Impact of Palm Oil-based Biodiesel Demand on Palm Oil Price

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ABSTRACT

Biodiesel has become an important renewable fuel, especially with the high price of petroleum and growing concern for the environment. This article analyses the impact of the rise in biodiesel demand on the price of Malaysian palm oil. The demand for biodiesel would reduce the volume of palm oil available in the market, putting upward pressure on its price and those of other vegetable oils. With this recent new demand, the palm oil price has increased sharply since July 2006, which can be taken as the date when the palm oil price began to be influenced by the traditional economic factors, such as its production, price of soyabean oil, stock-usage ratio and weather, as well as by the new demand for biodiesel. The autoregressive integrated moving average (ARIMA) method was used to estimate the palm oil price from July 2006 to end 2007 without the effect of biodiesel. This showed a rising trend – as with biodiesel included - but much less steep than with the effect of biodiesel included. This result was confirmed by the time-varying parameters model used to compensate for the ARIMA results. Using the model and considering all the factors, including biodiesel demand, the palm oil price is forecast to remain high, averaging RM 3500/t for 2008.

INTRODUCTION

Until June 2006, the crude palm oil (CPO) price locally was influenced by its production, stock and supply, and the demand for it and its substitutes, mainly soyabean oil. In addition, it was also affected by its international price.

From July 2006 onwards, with the rise in petroleum prices and growing concern for the environment, biofuel became a serious alternative fuel because of its renewable/sustainable production. Biodiesel, mainly from palm, rapeseed and soyabean oils, experienced increased demand. This considerably altered the economics of palm oil as the increased demand and production of biodiesel pushed up its price.

This article seeks to analyse the effects of biodiesel on the palm oil price as a new source of demand for it. The analysis will include a projection of the future palm oil price. We will first describe the oils and fats balance, give general description of biodiesel, the historical palm oil pricing (until June 2006) and the increased demand for it thereafter.

OILS AND FATS BALANCE

Oils and fats production, stocks (opening/closing), and exports/imports have all increased in this new millennium. The production

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of 17 major oils and fats grew from 115 million tonnes (MT) in 2000 to almost 150 MT in 2006, an increase of about 30% (*Figure 1*). Exports behaved similarly, although 30% - 40% less than the production as more and more of the production was consumed domestically, leaving less for exports. This is because main producers of soyabean oil (a major produced oil), like USA and China, exported less than 15% of their production in 2006. Similarly for rapeseed oil, major producers such as China, European Union (EU) and India exported less than 8% of their production. World closing stocks of oils and fats also rose from 15.7 MT in 2000 to 17 MT in 2006.

It is worth mentioning here the sterling performance of palm oil vis-à-vis the 17 oils and fats since the beginning of this millennium. World palm oil production increased from 22 MT in 2000 to 37 MT in 2006, overtaking soyabean oil to become the most produced oil (*Figure 1*). Its 2006 production was almost a quarter (24.58%) of the total oils and fats production (*Table 1*) with soyabean oil at 23.6%. The two main producers were Malaysia and Indonesia, the former alone producing 43% of the world total.

Figure 1 also shows that the palm oil exports constitute much (60% – 80%) of its production, both Malaysia and Indonesia consuming very little of what they produce. Malaysia actually exports almost all (91%) of its production due to its small population and moderate caput consumption (11 kg).

The performance of Malaysian palm oil against world palm oil is also shown in *Table 1*. The Malaysian share of opening stocks of palm oil was maintained at about 31% from 2000 to 2006, but its production share fell from 50% to 43% and its exports from 60% to 50% due to Indonesian competition, especially towards 2006. Malaysian closing stocks in 2006 dropped to 27.35% from 35% in 2000, mainly due to its decline in production share and new demand for biodiesel. In June 2006, Malaysia started to produce biodiesel and some palm oil was diverted to its production.

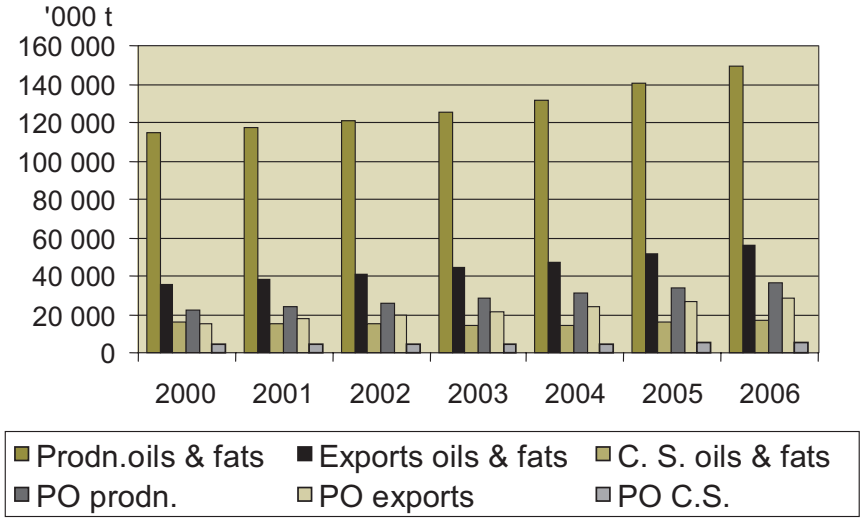

Figure 1. World oils and fats balance, 2000-2006.

WHAT IS BIOFUEL/ BIODIESEL?

Biofuel is a renewable fuel produced from vegetable oils such as rapeseed oil, sunflowerseed oil, soyabean oil, palm oil and also used frying oils or animal fats. The plants that produce these oils absorb carbon dioxide (CO_2) during their lifetime and give up the same amount when burnt. Thus, they are considered to be 'CO_2 neutral', meaning that they do not add CO_2 to the atmosphere. Biodiesel is an example of a biofuel. It reduces emissions of carbon monoxide

TABLE 1. PERFORMANCE OF PALM OIL AGAINST OTHER OILS AND FATS (%)

	Statistics/year	2000	2001	2002	2003	2004	2005	2006
Share of palm oil in world oils and fats	Opening stock	25.66	25.81	26.95	27.20	28.32	32.61	32.44
	Production	19.06	20.39	21.06	22.42	23.46	23.97	24.58
	Imports	42.66	46.02	47.38	49.68	51.28	51.95	51.18
	Exports	41.80	46.20	47.53	49.19	51.32	51.87	51.55
	Disappearance	19.19	20.23	21.06	22.44	22.84	23.78	24.35
	Closing stocks	25.81	26.95	27.20	28.32	32.61	32.44	32.42
Share of Malaysian palm oil in world palm oil	Opening stock	31.31	34.91	29.04	28.29	28.98	31.34	31.19
	Production	49.58	49.22	46.90	47.51	45.22	44.36	43.23
	Imports	0.38	0.94	1.91	1.94	2.69	1.77	1.72
	Exports	60.47	60.47	56.29	56.55	51.90	50.70	50.21
	Disappearance	7.25	6.49	5.75	5.25	5.74	5.66	5.67
	Closing stocks	34.91	29.04	28.29	28.98	31.34	31.19	27.35

TABLE 2. DIESEL CONSUMPTION IN THE TRANSPORT SECTOR (t/day)

	1990	1998	1999	2010	2015	2020
Europe	327 360	436 480	422 840	504 680	545 600	545 600
World	1 173 040	1 514 040	1 541 320	2 155 120	2 468 840	2 728 600

Source: Oils and Fats International (2005).

(CO) by approximately 50% and CO_2 by 78% on a net life cycle (Radin Diana and Noorly Akmar, 2008). In Malaysia, it refers to methyl esters derived from palm oil.

Biodiesel can be used effectively in the transport sector. In fact, the increase in oil demand in future may come mainly from this sector which may produce almost one-third of the world's greenhouse gas emission growth (Girard *et al.*, 2005). *Table 2* shows the diesel used in the sector which may be replaced by biodiesel in future. Doing so can reduce emissions from the transport sector. However, biodiesel is not competitive compared to petroleum diesel without subsidies or tax incentives, except in cases where petroleum prices are high in the extreme and vegetable oil prices low (Oil and Fats International, 2005). Thus, the viability of biodiesel production depends very much on an increase in the diesel price and decrease in the CPO price.

Biodiesel can be blended with diesel or used alone. Technically, blending has been guaranteed by the motor manufacturers in the European Union who have tested various blends with diesel and using 100% biodiesel. The use of biodiesel as transport fuel does not require any changes in the distribution system, therefore avoiding expensive infrastructural changes. Biodiesel is also used as an efficient heating oil.

Biofuel is an alternative energy source to fossil fuels. There is interest presently in alternative energy sources due to the world concern on environmental pollution, the rapidly depleting fossil fuels and their escalating prices. Biodiesel has been demonstrated to have significant environmental benefits in terms of decreased global warming, reduced emissions, greater energy independence and a positive impact on agriculture.

Various studies have estimated that using 1 kg biodiesel reduces about 3 kg CO_2. Hence, the use of biodiesel results in a significant reduction in CO_2 emission (65%-90% less than conventional diesel), particulate emissions and other harmful emissions. Biodiesel is extremely low in sulphur, and has high lubricity and fast biodegradability (European Biodiesel Board, 2007). These are all advantages which have been confirmed by various EC Commission programmes and tests by independent research institutes.

Palm oil has some techno-economic advantages over other oils. One of them is that it is the most productive oil crop. As shown in *Figure 2*, the oil palm has the highest productivity of about 3600 kg oil (palm oil + palm kernel oil) per hectare per year, compared to other crops such as jatropha (1600), soyabean (398) and rape (641). Another reason is the reliability in its supply. It is a perennial crop, and once planted can produce for the next 25 years. Annuals would have to be planted yearly, giving a somewhat unreliable supply. In addition, being perennial, it is less susceptible to the vagaries of weather compared to other crops, especially the annuals. The annuals are greatly affected by the weather, and their planting intentions can be easily changed because of it.

BIODIESEL DEMAND

Biodiesel can be a source of alternative energy in the future. It is produced by planting oil palm, soyabean, corn and rape, and increasing its demand will boost the demand for these crops.

Many countries have started to use renewable energy - 17 have so

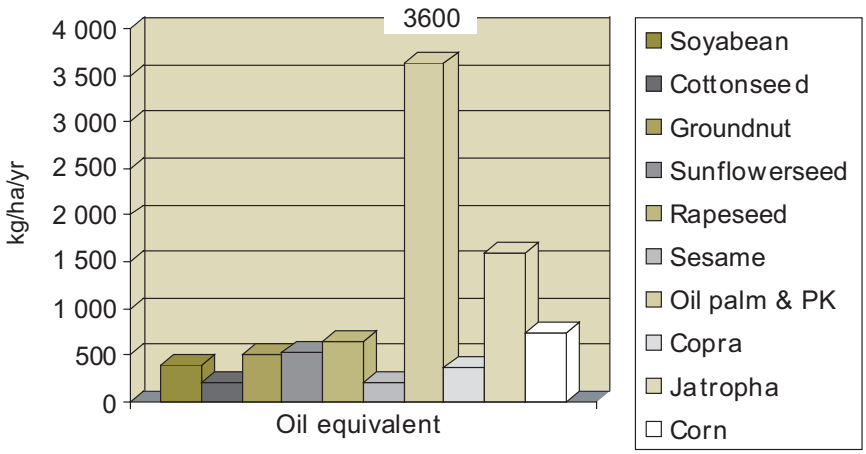

Figure 2. Productivity of various oilseeds.

Sources: Corn and jatropha from http://www.vegetableoildiesel.co.uk/forum/viewthread.php?tid=87
Other crops from Oil World.

far grown or committed to grow energy crops on a large scale. In 2006, more than one-third of the global maize crop went to ethanol for fuel, a 48% increase from 2005. Brazil and China grew the crop for this purpose and plan to build more biodiesel plants. The EU has said that 10% of all fuel must be biofuels by 2020. Indonesia wants to replace 10% of its petroleum oil products used in the country with biofuels by 2020, mainly to be produced from planting oil palm and sugar cane. For this, Indonesia will plant an additional 2 – 3 million hectares of oil palm by 2010. Malaysia has plans to use palm oil as renewable energy in its Ninth Malaysia Plan. To play its role as a biofuel producer, the country has issued licenses for the construction of biodiesel plants and has formulated a National Biofuel Policy. Malaysia and Indonesia have both agreed to allocate about 6 million tonnes of palm oil each for biodiesel to ensure the continuity of supply.

It is expected that more biofuels will be demanded in future as crude oil prices continue to surge. Vegetable oils and fats will have to be allocated for this additional demand, especially as tax incentives and new legislations to promote biodiesel in the EU and US will spur consumption.

PALM OIL PRICE BEFORE THE ADVENT OF BIODIESEL IN MALAYSIA

The CPO price, as shown in *Figure 3*, has been erratic. It was more than RM 1000 in early 2000 and declined towards end of the year to a trough until the first half of 2001. The price then fluctuated about and generally picked up in the first-quarter of 2004 to a high of RM 2000 in March. Between 2001 – 2004, there were a number of peaks - in August 2001 (RM 1215), August 2002 (RM 1496), November 2003 (RM 1865) and March 2004 (RM 2000). After this, the price started to drop to RM 1548 in June. *Figure 3* shows that the price then stabilized at slightly below RM 1500 until June 2006. The price for refined, bleached and deodorized (RBD) palm olein also showed a similar trend from 2000 to 2006.

The previous paragraph described the prices for CPO and RBD palm olein for the past seven years until June 2006. As mentioned earlier, this was the period before the introduction of biodiesel in Malaysia (*Figure 3*). During this period, CPO price responded to a number of factors which shaped palm oil price trend in the past. Among the factors are its reaction to supply and demand balance which affected its long-term price evolution; its own production (a short-term effect); its relationship with other vegetable oils, especially with its closest competitor, soyabean oil, as well as the effects of the weather. These factors are discussed in the following paragraphs.

Relationship Between CPO Price and Production

An analysis on the long-term time series for both prices and production of Malaysian CPO is necessary in order to analyse their relationship to reveal a more representative price pattern. Thus, annual data from 1990 to 2006 were used and graphed in *Figure 4*. It is noted that the series for CPO production exhibits repeated cycles almost every three to five years, as represented by the shaded bars in *Figure 4*. Production dropped in 1983 by 14.2% from 1982, in 1994 by 2.5% from 1993, and in 1998 by 8.3% from 1997. It recorded a small increase in 1987 by 0.21% from 1986, in 1990 by 0.63% from 1989, in 1991 by 0.77% from 1990, and in 2002 by 0.89% from 2001. All these took place at an interval of three to five years, indicating cycles of stress in which the palms produced less fruits than in the previous year.

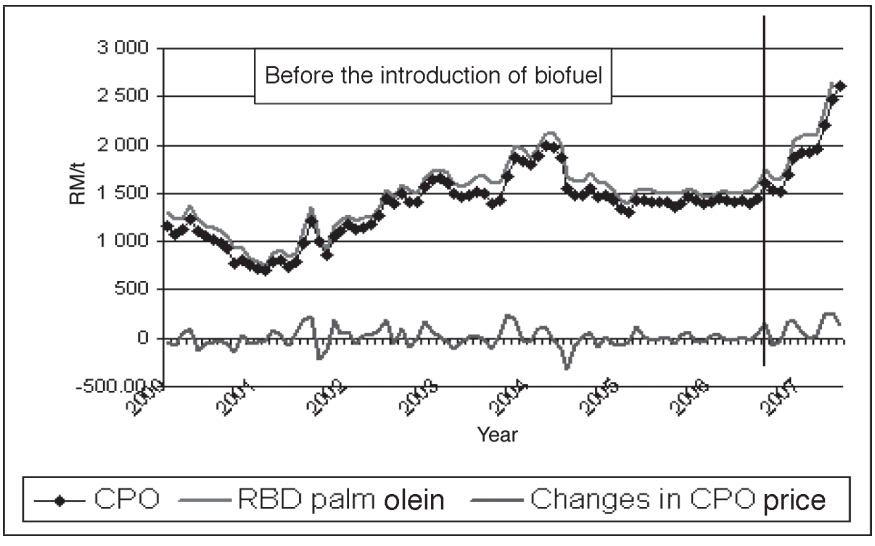

Figure 3. Price movements of crude palm oil (CPO) and refined, bleached and deodorized (RBD) palm olein (RM/t).

Since the last cycle of stress took place in 2002 which only produced a small increase of CPO from the previous year, it is interesting to inquire when the next cycle of stress will occur. In the past, the cycles have occurred between three to five years. This means that the next could be in 2007. There is already a suggestion of this in the latest CPO production data from January to July 2007 being below that in 2006 by 7%. Thus, it is expected that CPO production in 2007 will not reach 16 MT, putting a pressure on the price.

Always, if the CPO production drops in any year, its price will increase in the following year. *Figure 4* shows this behaviour. For example, a drop in production in 1983 resulted in an increase in price in 1984. Thus, it is hypothesized here that the palm oil price has a negative relationship with its production lagged one year. As a result, the expected drop in 2007 production will lead to an increase in the CPO price in 2008.

Relationship between CPO Price and Soyabean Oil Price

Prices of similar oils and fats are more highly correlated than those of non-similar ones. Palm oil and soyabean oil are two good examples of oils having similar characteristics and, thus, are substitutable in many applications. Due to this, their prices are highly correlated - palm oil registers the highest correlation index of 0.82 with soyabean oil than any other oils and fats except with palm kernel oil (PKO) (*Table 3*). Their close relationship in the past is depicted in *Figure 5*, and it was always the case that when the soyabean oil price increased/decreased, the CPO price followed.

Not only the palm oil price, but those of most other oils and fats prices have closely followed the soyabean oil price in many occasions in the past. The soyabean oil price quoted in the Chicago Board of Trade (CBOT) futures market is thus used as reference or benchmark by these oils and fats. As such, the soyabean oil price is a factor that influences the CPO price, in addition to its own (palm oil) production.

Beside the fact that CPO and soyabean oil prices are closely related, the former is generally sold at a discount to the latter. *Figure 5* shows the discount of CPO. One of the reasons for this was that soyabean oil was the major oil produced and its price in Rotterdam market was the benchmark. The spread narrowed from 2000 until 2002 and in 2007 but widened between 2002 until 2006.

Relationship between CPO Price and Stock-usage Ratio

Westcott and Hoffman (1999) noted that many commodity analysts used the stock-usage ratio as an explanatory variable in their analyses of commodity prices. For instance, Gerald and William (2004) found the ratio useful in explaining the soyabean oil price. It is the ratio of stock over consumption - a relatively comprehensive measure in that it incorporates both the supply and demand factors, such as total stock and total demand or consumption. In this respect, the ratio already incorporates the effects that lead to the final supply and demand relationships of oils and fats. Including these factors again in the analysis of CPO price will be redundant and, in econometrics, would cause the problem of multi-collinearity. Thus, it suffices to use the stock-usage ratio of palm oil to account for the fluctuation in palm oil price in Malaysia.

The relationship between stock-usage ratio of palm oil and price of CPO is shown in *Figure 6*. There is a negative association between the two. Correlation analysis shows a Pearson correlation coefficient of -0.37, meaning that the price will increase as the ratio declines.

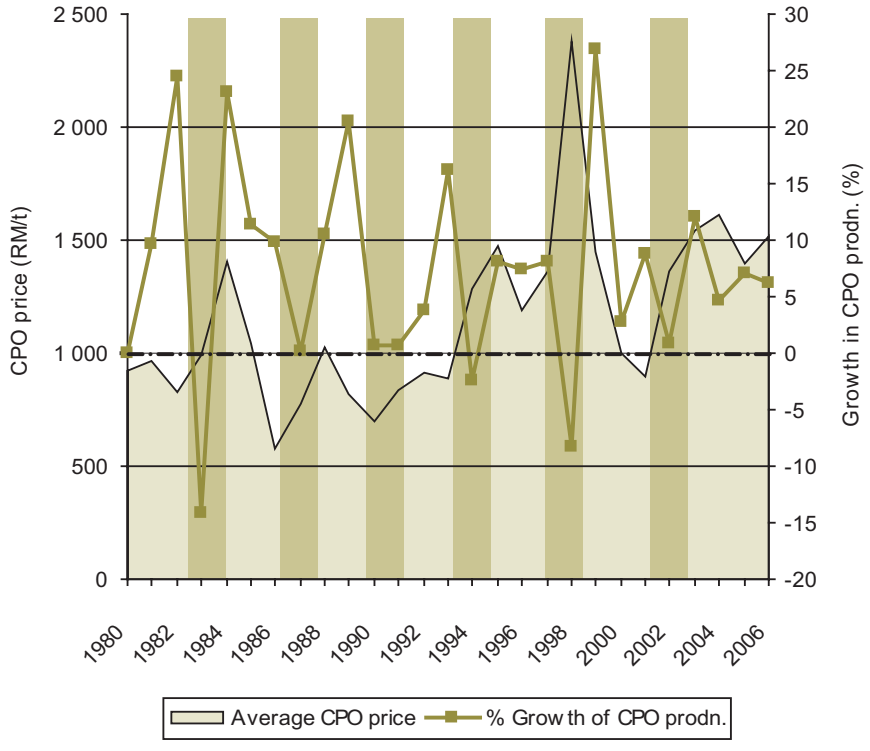

Figure 4. Relationship between crude palm oil (CPO) price and CPO production.

TABLE 3. CORRELATION MATRIX OF PRICES OF SELECTED MAJOR OILS AND FATS

	Palm	Rape	Soya	Sunflower	Groundnut	PKO	Coconut	Olive	Tallow
Palm	1.00	0.78	0.82	0.76	0.42	0.83	0.77	0.74	0.80
Rape	-	1.00	0.93	0.90	0.70	0.51	0.46	0.51	0.75
Soya	-	-	1.00	0.86	0.71	0.59	0.53	0.57	0.60
Sunflower	-	-	-	1.00	0.60	0.51	0.46	0.42	0.68
Groundnut	-	-	-	-	1.00	0.24	0.20	0.67	0.56
PKO	-	-	-	-	-	1.00	0.98	0.74	0.68
Coconut	-	-	-	-	-	-	1.00	0.76	0.64
Olive	-	-	-	-	-	-	-	1.00	0.68
Tallow	-	-	-	-	-	-	-	-	1.00

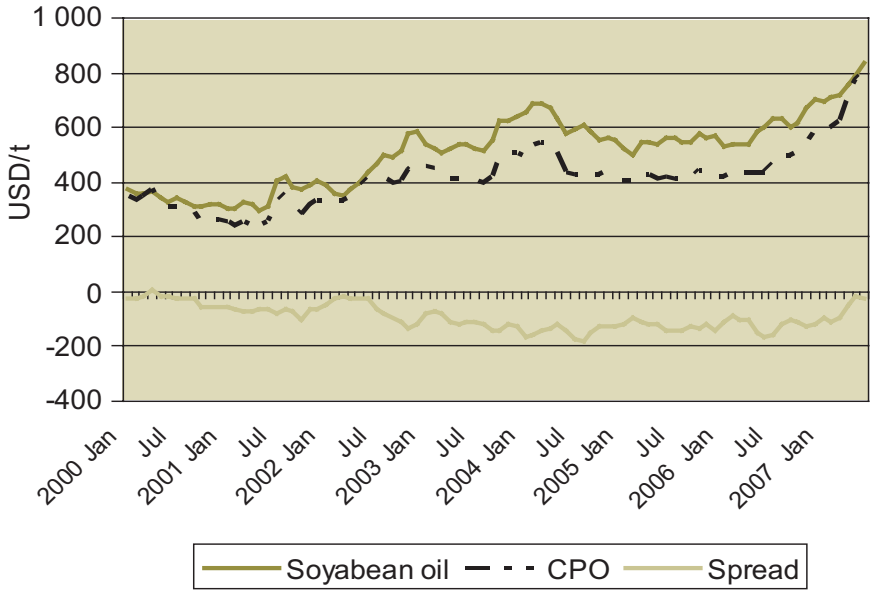

Figure 5. Relationship between crude palm oil (CPO) and soyabean oil prices.

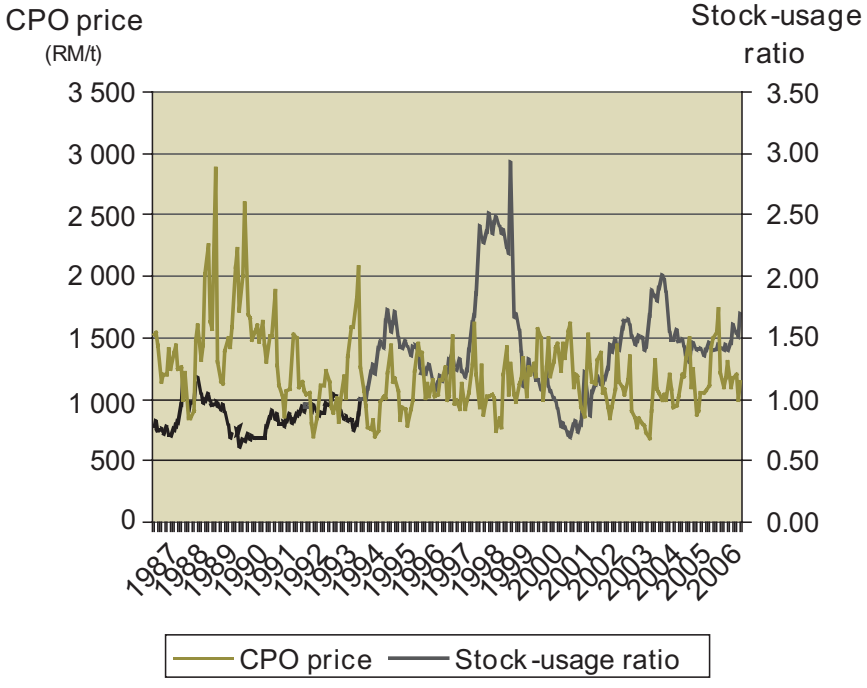

Figure 6. Relationship between crude palm oil (CPO) price and its stock-usage ratio.

Relationship Between the CPO Price and Weather

Crude vegetable oil prices are also affected by the weather, especially the oils from annual crops, such as soyabean and rape. For example, in 2002/2003, the rape crop was damaged, and this, combined with a higher demand for rapeseed oil, led to higher prices in 2003. In 2003/2004, severe crop damage to the US and South American soyabean crop caused soyabean oil prices to increase.

The contribution of weather to the pricing of perennial vegetable oils is rather indirect - it directly affects production which then affects the price. The bad weather in 1998 and 2002 are two good examples. In 2002, the CPO market tightened due to lower production attributed to the *El Nino* phenomenon. A similar situation occurred in early 1998, when drought sharply reduced CPO production and prices surged above RM 2000. Oil palm yield can be adversely affected by extreme weather, *e.g.* low humidity can stress the palms, but with the long gestation to yield, the effects are only noticeable months later. Hanson *et al.* (2005) found that drought had a negative impact on the development of the young palm leaf. Another study by Rao *et al.* (2003) showed that the percentage fruit-to-bunch declined during dry seasons but increased in wet seasons.

EFFECTS OF PALM OIL-BASED BIODIESEL DEMAND

Biodiesel was introduced in Malaysia commercially in June 2006. Four plants were operating in 2006 and produced about 60 000 t of palm diesel. *Table 4* shows that the export of palm biodiesel from Malaysia started in August 2006, and totalled 47 986 t for the year with a value at RM 121 million. In 2007, exports increased to 95 000 t.

The price of CPO in Malaysia was greatly affected by the advent of this new product, increasing sharply from RM 1441 in July 2006 to RM 2609 in June 2007. *Figure 7* clearly shows this, represented by the shaded area. The steep rise from July 2006 can be attributed to this additional biodiesel demand, acting together with the other factors mentioned above. Together, they caused a temporary shock to the CPO price, structurally breaking the CPO price series.

An attempt is made here to estimate the CPO price without the demand for biodiesel. From this, the effect of biodiesel on the price can be deduced. An autoregressive integrated moving average (ARIMA) approach was adopted. The analysis obtained ARIMA (1,0,1) with the results translated into the trend in *Figure 7*. It is clear that the CPO price would have increased anyway after July 2006 due to the expected shortage of supply in Malaysia. However, it would have been a smaller increase without the demand for biodiesel (actual trend). The difference between the two price trends (actual and ARIMA trend) represents the effect of the biodiesel demand.

TABLE 4. EXPORT VOLUME, VALUE AND PRICE OF BIODIESEL, 2006 - 2007

Year	Month	Volume (t)	Value (RM mil.)	Price (RM/t)
2006	Aug	8 107	20.61	2 542
	Sep	12 161	30.24	2 486
	Oct	4 122	10.50	2 548
	Nov	12 216	31.84	2 606
	Dec	11 380	27.70	2 346
2007	Jan	1 703	4.0	2 369
	Feb	3 040	7.2	2 383
	Mar	10 045	25.0	2 486
	Apr	9 091	21.90	2 405
	May	32 790	81.0	2 471
	June	7 125	17.5	2 456
	July	8 256	25.0	3 034
	Aug	36	0.2	6 502
	Sep	1 577	4.0	2 512
	Oct	11 892	38.5	3 240
	Nov	6 201	18.3	2 957
	Dec	3 256	10.4	3 204

Source: MPOB.

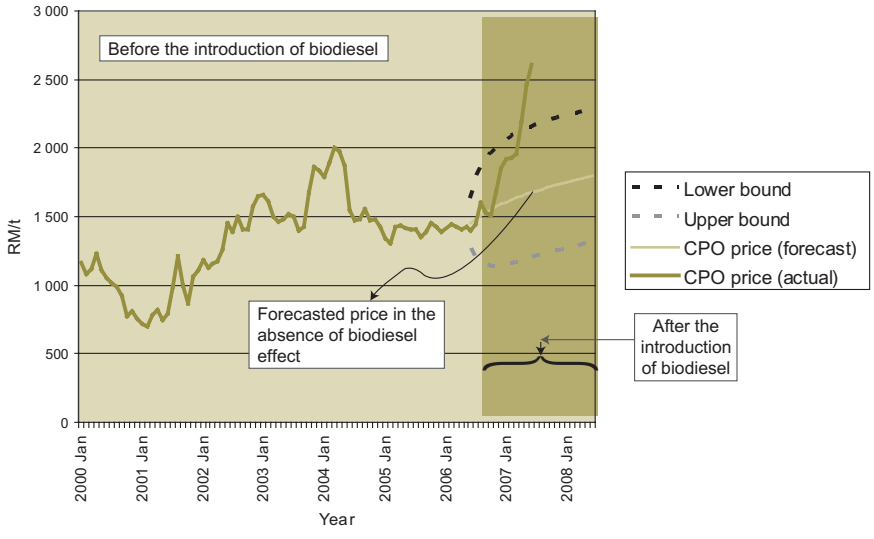

Figure 7. Effect of biodiesel demand on the crude palm oil (CPO) price.

PROJECTION OF CPO PRICE

An attempt is also made to project the CPO price from July 2007 to end 2008. Although the CPO prices for July-December 2007 are available, they were nevertheless estimated to test the reliability of the model and accuracy of the forecasts. For this, the time varying parameters (TVP) model was used. The model incorporates the stock-usage ratio of palm oil, price of soyabean oil, lagged production of palm oil and, lastly, the biodiesel demand. It also assumes that the price of soyabean oil follows the autoregressive pattern of order one, *i.e.* AR(1). This model employs the Kalman-Filter algorithm to estimate different values of coefficients to be used during the period.

The TVP model shows that the price will remain high at about RM 2600 to RM 3000 from September 2007 until December 2007 (*Figure 8*). The estimated price

trend is very close to the actual trend, indicating the model to be reliable. The differences were insignificant.

The price is expected to remain at RM 3100 to RM 3700 throughout 2008. This projection assumed that the 2007 production of CPO would decline to 15.82 MT from 15.88 MT in 2006, and production in 2008 to be 16.5 MT. In addition, stocks are to be 1.6 MT by end 2008 and production of biodiesel increase to 160 000 t in 2008. The shock is expected to persist into 2008. For the whole year 2008, the average price of CPO is expected to be about RM 3500/t (*Figure 8*).

CONCLUSION

Biodiesel has become important in the transport sector and oils and fats industry. Many countries, including Malaysia, have committed themselves to using it. As a result, there is an increase in the biodiesel demand which, in turn, has increased demand for the feedstock.

The increase in demand for biodiesel has led to its increased production, thus, requiring additional palm oil. This analysis shows the effect to be positive as price is increased higher than without any biodiesel demand. The country also benefited through higher export earnings and higher corporate tax.

Nevertheless, this good fortune has not been favourable to the licensees of biodiesel plants. Only four are operating out of 92 licenses awarded, the others preferring to wait-and-see. This is mainly due to the high price of palm oil which makes the economics of producing biodiesel questionable. We forecast that the future CPO price will remain high in the last few months of 2007 (RM 2600 to RM 3000) and to rise even higher in 2008 to average RM 3500 for the year.

CPO price (RM/t)			
Year		**Actual**	**Forecast**
2007	Jul	2 629	2 600
	Aug	2 533	2 580
	Sep	2 576.5	2 610
	Oct	2 765.5	2 720
	Nov	2 963	2 890
	Dec	2 925.5	2 900
2008	Jan	3 221	3 150
	Feb	3 515	3 400
	Mar	-	3 500
	Apr	-	3 510
	May	-	3 550
	Jun	-	3 500
	Jul	-	3 500
	Aug	-	3 690
	Sep	-	3 610
	Oct	-	3 630
	Nov	-	3 500
	Dec	-	3 410
Average	2008	-	3 496

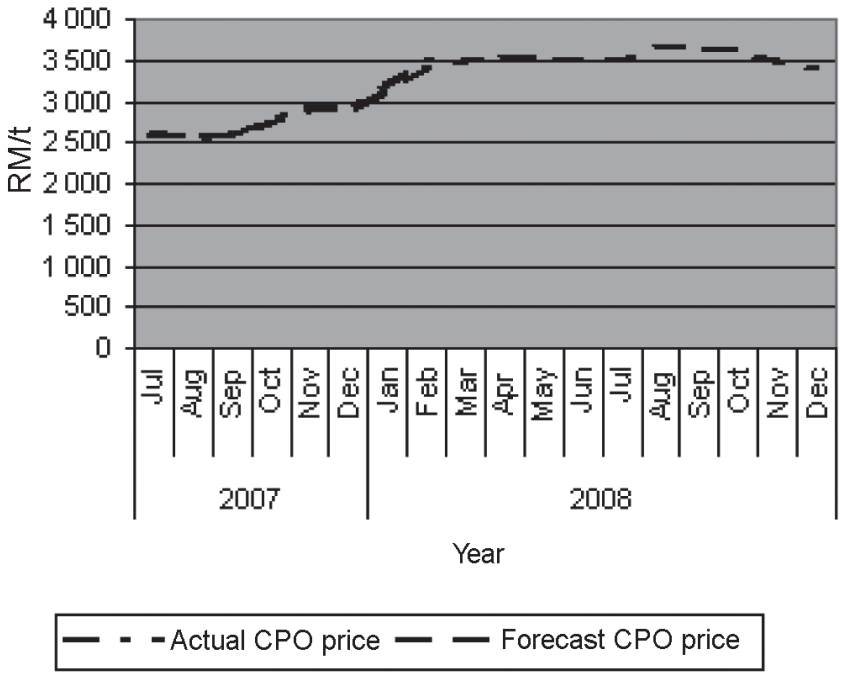

Figure 8. Crude palm oil (CPO) price trend in 2007 and 2008.

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