Simulation Study on the Availability of Palm Oil Stock

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ABSTRACT

The volume of palm oil stock has a strong influence on its price. The palm oil stock has long hovered around one million tonnes, and has become the psychological level below and above which prices tend to be bullish and bearish, respectively. The stock level mainly depends on the production and export of palm oil, while imports and local consumption play minor roles. An unanticipated high production of crude palm oil, generally leads to an unintended build-up of palm oil stock, especially when the export is slow. The rapid development in the production of palm oil and diverse usage of it, justify the revision of the psychological stock level that implies also the supply reliability of Malaysian palm oil.

INTRODUCTION

The stock of a commodity is essential for explaining market adjustments, although focus is usually given more to the actual price movements. A well-known characteristic for agricultural perennial crops is the demand and supply behaviour that tend to be relatively price-inelastic in the short-run. Hence, stock movements, which are more price-elastic, provide the vehicle whereby markets achieve equilibrium (Labys, 1998).

Another role of stock is the importance of having certain amount of quantity in hand that can meet buyer requirement at the time and in quantities desired, which avoid stockout incidence. A stockout occurs when a seller faces a potential buyer, but has no inventory stock and loses the sale.

The supply of Malaysian palm oil consists of crude palm oil (CPO) and numerous products of processed palm oil (PPO). The availability of these products during any period equals the sum of CPO production, imports of CPO and beginning inventories of both CPO and PPO.

The production of oil palm fruits that provide CPO basically depend on yields and planted acreages (Mad Nasir *et al.*, 1995), while technology improvement can also enhance the yield (Basri and Zaimah, 2002). Meanwhile, the import of CPO was found to be positively and highly elastic to industrial production index and negatively related to beginning stock, which meant that imports provide substitutes for decreasing stocks (Basri and Zaimah, 2002).

Export demand of palm oil is an aggregate export of CPO and PPO, which depends on the lagged export demand, own price in the world market, level of economic activities of the importing countries, world prices of palm oil substitutes, exchange rates of

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Malaysian ringgit, export tax and import duties imposed by each of the importing countries (Mad Nasir *et al.*, 1995).

The varying price of soyabean oil is associated with an opposite response of palm oil exports in the short-run, as compared to the positive response with increasing world population and exchange rate (Basri and Zaimah, 2002).

The domestic demand for palm oil is negatively related to the domestic price of palm oil, and positively related to the prices of soyabean and coconut oils, Malaysian industrial production index and also previous domestic demand (Mad Nasir *et al.*, 1995). The prior consumption level and the domestic economic activity are important factors that influence the local demand of palm oil. In the short-run, a 10% increase in industrial production index would cause an increase in domestic consumption by 3% (Basri and Zaimah, 2002).

The supply and demand of palm oil emphasize inventory level or stock level as the critical buffer that balancing the palm oil market as it adjusts to supply and demand shocks. Results from previous study revealed that the price of palm oil has negative relationship with the stock level, but positive correlation with the export demand (Mad Nasir and Fatimah, 1999). Therefore, the monthly palm oil closing stock in the country is one of the information widely used to gauge the palm oil market outlook, as it acts as proxy for the underlying supply and demand fundamentals. The volume of palm oil stock, especially the one million tonnes has become a strong psychological factor that can indicate a bullish or bearish outlook for the Malaysian palm oil industry, presumably under the belief that stock affects market prices.

OBJECTIVE

The purpose of the study is to determine the appropriate stock level for Malaysian palm oil from the macro perspective and also the relevance of the psychological level, *i.e.* 1 million tonnes. In addition, a simulation exercise will further examine the consequences of different supply and demand growth rates on the level of palm oil stock.

DATA AND METHODOLOGY

Annual and monthly data of production, export, import and closing stock of Malaysian palm oil from January 1987 to December 2006 and published by MPOB were used in the study. The stock of palm oil refers to the total physical amount of crude and PPO in the mills, refineries, bulking installations and oleochemical plants.

A day's forward cover analysis or day's supply is used to gauge how long the inventory could have lasted without replenishment at the current rate of daily demand. The average daily demand was computed by dividing the annual total demand by 365 days. Then, the useable inventory, or closing stock is divided by the average daily demand to determine the number of days' supply.

The model used in the simulation exercise is based on the relationship of the palm oil stock with other components of palm oil market (Mad Nasir *et al.*, 1995):

$$SPO_t = SPO_{t-1} + Q_t - DDPO_t - EDPO_t \quad -\!- (1)$$

The import of palm oil was initially not included due to its negligible volume then, but as its volume has increased, it is included in Equation 1 and rewritten as:

$$SPO_t = SPO_{t-1} + Q_t + I_t - DDPO_t - EDPO_t - (2)$$
where
SPO_t = stock level of palm oil at year t
Q_t = palm oil production at year t

I_t = import of palm oil at year t
$DDPO_t$ = domestic demand of palm oil at year t
$EDPO_t$ = export demand of palm oil at year t

The domestic demand is also obtained from Equation 2 through solving for $DDPO_t$. The equation will be simulated directly by probability density function following the Monte Carlo simulation technique. Historical annual growth of each component will be evaluated to determine the average and standard deviation of each component as well as the appropriate probability distribution. The computer program will generate random numbers based on the parameter and its probability distribution. This will provide results that can assess the stock situation in detail with various possibilities of demand and supply growth rates. The analysis use statistics of 2006 as initial values for the simulation exercise.

RESULTS AND DISCUSSION

Figure 1 shows the uptrend in palm oil monthly supply and demand from January 1987 to June 2006. The fitted long-term linear trends (with log-transformation) for both parameters show the gap between supply and demand of palm oil to have widened over the years, *i.e.*, supply growing faster than demand. The simple average growth rate of production of 6.47% was slightly higher than export growth of 6.34% per annum from 1987 to 2006.

The substantial increase in palm oil production by 2.2 million tonnes was registered in 1998/1999 and 1.4 million tonnes in 2002/2003. The upsurge was driven by more mature area expansion in east Malaysia, approximately by 100 000 ha in Sabah in 1996/1997 and 1999/2000, and 123 924 ha in Sarawak in 1998/1999.

Meanwhile, the export of palm oil increased considerably in

1998/1999, 2000/2001 and 2002/2003 with increment amount of 1.4 million tonnes, 1.5 million tonnes and 1.4 million tonnes, respectively. Growth in consumption of palm oil in markets such as China, India and Pakistan contributed to bigger export of palm oil. The relatively slower export movement compared to production had contributed to the accumulation of ending stock to a new level.

Figure 2 displays the increasing monthly closing stock of palm oil over the years. Before 2000, the monthly stock of palm oil fluctuated generally below 1 million tonnes level, with only very few occasions rising above that level, *i.e.* October 1989 – February 1990 (six months), September 1993 – December 1993 (four months) and October 1997 – December 1997 (three months). On the other hand, post-2000, the monthly closing stock was generally above 1 million tonnes. Since 2000, the 1 million tonnes level has become the lower, rather than upper limit.

The situation is further elucidated by plotting five-year moving averages (*Figure 3*), which shows growing trend of the palm oil stock. It started to be above 1 million tonnes since 1996 – 2000 onwards. Although it was rather stable at 0.8 million tonnes level, but it elevated faster after surpassing the 1 million tonnes level.

In general, an unanticipated high production of CPO generally leads to build-up of palm oil stock, especially when the export demand is sluggish. Therefore, demand creation is critically important in helping the palm oil market to adjust to any sudden surge in supply, so as to hold palm oil stock at the desired level for maximum benefit to the industry.

Figure 4 shows the composition of the annual palm oil closing stock
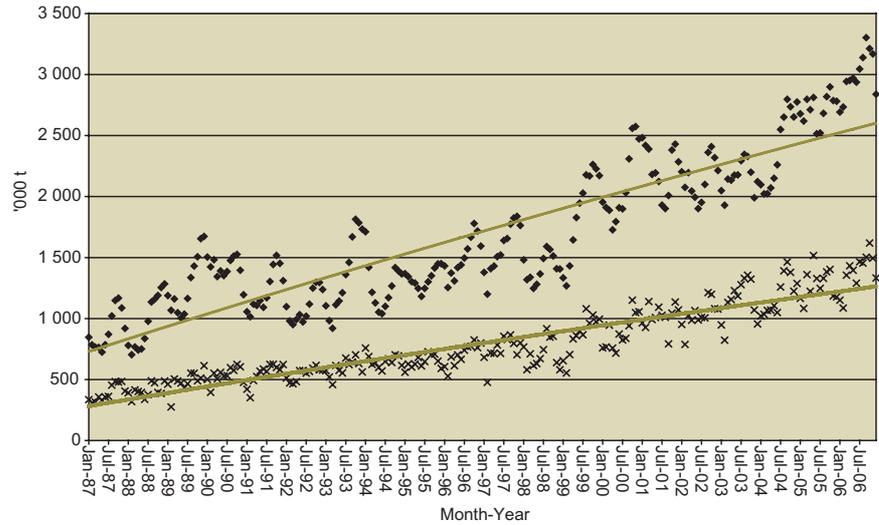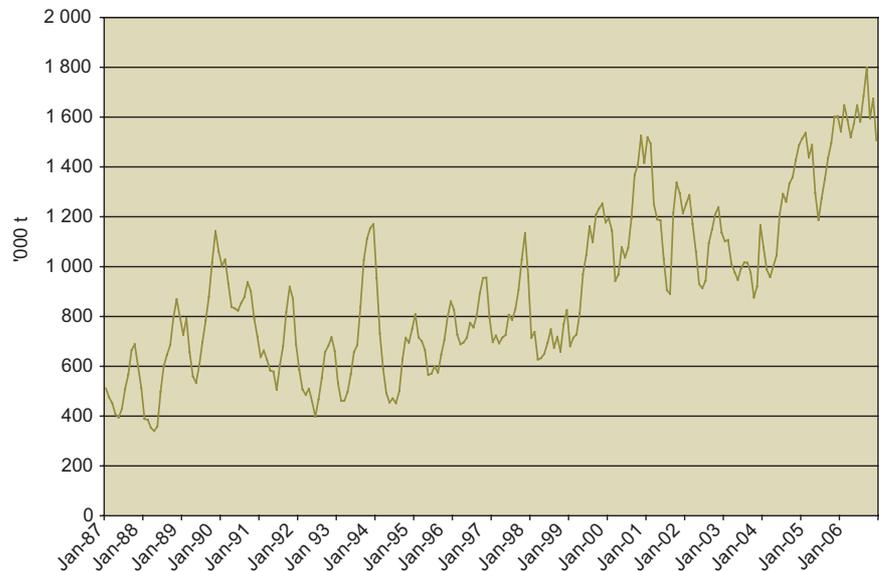

Figure 1. Monthly supply and demand of palm oil.

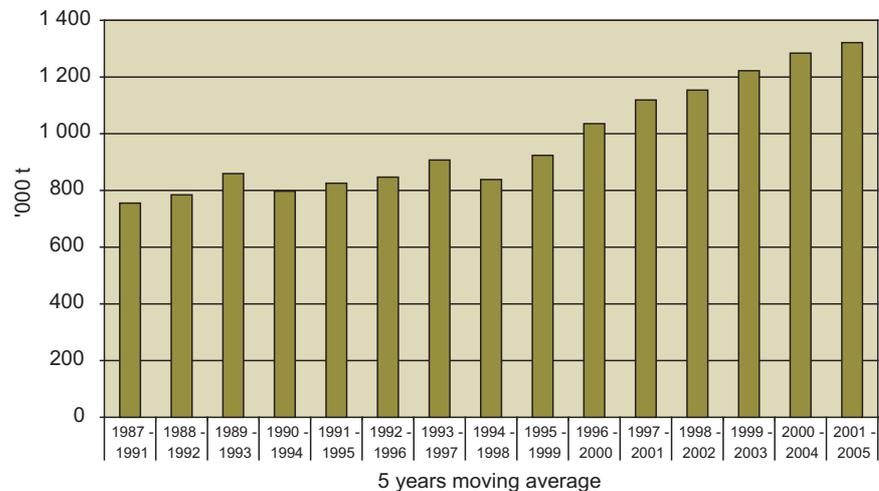
Figure 2. Monthly closing stock of palm oil.

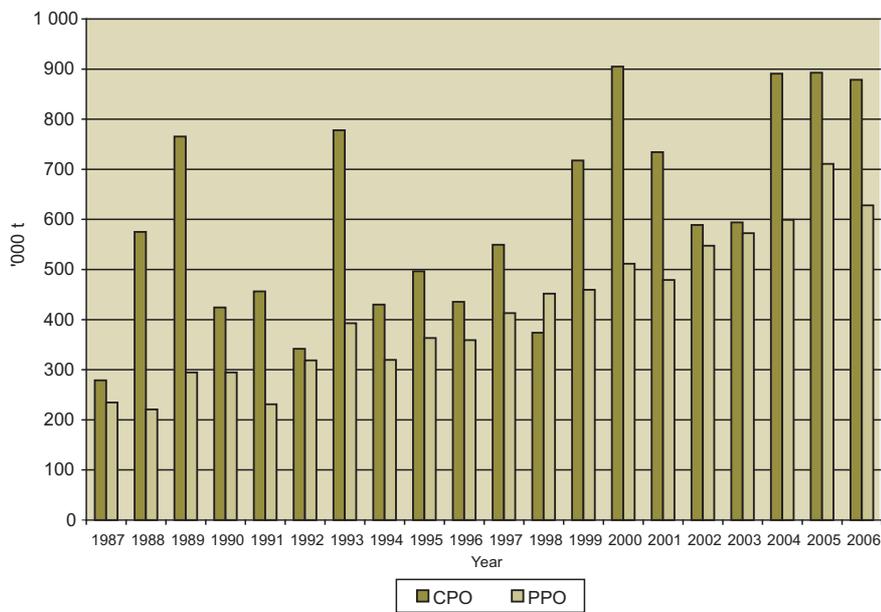*Figure 3. Five-year moving averages of ending stock of palm oil.*

Figure 4. Annual closing stock crude palm oil (CPO) and processed palm oil (PPO).

(CPO + PPO) since 1987. There is usually more CPO than PPO with approximate ratio 60:40, except in 1998 when PPO was more than CPO. The stock of CPO grew about 6% per annum, and showing abrupt increases in certain periods, closely following the production cycle of CPO. Meanwhile, the stock of PPO expanded 5% per annum, slightly slower than CPO but at consistent rate.

Table 1 shows the average daily demand for palm oil (export and domestic) since 1987. The daily export demand has increased annually by an average 1471 t to about 39 000 t in 2006, while the daily domestic demand has increased by 246 t every year to nearly 6000 t in 2006. Overall, the total average daily demand has escalated from merely 13 000 t in 1987 to 45 000 t in 2006.

The export demand comprises nearly 90% of the total demand, and it is mainly PPO, which constitutes about 80% of the total demand. The remainder is the domestic demand and CPO export demand. The average daily export demand of PPO has tripled from 11 000 t in 1987 to 33 000 t in 2006, while the daily export demand for CPO has grown also to register approximately 6500 t in 2006.

Figure 5 shows the days supply, whereby the total stock of palm oil can last within 30 to 45 days, with an average of 41 days. In 1988, 1989, 1993 and 2000, the duration was found rather lengthy, *i.e.* more than average due to higher stock level.

The stock of PPO can meet the requirement of PPO export demand for at least 15 days in 1991 or at most 24 days in 1993. Overall, the average days supply for PPO is about 20 days.

Meanwhile *Figure 6* shows three-year moving average of palm oil days supply that gradually dropped from 55 days (1987/1989) to 45 days (1993/1995) 39 days (2000/2002) and 36 days (2004/2006) illustrating a trend in the industry to more efficient inventory management systems (Considine, 2002).

Based on the daily palm oil demand of 45 426 t in 2006, the appropriate stock level should be 1.36 million tonnes to 1.82 million

TABLE 1. AVERAGE DAILY DEMAND* OF PALM OIL						
Year	Export (t)			Domestic (t)	Total (t)	Export PPO share (%)
	CPO	PPO	Total			
1987	468	11 090	11 557	1 239	12 797	86.7
1988	59	11 837	11 896	1 437	13 333	88.8
1989	53	14 172	14 225	1 723	15 947	88.9
1990	257	15 434	15 692	1 984	17 675	87.3
1991	246	15 023	15 269	2 712	17 981	83.6
1992	196	15 050	15 247	2 741	17 987	83.7
1993	161	16 599	16 759	2 785	19 544	84.9
1994	151	18 343	18 494	3 004	21 498	85.3
1995	47	17 796	17 844	3 358	21 202	83.9
1996	189	19 570	19 759	3 437	23 196	84.4
1997	86	20 435	20 520	3 962	24 482	83.5
1998	113	20 338	20 452	2 999	23 451	86.7
1999	718	23 699	24 421	4 094	28 514	83.1
2000	1 091	23 790	24 879	4 375	29 255	81.3
2001	3 495	24 881	29 109	4 322	33 431	74.4
2002	3 194	29 109	29 825	4 117	33 942	85.8
2003	3 396	29 825	33 606	4 158	37 764	79.0
2004	3 629	30 824	34 419	4 892	39 304	78.4
2005	4 415	32 422	36 837	5 366	42 203	76.8
2006	6 511	33 004	39 516	5 910	45 426	72.7

Note: *Annual demand divided by 365 days.

tonnes to fulfill normal demand for 30 to 40 days. Hence, for an average 41 days supply the necessary stock is 1.86 million tonnes, which is higher than the closing stock in 2006 of 1.51 million tonnes. The level would meet daily demand for 33 days, while 1 million tonnes stock level would only be sufficient for 22 days supply, which is less than a month.

For PPO, about 660 080 t stock is needed to meet the daily demand of 33 004 t for the average days' supply, *i.e.* 20 days. Since PPO export demand is more critical in the trading of Malaysian palm oil, particularly the lead-time from harvesting the fruits to producing PPO ready for shipment. This is shown in *Table 2*. It requires 16 days, which is less than the average day's supply of PPO at the current rate of PPO export demand. There seems, therefore, little likelihood of stock-outs.

However, with palm oil stock at 1 million tonnes stockouts seem quite possible, especially if only 40% of the amount of stock is PPO, which would only be a 12 days supply, less than the 16 days required to produce fresh PPO from the fruits. This calculation suggests that 1 million tonnes is an insufficient stock level with shortages likely to occur. Hence, based on 616 480 t PPO stock for 20 days' export and a CPO: PPO ratio of 60:40 the CPO stock should be 925 260 t that add up the total palm oil stock approximately at 1.54 million tonnes.

Figure 7 plots the palm oil closing stocks for each year with the demand volumes for 30 days and 40 days. The lower line (stock for 30 days' demand) crossed the 1 million tonnes level in 2000/2001, while the upper line (stock for 40 days' demand) did so in 1998/1999 which coincided with the palm oil stock then. *Figure 7* also shows that the palm oil stock
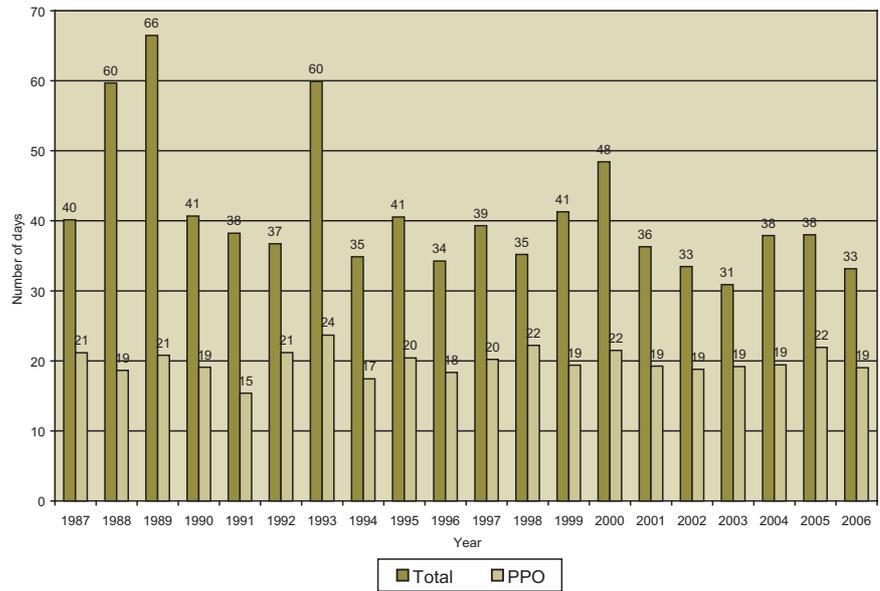

Figure 5. Days supply of closing stock of total palm oil and processed palm oil (PPO) (1987-2006).
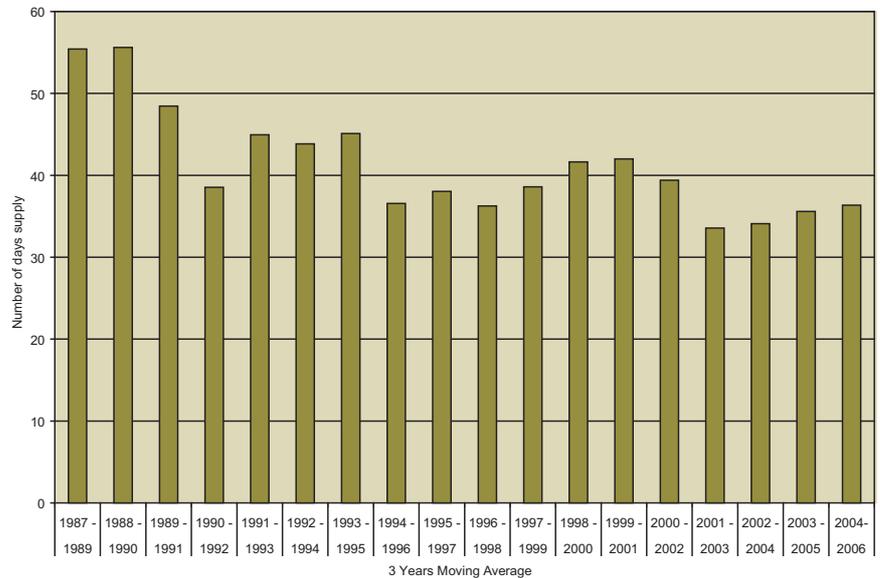

Figure 6. Three-year moving averages of palm oil days supply.

TABLE 2. LEAD TIME (by activity) FROM FRUIT HARVESTING TO PRODUCING PROCESSED PALM OIL (PPO) READY FOR EXPORT	
Activity	**Days**
Oil extraction from fruits in PO mill	2
Transport of CPO to refinery	1
Storage (pending use) in refinery	2
Refining	1
PPO holding stock	2
Transport of PPO to bulking installation	1
Stock build-up ready for shipment and awaiting vessel	7
Total	16

Source: excerpt from Chang (2003).

has generally remained at 40 days' supply, only occasionally deviating (up and down) substantially. It has been consistently higher than the level for 30 days' supply. Therefore, it does seem appropriate that the palm oil stock level should be adequate to serve demand for 40 days.

In the simulation exercise, data from 2006 were used as the initial values, *i.e.* opening stock 1 603 801 t, production 15 880 786 t, import 489 269 t, export 14 423 168 t and closing stock 1 506 586 t. The domestic demand was calculated at 2 044 102 t.

Table 3 shows the average logarithmic growth rates of production and import, which is 6.6% and 9.0%, respectively. On the demand side, the average growth rate of export is 6.4%, while domestic demand grew 8.1% annually. The standard error for each average is also provided for simulation purposes.

Based on assumption that each component was independent of each other, and the underlying distribution for the summarized data was Gaussian distribution, random values for each component was generated by the computer. The trial generated 1000 runs to simulate Equation 2 that would calculate the closing palm oil stock. Then, the results was sorted in ascending order and summarized in *Table 4*.

The average value calculated from the simulation trial was 1 515 766 t as compared to the real value of closing tock in 2006, *i.e.* 1 506 586 t, and the difference was only 9180 t or 0.61%.

Table 4 shows the probability of palm oil stock would be <1 million tonnes was only 10%, and implied that 90% or very likely that the stock of palm oil would be more than 1 million tonnes. However, the condition for the palm oil stock to be < 1 million tonnes required the average export and domestic

demand growth rates of 8.4% and 9.9% respectively, and also the average production growth rate of 4.6% and negative growth for import. It is noted also that the

growth rate of palm oil export should be doubled of that production.

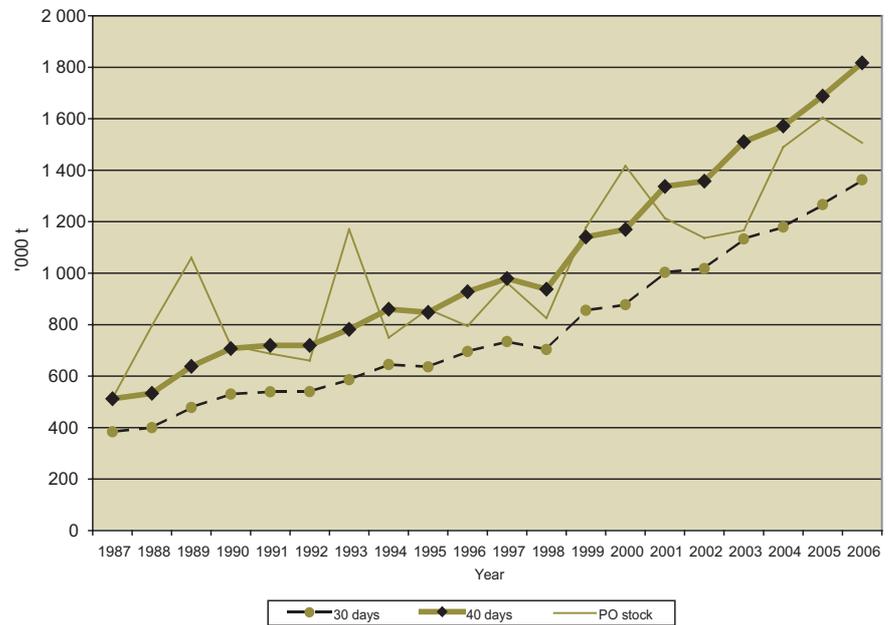Palm oil stock will be <1.5 million tonnes if the export grows

Figure 7. Palm oil closing stock and 30 days' and 40 days' demand volumes for palm oil.

TABLE 3. AVERAGE AND STANDARD ERROR OF PALM OIL PRODUCTION, IMPORT, EXPORT AND DOMESTIC DEMAND GROWTH RATES

	Production	Import	Export	Domestic
Average	0.0660	0.1019	0.0647	0.0822
Standard error	0.0171	0.2542	0.0150	0.0301

TABLE 4. PROBABILITY OF VARIOUS LEVELS OF PALM OIL STOCK AT DIFFERENT GROWTH RATES OF PALM OIL PRODUCTION, IMPORT, EXPORT AND DOMESTIC DEMAND

Stocks (million tonnes)	Probability (%)	Annual growth rate (%)			
		Production avg* = 6.6	Import avg = 1.0	Export avg = 6.5	Domestic avg = 8.2
< 1.00	10.0	4.6	-2.4	8.4	9.9
1.00 – 1.09	5.2	5.3	-3.0	7.5	10.1
1.10 – 1.19	7.2	5.7	1.2	7.6	8.8
1.20 – 1.29	5.8	5.9	6.1	7.3	9.0
1.30 – 1.39	9.8	6.2	6.8	6.9	9.1
1.40 – 1.49	9.7	6.4	15.6	6.7	8.5
1.50 – 1.59	10.8	6.8	13.9	6.4	8.6
1.60 – 1.69	10.0	7.2	22.9	6.4	8.6
1.70 – 1.79	8.0	7.6	20.0	6.2	8.3
1.80 – 1.89	7.2	7.9	17.5	5.9	7.3
1.90 – 1.99	5.3	8.3	21.6	5.6	8.4
> 2.00	11.0	9.1	27.0	5.0	7.6

Note: avg* =average.

faster than production with considerable increases in imports and domestic demand. The probability of palm oil stock to be between 1 million tonnes to 1.5 million tonnes was about 38%.

However, considering that production growing slightly faster than exports, it is likely that the stock will be between 1.5 million tonnes to 1.6 million tonnes, as shown by average production growth of 6.8% versus export of 6.4%. Finally if production grows by > 8% while export by only 5%, then the stock may exceed even 2 million tonnes, although the possibility is quite low.

CONCLUSION

The volume of palm oil stock is an important indicator of the supply and demand situation of the industry, and, more importantly, can directly influence the product price. Basically, low stock is preferred as it implies higher demand relative to the supply, but a certain level is required to ensure a certain level of trade to avoid stockout.

The stock of palm oil would be <1 million tonnes is unlikely to recur, although possible only if export grows faster than production. Furthermore, at the current rate of palm oil requirement approximately at 45 426 t/day stock of 1 million tonnes can only supply 22 days' demand for palm oil, and 12 days for PPO. This situation risks stockouts and can tarnish the image of Malaysian palm oil by its 'irregular' supply. Therefore higher stock is required.

Based on requirement of 616 480 t PPO stock for an average 20 days' supply, and also a CPO: PPO ratio of 60:40 the CPO stock should be about 925 260 t, and made up the total palm oil stock at 1.54 million tonnes.

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