROUND

Palm oil is mainly used as frying oil and in food applications. In addition, it can also be converted into palm methyl ester (PME), a diesel substitute which is expected to create new opportunities for market expansion of palm oil. Production of PME would firm up palm oil prices as it reduces the risk of falling prices when there is excess supply of the commodity.

Using palm oil for the production of biodiesel has a number of advantages. Unlike fossil fuels, the combustion of palm oil biodiesel does not increase the level of carbon dioxide in the atmosphere as the oil is merely returning carbon dioxide obtained earlier from the atmosphere through photosynthesis. Oil palm is the most productive oil bearing plant species. *Table 1* shows that biodiesel yield from oil palm is the highest as compared to other vegetable oils, which is 1 ha of land can produce 3750 litres of biodiesel only required 1 ha land. Meanwhile, biodiesel from soyabean and rapeseed requires 9.4 and 6.8 ha land respectively to produce 3750 litres of biodiesel (Wolfgang Rupilius and Salmiah Ahmad, 2009). This means that, biodiesel yield from oil palm are nine and seven times higher than rapeseed and soyabean respectively.

In term of pricing, palm oil is priced competitively *vis-à-vis* other major oils in the world market. It is traded at a price discount to other competing oils and this discount widened or narrowed based on the dynamics of the supply and demand situations (*Table 2*). It is the cheapest raw material for the production of biodiesel compared to other vegetable oils.

There are several factors which support the movement of the world biodiesel industry and the Malaysian palm oil-based biodiesel industry. The first factor is the rising crude oil price. A gain in crude oil price has a positive effect for prices of palm oil. Palm oil pricing has an indirect link to crude oil even though its usage is very low in the global biodiesel market. There is a close correlation in the pricing because it is a substitute for other vegetable oils that are being burnt as biodiesel. The scenario in 2007 is shown in *Figure 1*. Both prices moved together from the time Malaysia started to produce and export biodiesel.

Secondly, palm oil-based biodiesel industry is driven by regulations. Malaysia's National Biofuel Policy of 2006 proposes laws to enforce the use of a biofuel made from diesel mixed with 5% palm oil called B5 biodiesel [5 is the percentage of palm oil blended (B) with 95% diesel]. In general, it is called Bx biodiesel, with 'x'

TABLE 1. GLOBAL BIODIESEL YIELDS

Oil	Biodiesel (litre)	Land (ha)
Palm	3 750	1.0
Rapeseed	3 750	6.8
Soyabean	3 750	9.4
Sunflower	3 750	7.5

Source: Wolfgang Rupilius and Salmiah Ahmad (2009).

TABLE 2. PRICE OF CRUDE PALM OIL, SOYABEAN OIL AND RAPESEED OIL (USD/t)

Year/ month	Crude palm oil (A)	Soyabean oil (B)	Premiums/ discounts (A)-(B)	Rapeseed oil (C)	Premiums/ discounts (A)-(C)
(2009)					
Jan	562	789	-227	817	-255
Feb	571	748	-177	760	-189
Mar	598	727	-129	709	-111
Apr	702	801	-99	807	-105
May	801	892	-91	933	-132
Jun	726	896	-170	920	-194
July	640	837	-197	846	-206
Aug	723	886	-163	887	-164
Sept	674	846	-172	857	-183
Oct	680	897	-217	896	-216
Nov	725	931	-206	928	-203
Dec	791	933	-142	945	-154
(2010)					
Jan	793	923	-130	916	-123
Feb	798	914	-116	893	-95
Mar	832	915	-83	897	-65
Apr	830	903	-73	909	-79
May	811	865	-54	864	-53
Jun	798	859	-61	880	-82
July	807	907	-100	946	-139
Aug	905	1 002	-97	1 013	-108
Sept	912	1 042	-130	1 037	-125
Oct	987	1 157	-170	1 156	-169
Nov	1 109	1 247	-138	1 249	-140
Dec	1 228	1 322	-94	1 396	-168

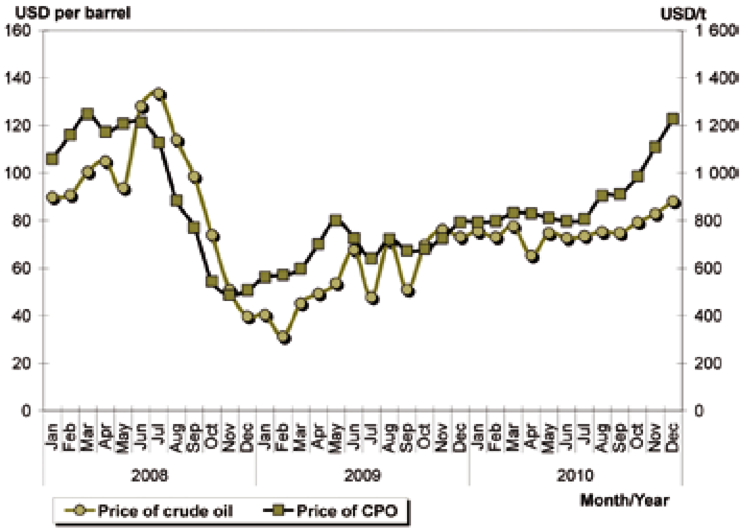

Figure 1. The relationship between crude oil and crude palm oil (CPO) prices.

represents the percentage of palm oil to be blended with diesel. This could help reduce the use of diesel in the transport sector, estimated at 10 million tonnes each year where currently the use of PME is about 0.5 million tonnes annually. Meanwhile, biodiesel in developed countries is regulated by Kyoto Protocol. Based on Kyoto Protocol, the international treaty requires developed countries to cut greenhouse gas emissions by at least 5%, which requires switching from conventional energy sources to biofuel in the period from 2008 to 2012.

With the implementation of the Malaysian Biofuel Industry Act 2006, Malaysian Palm Oil Board (MPOB) had started issuing licenses for biodiesel production in Malaysia in 2008, taking the role from the Malaysian Industrial Development Authority (MIDA). When the ministry gazettes the Act, MPOB will become the implementation agency, taking over the licensing responsibility.

Due to the concerns over finite supply of fossil fuel, geopolitical uncertainties, and the environment, interest on biodiesel has gradually increased. Presently, worldwide production and consumption of biofuel (ethanol and biodiesel) are still a small fraction of total energy balance. According to Worldwatch Institute (2006), world top ethanol producers such as Brazil and US each produced less than 17 000 million litres in 2005. Germany, the largest producer of biodiesel, produced only 1920 million litres in 2005, followed by France with only 511 million litres. Feedstocks for biodiesel are oil palm, jatropha, rapeseed, sunflower seed, castor beans and soyabeans. The choice of feedstock in any region or country invariably depends on their relative cost and reliability of supply.

Meanwhile according to Faizah *et al*. (2005), biofuel programmes have improved the prices of soyabean, rapeseed, sugar and corn oils due to removal of excess production to new uses. Correlations between their prices and production of biofuel were high and showed positive relationship after commercialisation of the biofuel in those countries. The findings indicate that the biofuel programme can remove excess production to new uses and improve prices. Hence, it can be deduced that removal of excess palm oil from the market into new uses could improve palm oil price.

On the other hand, according to Kingsman (October 2009), US soyabean farmers received an additional USD 2.5 billion in net returns over the last four years due to biodiesel industry demand for soyabean oil. This demand added up to 25 cents in support for the per bushel price of soyabeans. According to Salazar (2007), the objective of the biofuels bill in Philippines are to reduce dependence on imported oil, to increase economic activity in the country and boost employment, to improve energy efficiency and to contribute in improving air quality.

There are several challenges faced by the biodiesel industry. According to Fry (2007), these include European Union (EU) policy inconsistencies and the US biodiesel policy dilemma. The EU and its member states are far from consistent in their policies towards biofuels. An example of such inconsistency is their hostility to the use of PME, accusing as not being able to comply to meet sustainability criteria. Meanwhile, US biodiesel policy was designed to give strong support to local production and consumption of biofuels.

Palm oil has the advantages to become a feasible feedstock of biodiesel as compared to other vegetable oils. According to Unnithan (2007), technical advantages of palm oil include its characteristic of being a renewable resource, and biodegradable. PME is able to reduce emissions of carbon monoxide by approximately 50% and carbon dioxide by 78.45% compared to petroleum diesel. It has free sulphur and non-toxic.

The government approved 61 palm oil-based biofuel manufacturing licences with a total capacity of 6.791 million tonnes annually. Due to the uncertainty in the world market and domestic conditions for palm biodiesel, the production of PME was slow although trending upward from

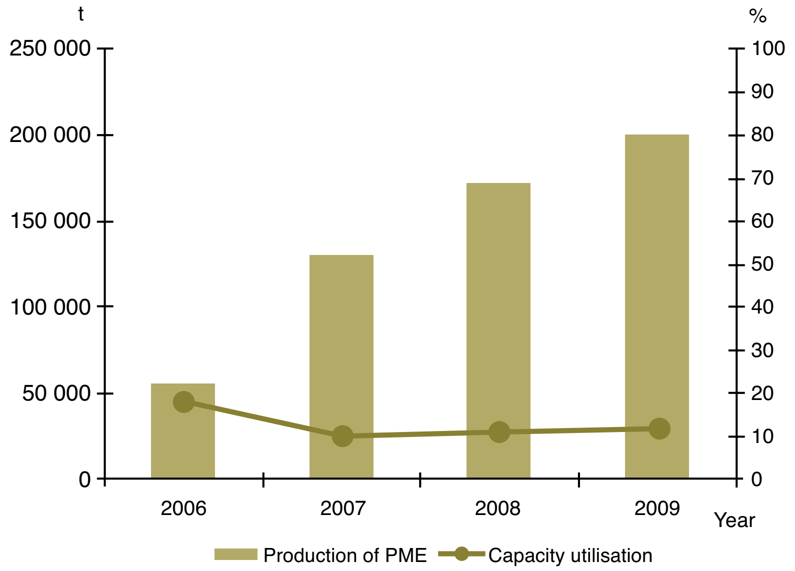

Figure 2. The comparison between palm methyl ester (PME) production and capacity utilization.

2006 to 2009 (*Figure 2*). In 2006, the total production of PME was 54 981 t and increased to 129 706 t or by about 135% in 2007. The increase in PME production in 2007 was mainly due to the high price of crude oil in the world market and therefore brings a good prospect for PME in the world market. In 2008 and 2009, the production of PME were at 171 555 and 199 825 t respectively.

However, based on capacity installation by biodiesel producers, it shows that they had difficulties from year 2006 to 2009. In 2006 there were four operating producers with capacity of 300 000 t (*Figure 2*). Based on production of PME 54 981 t, they were running over capacity around 81.7% or only 18.3% from their capacity utilization. In 2007, there were 11 producers with the total capacity of 1 262 000 t. With total PME production of 129 706 t, they were again running over capacity at 89.7% or only 10.3% from capacity utilization. In 2008 there were 14 producers with total capacity of 1 562 000 t. With total PME production of 171 555 t, their capacity utilization was only 11%. Meanwhile in 2009, there were 10 producers operating with total capacity utilization of 1 333 000 t and PME production only at 221 786 t or 17% capacity utilization.

Due to production capacity running as low as 10%-19%, this is hardly sustainable even for small plants with an annual capacity of 50 000 t. If the implementation of Bx in local market could not be implemented and in addition with uncertainty of PME penetration in the world market, many palm-based biodiesel producers will continue to face difficulty. This is because their margin presently is very thin or sometimes negative. This could discourage new players to enter this industry and existing players could leave this business. Therefore, to ensure Malaysian biodiesel industry to be sustainable in the future, the way to strengthening this industry needs to be identified.

This article will explore options which could help to strengthen the Malaysian palm biodiesel industry and to examine the impact of PME production and Bx implementation programme on CPO prices.

METHODOLOGY

This article will utilize qualitative and econometric approaches. The qualitative approach was done through meetings with four operating biodiesel producers, sending a set of questionnaire to 10 biodiesel producers (operating their businesses in 2009) and through research publications to gather as much information as possible to meet the objectives of this project. Meanwhile, econometric modeling was adopted to study the impact of PME production and Bx implementation programme on CPO prices. The details of the econometric approaches are explained below.

The Impact of PME Production on CPO Prices

The impact of PME production on CPO prices was analysed using monthly data spanning from January 2000 to July 2006 (before the industry produced PME). To ensure a good regression, data was transformed into logarithmic form prior to analysis. The model of dynamic price analysis utilises multiple regressions using Ordinary Least Square (OLS) method as a basis. The general price model is stated in equation (1) below:

$$PCPO = f[PSBO, SS, DD, PCPO(-1)] \quad (1)$$

where;

PCPO = price of crude palm oil (USD/t).

PSBO = price of soyabean oil (USD/t).

SS = supply of palm oil (production of CPO + import of CPO + opening stock of palm oil in tonnes).

DD = demand of palm oil products (export of palm oil in tonnes).

PCPO(-1) = price of crude palm oil lag 1 (USD/t).

Based on the econometric analysis method, the price of CPO model can be represented as in equation (2) below:

$$\ln PCPO = \beta_1 + \beta_2 \ln PSBO - \beta_3 \ln SS + \beta_4 \ln DD + \beta_5 \ln PCPO(-1) + \mu_t .. (2)$$

where;

$\beta_1 - \beta_5$ = coefficient for the corresponding variables.
ln = logarithmic form.
μ_t = residual in the model.

This model was used to estimate the movement in CPO prices starting from 2000 until 2006 and to forecast CPO prices starting from 2006 until 2009. The main objective to estimate CPO prices for periods 2000 until 2006 is to examine the performance of the model. If the error of estimating CPO prices is less than 5%, this model will be used for forecasting CPO prices for periods 2006 until 2009. Meanwhile, the objective for forecasting CPO prices from 2006 until 2009 is to examine what really happens on CPO prices if the Malaysian palm oil industry does not produce PME as a diesel substitute in the market for those periods.

Equation (3) shows the equation for CPO prices to be estimated for periods 2000 until 2006:

$$\ln PCPO = \beta_1 + \beta_2(\ln PSBO_t) - \beta_3(\ln SS_t) + \beta_4(\ln DD_t) + \beta_5[\ln PCPO(-1)_t] \ldots\ldots (3)$$

where;

t = current year

Meanwhile, the equation for forecasting CPO prices for periods 2006 until 2009 as shown in equation (4) below;

$$\ln PCPO_i = \beta_1 + \beta_2(\ln PSBO_i) - \beta_3(\ln SS_i) + \beta_4(\ln DD_i) + \beta_5[\ln PCPO(-1)_i] \ldots\ldots (4)$$

where;

i = current year.

Note: ARIMA model with data spanning from 2000 to 2006 was used to forecast PSBO, SS and DD.

The Impact of Bx Implementation Programme on CPO Prices

The impact of Bx implementation programme on CPO prices was analysed using monthly data spanning from August 2006 (when the industry started produce PME) to June 2010. The difference between this model as compared to previous models is that the crude oil prices were included as an independent variable.

This is because after PME production started in August 2006, it was found that there was high correlation between CPO and crude oil prices. On the demand side, this comprises elements of export of palm oil, export of PME and estimated demand for Bx. To ensure a good regression, data was transformed into logarithmic form prior to analysis. The model utilises multiple regressions using OLS method as a basis. The general price model is stated in equation (5) below:

$$PCPO = f(PSBO, SS, DD, PCO) \ldots\ldots (5)$$

where;

PCPO = price of crude palm oil (USD/t).
PSBO = price of soyabean oil (USD/t).
SS = supply of palm oil (production of CPO + import of CPO + opening stock of PO) minus by estimated demand of Bx.
DD = demand of palm oil products (export of palm oil + export of PME + estimated demand of Bx).
PCO = price of crude oil (USD/barrel).

Based on the econometric analysis method, the dynamic price model can be represented as in equation (6) below:

$$\ln PCPO_t = \alpha_1 + \alpha_2 \ln PSBO_t - \alpha_3 \ln SS_t + \alpha_4 \ln DD_t + \alpha_5 \ln PCO_t + \mu_t \ldots\ldots (6)$$

where;

$\alpha_1 - \alpha_5$ = coefficient for the corresponding log variables.
ln = logarithmic form.
μ_t = residual in the model.
t = the current month.

This model was used to estimate the movement in CPO prices starting from 2006 until 2009. This model was also used to examine the impact of Bx implementation programme on CPO prices. This is because the main objective of this model is to study the impact of Bx implementation programme on CPO prices and to prove that from Bx implementation programme, it can help to increase CPO prices in the market.

The technique for estimating CPO prices due to Bx implementation programme on this model is as shown in equation (7). In this model, variable of PO supply (SS) is deducted by the expected rate of Bx implementation programme which is started at 1% up to 5% (0.1 million tonnes – 5 million tonnes). Meanwhile demand for palm oil (DD) will include demand for Bx.

$$\ln PCPO_t = \alpha_1 + \alpha_2(\ln PSBO_{by}) - \alpha_3(\ln SS_{by} - \ln PMEBx) + \alpha_4(\ln DD_{by} + \ln PMEBx) + \alpha_5(\ln PCO_{by}) \ldots (7)$$

where;

PMEBx = quantity (t) of PME for Bx implementation programme (B1–B5)
by = average of corresponding log variables in base year [January - June (2010)]

The hypotheses to be tested in this analysis are stated below:

Hypothesis null (Ho) : price of CPO does not increase after Bx implementation programme.

Hypothesis alternative (Ha) : price of CPO increase after Bx implementation programme.

RESULTS AND DISCUSSION

Problems and Challenges Faced by Biodiesel Producers

Malaysia started producing and exporting biodiesel in 2006. Both exports and production volumes increased since then until 2009, despite facing a few challenges in the country. In 2006, the exports of PME totalled 47 986 t with a value of RM 120.89 million. Export volume in 2007 increased by 98% to 95 013 t with a value of RM 253.20 million (*Figure 3*). It continued to increase by 92% to 182 08 t with a value of RM 610.70 million in 2008. The export volume surged further in 2009 by 19% as compared to 2008. However, its export value declined to RM 576.31 million from the previous year. The decline in values was mainly due to low PME prices in 2009 as compared in 2008.

Based on major market developments of PME, especially in the EU, export of PME is expected to be uncertain in the near future. PME is expected to face several issues and challenges in the world market and they are:

- in November 2010, the EU imposed a new directive that specifies minimum required greenhouse gas (GHG) emission reductions to qualify for the EU's biofuel programme that includes tax incentives and financial support. According to the proposed directive, biofuels must result in GHG reduction of at least 35% compared with fossil fuels by 2010 and will go up to 60% by 2018, to be eligible for government support. The current estimate of default GHG savings from the use of palm oil of only 19% would leave it ineligible for the vital incentives under existing criteria of Renewable Energy Directive (RED). The RED is to be implemented nationally by December 2010 which will restrict unsustainable certified imported biodiesel and raw materials.

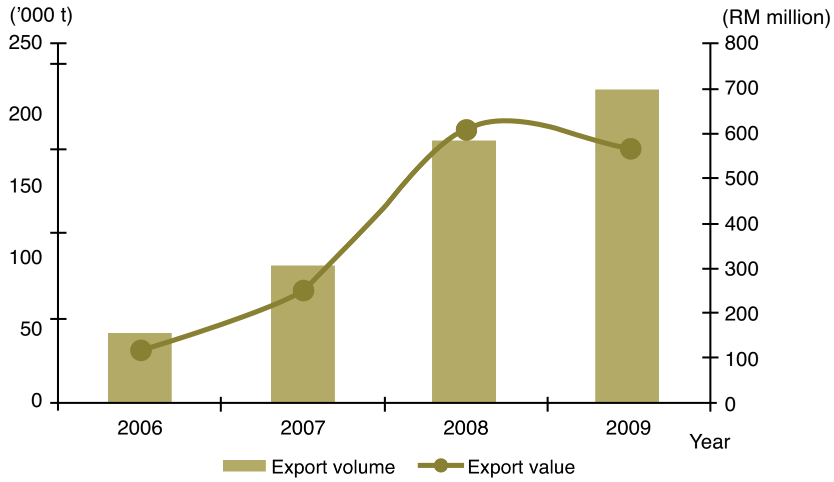

Figure 3. The export volume and value of palm methyl ester (PME).

Meanwhile, US Environmental Protection Agency (EPA) has yet to determine whether palm oil-based biodiesel complies with a 50% GHG savings requirement to benefit from US government mandate. Until the EPA is able to determine if palm oil-based biodiesel can meet the GHG saving target, palm biodiesel cannot be sold to the US in 2010.

Therefore, MPOB has conducted related studies regarding life cycle assessment (LCA) and indirect land usage change (ILUC) to prove that biodiesel from palm oil can fulfill EU regulation and not harm the environment. Meanwhile, palm oil players were discussing the EU's sustainability criteria on the minimum GHG saving of 35%. There is a difference between the methodologies used by experts in Malaysia and the EU on GHG savings. Based on the methodology used by experts in Malaysia, it was found that Malaysia's palm oil industry is saving as much as 50% in GHG.

- demand from Europe for PME or palm-based biodiesel typically slows after the peak summer usage period. During the winter, demand from Europe switches to biodiesel with a cold filter plugging point (CFPP) of around -20°C or lower. In comparison, palm-based biodiesel has a CFPP of around plus 12°C, which can solidify in cold temperatures and stop the flow of fuel to vehicles' engines, making it unsuitable for use in winter weather conditions. Therefore, high export of PME in EU is likely to be in warm weather. May was the best month for European buyers to buy PME from Malaysia as the cargoes would reach Europe in about one to two months, coinciding with the peak summer demand season.

However, this problem has already been solved with the technology now available for 15°C to -21°C CFPP introduced by MPOB.

- the use of palm oil as a raw material for biodiesel has come under fire from non-government organisations who say that deforestation for expansion of plantations and gases emitted when palm oil is processed negate most of its environment benefits as an alternative fuel. This has led to consumer boycotts of the commodity and has hurt margins of biodiesel producers.

  To overcome this problem, Malaysia has played an active role in Round-table on Sustainable Palm Oil (RSPO) to ensure palm oil could be recognised as a sustainable products in the world market. RSPO's vision is to assure palm oil contributes to a better world and their mission is to advance the production, procurement and use of sustainable oil palm.

  Besides that, MPOB already introduced codes of practices (CoP) and *Sustainability Manual* launched in August 2007. There are six CoP which include good nursery, good agricultural, good milling, good kernel crushing, good refinery, good handling, transport and storage.

- moreover, the competition between food and fuel uses for first generation feedstock is seen as an important constraint to future development of first generation biodiesel.

  To overcome this problem, MPOB already conducted a study regarding the potential of second generation for biodiesel from palm biomass. It was found that palm oil biomass is suitable as solid fuel and its composition has potential as second generation feedstock for bio-ethanol. The feedstock depends on existing palms and thus does not conflict for food use.

- Malaysian biodiesel producers sometimes are suffering from an uneconomical price levels of PME. This situation is reflected in biodiesel export figures, due to producers minimising their losses. It is expected high feedstock prices continue to pose a challenge for biodiesel producers in 2010.

  The outlook is bleak as CPO prices have gone up a lot in relation to crude oil and dollar weakening. This will make PME less competitive and therefore the export market performance in 2010 is expected to continue to decline.

- Overcapacity is still a major problem in the biodiesel industry worldwide. It estimated that global biodiesel production capacity will reach about 46 million tonnes at the end of 2009, up by about 8 million tonnes in the 2009 and up 20 million tonnes in the past two years. World production is expected to accelerate from January 2010, driven by state programmes for compulsory blending of the green fuel in fossil diesel to protect the environment in Europe, Brazil, Colombia, Thailand, Brazil and Argentina.

  This problem can be overcome through Bx implementation programme for local market by government in the near future (expected in June 2011 in central region of Peninsular Malaysia). It is hoped that it can be a 'safety net' for biodiesel players to ensure they can survive even though there is uncertainty scenario in the world market.

The Profit and Loss Analysis in 2009

The analysis on the cost of PME production in 2009 has been done through a survey on 10 operating biodiesel producers in 2009. The response rate was 80%. From the eight biodiesel producers, three of them used CPO as their feedstock, three used RBD palm oil and two used RBD palm stearin. Based on the survey, it was found that cost elements of PME production involved four major components namely input cost, fixed cost, cost of oil loss and depreciation. The real cost of PME production needs to take into consideration the glycerin credit, as a by-product which could be treated as an incentive received by the producers.

Based on the analysis regarding cost of PME production, it shows that if depreciation is taken into account all biodiesel producers showed losses. The average cost ranging from RM 704/t to RM 1446/t. This was due to problem of overcapacity faced by majority of the biodiesel producers. Biodiesel producers can gain some profit if depreciation is not taken into account. Based on the survey, the cost of PME production if does not include depreciation, is estimated to range from RM 424/t to RM 510/t.

The Impact of Palm Methyl Ester Production and Bx Implementation Programme on CPO Prices

Based on econometric analysis, the impact of palm biodiesel industry on CPO prices could be determined. The analysis will look at two different scenarios, first the impact of PME production on CPO prices and second the impact of Bx implementation programme on CPO prices.

The impact of PME production on CPO prices. Two different angles will be examined on the impact of PME production on CPO prices. First is to estimate what is going to happen on CPO prices, if the industry does not produce PME in the market from 2006 to 2009. Second is to examine the additional income received by oil palm growers over the last four years (2006-2009) due to PME production factor.

The empirical result for the regression is shown in equation (8). It shows that demand for palm oil (DD), price of soyabean oil (PSBO), and price of CPO lag 1 [PCPO(-1)] have positive relationships with CPO prices. Meanwhile, supply of palm oil (SS) shows a negative relationship with CPO prices.

$$\begin{aligned} \ln PCPO = {} & 2.3590 + 0.5201\ln PSBO - 0.18661\ln SS + 0.0565\ln DD \\ & (3.6844)^{**} \quad (8.3724)^{**} \quad (-4.6098)^{**} \quad (1.5165) \\ & + 0.3945\ln PCPO(-1) \\ & (6.0629)^{**} \quad \ldots\ldots (8) \end{aligned}$$

Note: numbers in parenthesis are t-statistic and ** indicate significant level at 99%.

R-squared = 0.9633.
D-Watson = 1.9672.
F-statistic = 0.0000.

Before this model can be used to estimate what would happen if there is no PME production, this model was tested based on their estimation error, as shown in *Table 3* from 2000 until 2006 (years before no PME production). The error ranges from USD 1 to USD 13/t of CPO or around 0.24% up to 3.08%. The average error of estimating CPO prices for four years was USD 7.43/t or only around 1.91%. Due to close gap (less than 5%) between estimate and actual CPO prices, therefore this model can be used to estimate what is going to happen in 2006 to 2009 if there is no PME production by the industry on CPO prices.

Table 4 shows the result of estimating CPO prices from 2006 until 2009 with an assumption that there is no PME production. It shows that the industry had benefited from the high price of CPO after production of PME.

TABLE 3. THE PERFORMANCE OF THE MODEL FOR IMPACT OF PALM METHYL ESTER (PME) PRODUCTION ON CRUDE PALM OIL (CPO) PRICES

Year	Actual price (USD/t)	Estimate price (USD/t)	Diff. (USD/t)	(%) Diff
2000	285	281	(4)	1.40
2001	286	293	7	2.45
2002	389	377	(12)	3.08
2003	443	447	4	0.89
2004	471	482	11	2.34
2005	422	421	(1)	0.24
2006	442	429	(13)	(2.94)
Average	-	-	7.43	1.91

TABLE 4. ESTIMATED CRUDE PALM OIL (CPO) PRICES

Year	Actual price when there is PME Prod.		Estimate price if no PME Prod.		Difference		(%) Diff
	(USD/t)	RM/t	(USD/t)	RM/t	(USD/t)	RM/t	
2006	478	1 510.50	436.40	1 357.80	41.60	152.70	8.70
2007	780	2 530.50	689.20	2 218.20	90.80	312.30	11.64
2008	949	2 777.50	800.70	2 283.70	148.30	493.80	15.63
2009	683	2 244.50	587.80	1 909.40	95.20	335.10	13.94
Average	-	-	-	-	94.00	323.50	12.48

TABLE 5. ESTIMATED ADDITIONAL INCOME OF OIL PALM GROWERS DUE TO BIODIESEL FACTOR

Year	FFB production (million tonnes)	Additional price (RM/t)	Total additional income (RM bil.)
2006	79.66	29	2.310
2007	79.01	59	4.662
2008	88.53	94	8.322
2009	86.58	64	5.541
Total	333.78	-	20.835
Average	-	61.50	-

Based on the analysis, it was found that in 2006 the industry received additional USD 41.60/t of CPO prices or higher price (or 8.70%) when the Malaysian palm oil industry started to produce and export of PME in August 2006. In 2007, the actual price of CPO was USD 780/t. According to the model, if there was no PME production, the CPO prices could only reach USD 689.20/t. This gives a difference of USD 90.80/t or 11.64%. In 2008 and 2009, the difference between both prices was USD 148.30 and USD 95.20/t respectively.

Table 5, shows an additional income received by oil palm growers over the last four years (2006-2009) due to biodiesel factor. If estimated OER is 19% this means that additional price received by them in 2006 was RM 29/t (RM 152.70 x 0.19). Total fresh fruit bunch (FFB) production in 2006 was 79.66 million tonnes and this gives an estimated additional income of around RM 2.31 billion in 2006. Based on the last four years it is estimated that total additional income received by oil palm growers was RM 20.835 billion. This scenario added up around RM 61.50/t (or 16%) in support of FFB prices.

Based on this analysis, production of PME had helped to increase CPO prices as well as creating value chain for palm oil products. This benefits all sub-sectors in the Malaysian palm oil supply chain. Therefore, the government must ensure that the palm biodiesel industry in Malaysia could be sustained in the future to ensure the Malaysian palm oil industry to continue to be profitable.

The impact of Bx implementation programme on CPO prices. In studying the impact of Bx implementation programme on CPO prices, the study utilised multiple regressions using OLS method as a basis. The empirical result for the regression is shown in equation (9). It shows that prices of crude oil and soyabean oil and demand for palm oil have positive relationships with CPO price. The result also shows that the supply of palm oil has negative relationship with CPO prices.

Price of soyabean oil (PSBO) is the most important factor that influenced the movement of CPO prices due to high coefficient values (0.9299) as compared to other coefficients. The analysis shows that when price of SBO increases by 1%, estimated price of CPO would increase by 0.93%. Meanwhile, the equation shows that when supply of palm oil increases by 1%, the price of CPO would decrease by 0.72%. Other significant factors that influence CPO prices are prices of crude oil and palm oil demand. The result shows that when price of crude oil and demand for palm oil increase by 1%, price of CPO would increase by about 0.14% and 0.12% respectively.

The production of PME for Bx implementation in domestic market is expected to reduce stock which will subsequently increase demand for palm oil products. Based on the negative relationship between stock and price of CPO and positive relationship between demand of palm oil products with price of CPO, it is expected that reduced stock and increased demand would lead to increases on CPO prices.

Therefore, to prove this statement, equation (9) will be used. To ensure this model is the right model to be used for price projection after Bx implementation programme, it was examined as regard to error of estimation. *Table 6* shows the performance of this model based on its strength in estimating CPO prices from 2006 until 2009. It was shown that the error ranges from USD 1 to USD

$$\begin{aligned} lnPCPO = {} & 8.7779 + 0.9299 lnPSBO - 0.7220 lnSS + 0.1205 lnDD \\ & (5.4183)^{**} \quad (9.4942)^{**} \quad (-5.3455)^{**} \quad (1.1067) + \\ & 0.1423 lnPCO \ldots\ldots (9) \\ & (1.9671)^{*} \end{aligned}$$

Note: numbers in parenthesis are t-statistic and **, * indicate significant level at 99% and 95%.

R-squared = 0.9014.
D-Watson = 1.9614.
F-statistic = 0.0000.

TABLE 6. THE PERFORMANCE OF THE MODEL FOR IMPACT OF Bx IMPLEMENTATION PROGRAMME ON CRUDE PALM OIL (CPO) PRICES

Year	Actual price (USD/t) (A)	Estimate price (USD/t) (B)	Diff. (USD/t) (A)-(B)	Diff (%)
2006*	529	528	(1)	(0.19)
2007	780	782	2	0.26
2008	949	977	28	2.95
2009	683	684	1	0.15
Average	-	-	8	0.89

Note: *average of five months (August-December).

TABLE 7. IMPACT OF Bx IMPLEMENTATION PROGRAMME

Bx programme	Additional demand for palm oil		CPO price difference compared to No. Bx programme	
	t/yr	(t/mth)	RM/t	%
B0	-	-	-	-
B1	100 000	8 333	13	0.55
B2	200 000	16 667	33	1.40
B3	300 000	25 000	55	2.33
B4	400 000	33 333	85	3.59
B5	500 000	41 667	120	5.07

Note: CPO – crude palm oil.

28/t of CPO or 0.15% up to 2.95% from 2006 to 2009. The average error of estimating CPO prices for four years is around USD 8/t or around 0.89% as compared to actual CPO prices for those periods. Due to close errors (less than 5%), therefore this model can be used to project CPO prices when Bx programme implemented.

Prior to forecast, the price of CPO and all the independent variables in the model (PSBO, SS, DD, PCO) need to be identified. All independent variables were averaged monthly from January to June 2010. As an example the average production of CPO in 2010 (January-June) was 1 336 087 t.

The first independent variable in the model is the SBO prices. The average price of SBO in 2010 (January-June) were USD 896/t. Second independent variable in the model is supply of palm oil that comprises the production of CPO, opening stock of palm oil and import of CPO. In order to examine the impact of Bx implementation programme, total available supply of palm oil will be deducted by estimated use of PME according to the Bx implementation rate. As an example based on B1 implementation programme it is estimated that 8333 t (monthly) or 100 000 t (yearly) of PME will be used for B1.

The third independent variable in the model is demand of palm oil which comprises export of palm oil, export of PME and estimated demand for Bx in local market. Meanwhile, based on B2 implementation programme, it is estimated that around 16 667 t of PME will be used. Meanwhile, the fourth independent variable in the model is price of crude oil. The average crude oil prices in 2010 (January-June) was USD 73 per barrel.

Based on the analysis it was shown that when there is no production of PME the price of CPO is expected to marginally increase at around RM 13 or higher by about 0.55% (*Table 7*). Based on the same approach, if the production of PME increases to 0.2 million tonnes, the price of CPO is expected to increase additionally at RM 33/t or 1.40%. The aggressive implementation of biodiesel blending at 5% equivalent to PME production and usage of 0.5 million tonnes per year (or 41 667 t per month) would result in the price of CPO increases additionally at RM 120/t or 5.07%.

Therefore, based on this analysis, it can be proved that the null hypothesis (price of CPO does increase after Bx implementation) can be rejected. Therefore, alternative hypothesis (price of CPO can be increased after Bx implementation) is accepted. As an explanation, Bx programme could help to decrease stock level of palm oil which eventually increases the demand for palm oil products. This fact helps to increase CPO prices marginally in the market.

THE WAY FORWARD FOR STRENGTHENING PALM-BASED BIODIESEL INDUSTRY IN MALAYSIA

To ensure 'golden egg' (palm-based biodiesel industry) of the Malaysian palm oil industry to sustain in the short and long run, the industry needs a form of government intervention. They are:

- as a 'safety net' for the palm oil-based biodiesel industry in Malaysia, the implementation of Bx in the local market should be implemented as soon as possible. The implementation of Bx in the local market can generate additional demand for PME. Therefore, this will help producers in term of generating profit from local market. Beside that it can establish a global reputation for palm biodiesel and establishing commitment to combat GHG emissions.

- to improve cash flow analysis for palm-based biodiesel industry, Malaysia should encourage producers to maximize value addition of by-products from PME which include carotenes, vitamin E and crude glycerine.
- PME production should meet the most stringent global specification for biodiesel and improvement on it should always be continuous.
- to minimize the burden of additional subsidy for Bx in the local market, the best mechanism should be identified. Subsidy of input (example discount price of methanol or caustic soda) to reduce cost of PME production should be studied and implemented.

CONCLUSION

The production of PME creates an additional demand for palm oil products in the market while the increase in CPO prices creates multiplier effects on the prices of the other palm oil products. The increases in such prices will then generate higher profits to all sub-sectors in the Malaysian palm oil supply chain in particular and the country in general. Although still at infancy stage, the palm oil-based biodiesel industry has already faced with a few challenges. These challenges can be either within the oil palm industry itself or outside the industry.

The main challenge is the implementation of the Bx programme for the local market. The programme is implementable if MPOB/government and all players in the palm oil industry cooperate among themselves. It can be a 'key' to the success story of the Malaysian biodiesel industry in particular and the whole industry in general. When there is cooperation among the other sectors in palm oil supply chain such as to give back their additional profit received by them (due to high price of CPO) to the industry, all sectors can be ensured of profitable business in short and long run. This becomes a challenge to all parties to cooperate together to ensure biodiesel industry could be sustained.

Meanwhile the challenge from outside the market (industry) is difficult to handle as it is beyond the control of the industry as it is difficult to be solved. The challenge is related to the roles and regulations from importing countries in order to protect their own products. This challenge can be solved through bilateral negotiation between related governments or related agencies to discuss different issues between them. Meanwhile, palm oil industry itself should always produce palm oil products in a sustainable manner at all levels of production to ensure this industry can sustain in the future.

It can be concluded that palm biodiesel investment viability depends on three key factors. First is sustained when high fossil fuel prices, second is willingness to offer subsidy programme to producers or consumers and lastly depending on cheap raw material. At this moment it was found that palm biodiesel investment is unfavourable and full of uncertainties. Therefore all players involved in the palm oil industry need to work together to find solutions on how to ensure biodiesel industry can continue to survive in the future for the betterment of the Malaysian palm oil industry as a whole.

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