Production and Price Forecast for Malaysian Palm Oil

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ABSTRACT

In the oils and fats sector, Malaysia can always be associated with palm oil due to its being the world's biggest producer and exporter of the commodity. Malaysia produces and exports most of its palm oil due to its small population size and receives quite substantial amount of revenues from this product to support its economy. Thus, in this respect, it is important for the country to monitor the commodity's production as well as its price that can be used in a way to determine the country's revenue or in various decision-making processes. It is the objective of this paper then to analyse them econometrically and finally to forecast them. The paper indicates that production of palm oil will increase at a decreasing rate in future due to limited availability of land. By 2020, production is expected to reach 22 million tonnes while in the short-term, it will be about 15.9 million tonnes in 2006. Price of palm oil is expected to fluctuate as before but in the near future, strengthening its level by increasing gradually in 2006.

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INTRODUCTION

In the oils and fats sector, Malaysia is very well-known as the world leader of palm oil in terms of production and export. This is due to the tremendous increase in production and export volumes and thus, the world's biggest producer and exporter of the commodity until presently.

The success story of the Malaysian palm oil industry was due to the synergistic efforts of the Malaysian Palm Oil Board (MPOB) and the industry in carrying out R&D and marketing activities. These non-stop efforts have led to higher production and exports, making palm oil always readily available in the world market. If one tries to imagine if palm oil were not traded in the total oils and fats sector, there could be a shortage of 23 million tonnes in 2004 and as a result the world will suffer with the increase in prices of oils and fats due to the shortage. Hence, palm oil is needed to feed the world and to soften the world prices of oils and fats.

As the leader in the palm oil industry, it is worthwhile monitoring the development of its crude palm oil (CPO) production and price. This involves monitoring its development in the past as well as into the future which then becomes the objective of this paper. The paper is divided into three sections. The first section deals with production of CPO which covers its past as well as its future development. The price of CPO is dealt with in the second section, similarly covering its development in the past and its expected price in future. The third section is the conclusions of the paper.

PRODUCTION OF CRUDE PALM OIL AND ITS FORECAST

Malaysian palm oil production had been accelerating at a rapid rate in the past, especially prior to 1980s. The country recorded about 186% growth rate in palm oil production during the period of 1970 to 1975 and about 105% for the period of 1975 to 1980 (*Table 1*). The rapid growth prior to 1980s was due to the significant increase in area planted and thus, led to the increase in matured areas. While the industry was still being considered as a new industry to the country at that time, it had attracted many investors and hence, many new areas were converted into and planted with oil palm trees. In the 1980s, 1990s, and 2000s, the production growth rates declined from 61% in the period of 1980 to 1985 to 28.9% for the period of 2000 to 2004. The declining growth rate towards the millennium indicates limited availability of land areas for oil palm expansion especially in West Malaysia and Sabah. Sabah was just about to experience the limitation starting from the millennium. Sarawak, however, still indicates a significant expansion in production due to availability of land in the state.

The yield per hectare can be said to be stagnant during the period of 1975-2004, as can be seen in *Figure 1*. Thus, the factor that really pushed production high every year is mainly the increase in matured area. This is the productive area and it can be seen that it increased from 1975 to 2004. As planted area increased every year, there will be a multiplication of matured oil palm trees and this will go on in the following years. As a result, we can expect an increase in production every year due to the increase in matured areas.

Table 2 shows the development of palm oil production in Malaysia for the past 10 years. The percentage growth of production in the country can be seen in the last column of *Table 2*. The growth rates fluctuated. However, it is interesting to note that when the production experienced negative growth in one year, it was then followed by a significant positive growth (recovery) in the following year. From *Table 2*, it can be seen that production declined in 1994 by -2.47% from the previous year. In the following year, production recovered by having a positive growth of 8.17% to reach 7.8 million tonnes level. Four years later in 1998, the oil palm trees had been over productive and the industry again experienced a drop in production by -8.26% from 9.1

TABLE 1. MALAYSIAN PALM OIL PRODUCTION AND PLANTED AREA (1975-2004)

Year	Planted Area ('000 ha)				CPO Production ('000 t)			
	Malaysia	West Malaysia	Sabah	Sarawak	Malaysia	West Malaysia	Sabah	Sarawak
1970	261	261	-	-	440	402	-	-
1975	642	569	59	14	1 258	1 137	116	5
1980	1 023	907	94	23	2 573	2 397	157	22
1985	1 482	1 292	162	29	4 134	3 799	285	49
1990	2 029	1 698	276	55	6 095	5 302	679	108
1995	2 540	1 903	518	119	7 811	6 095	1 494	222
2000	3 377	2 046	1 001	330	10 842	7 212	3 110	520
2004	3 875	2 202	1 165	508	13 976	8 094	4 766	1 117
5-year growth (%):								
1970-1975	146.0	118.0	-	-	186.0	182.8	-	-
1975-1980	59.4	59.4	58.9	61.4	104.6	110.8	34.7	396.7
1980-1985	44.9	42.6	71.9	25.3	60.7	58.5	81.9	118.1
1985-1990	36.9	31.4	71.0	92.2	47.4	39.5	138.2	119.4
1990-1995	25.2	12.1	87.6	116.8	28.2	14.9	120.0	106.6
1995-2000	32.9	7.5	93.2	178.1	38.8	18.3	108.2	133.9
2000-2004	14.8	7.6	16.5	53.9	28.9	12.2	53.2	114.6
1975-2004	503.8	287.2	1 870.6	3 507.3	1 011.4	612.0	3 999.0	24 553.3

Source: MPOB.

million tonnes in 1997 to 8.3 million tonnes in 1998. Production recovered in 1999 and over-produced palm oil by 21.67% to reach 10.1 million tonnes. Another round of peak production can be observed in the year 2003 when it reached 13.4 million tonnes, indicating an increase by 12.1% from the previous year. What this all means is that there is a cyclical nature of the oil palm trees where it repeats the peak production for every four years. West and East Malaysia also showed the same pattern of production cycles during the past 10 years.

In 1975, production of CPO by Malaysia was 1.3 million tonnes which was about 44% of the world production of palm oil (*Table 3*). The country was the largest producer then and had become a significant contributor of palm oil supply in the world. The share increased for the next 10 years until 1985 with a share of 59.3%. After this year, the proportion of Malaysian palm oil production from the world production of the same commodity declined toward 2004 where the proportion equalled 45.6%. This is due to the active participation of Indonesian palm oil in world production in the last few years which gradually affected the Malaysian share.

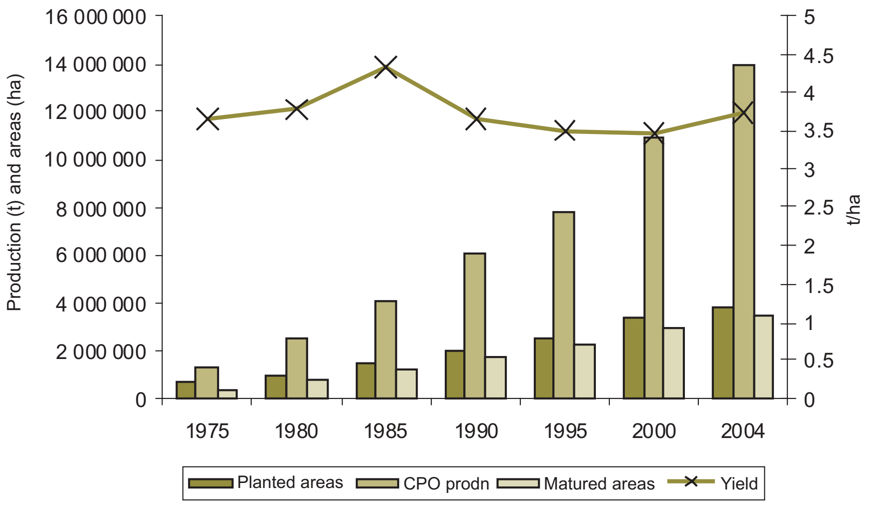

Figure 1. Area, yield and production by Malaysian palm oil industry.

TABLE 2. DEVELOPMENT OF MALAYSIAN PALM OIL PRODUCTION (1994-2004) ('000 t)

Year	West Malaysia	% Growth	East Malaysia	% Growth	Malaysia	% Growth
1994	5 920	-4.37	1 301	7.23	7 221	-2.47
1995	6 094	2.96	1 716	31.89	7 811	8.17
1996	6 407	5.13	1 979	15.31	8 386	7.36
1997	6 612	3.20	2 456	24.14	9 069	8.14
1998	5 994	-9.35	2 326	- 5.31	8 320	-8.26
1999	7 222	20.49	2 900	24.70	10 122	21.67
2000	7 212	-0.15	3 631	25.18	10 842	7.11
2001	7 477	3.69	4 326	19.17	11 804	8.87
2002	7 019	-6.13	4 890	13.03	11 909	0.89
2003	7 945	13.19	5 410	10.62	13 355	12.1
2004	8 094	1.88	5 882	8.73	13 976	4.65

Source: MPOB.

TABLE 3. PRODUCTION OF CPO, OILS AND FATS IN MALAYSIA AND IN THE WORLD ('000 t)

Year	Malaysian CPO production	World CPO production	World oils and fats production	Malaysian CPO production from world CPO production (%)	Malaysian CPO production from world oils and fats production (%)
1975	1 258	2 858	44 933	44.0	2.8
1980	2 573	4 619	57 049	55.7	4.5
1985	4 134	6 975	68 892	59.3	6.0
1990	6 095	10 953	80 674	55.6	7.6
1995	7 811	15 211	94 926	51.4	8.3
2000	10 842	21 868	114 758	49.6	9.4
2004	13 976	30 657	131 149	45.6	10.7

Sources: MPOB and Oil World.

Out of the total production of oils and fats, Malaysian's share of production of palm oil was about 2.8% in 1975. Unlike its share from world palm oil production, this share had increased over the years since that year. So from 2.8% in 1975, the share gradually rose to 10.7% in 2004. This means that Malaysian share had taken over some shares of other commodities in the world market.

As mentioned earlier, it is the increase in matured area that really raises the production volume of CPO. Thus, an analysis of production should involve this variable in the model meant for forecasting long-term production of CPO in Malaysia. The model also includes yield in addition to matured area. Implicit in the model is the computation of matured areas based on age distribution from year 1 to year 30 for each year understudied.

$$Prodn_t = MaturedArea_t * ExpectedYield_t \quad \text{..............(1)}$$

where t = time,

$Prodn_t$ = CPO production in Malaysia at time t,

$MaturedArea_t$ = Matured area at time t,

$ExpectedYield_t$ = expected yield at time t,

$$ExpectedYield_t = \frac{\sum_{age=3}^{age=30}(MaturedArea_{age} * ExpectedYield_{age})}{\sum_{age=3}^{age=30} MaturedArea_{age}} \quad \text{.........(2)}$$

For short-term production of Malaysian CPO, another model is involved. In this model, the trend from the long-term forecast and rainfall variable will be incorporated into. For short-term, forecast is normally made in December every year for projection in the coming year. The model for short-term is:

$$MonthlyProdn_t = f(Rainfall_t, \text{Long-term } trend_t), \quad \text{.........(3)}$$

Long-term forecast of Malaysian palm oil production is shown in *Table 4* for production starting from 2005 to 2020. We expect production to reach 15.434 million tonnes in 2005, a significant increase by about 10.16% from the previous year. This is in fact not a peak year if we base on the four-year cycle of palm oil production which would happen in 2006/2007 (the previous peak was recorded in 2003). Thus, this growth is not due to the biological nature of the trees, but mainly due to the increase in matured areas as a result of the replanting programme introduced by the government in 2001/2002. Matured area is expected to reach 3.7 million hectares in 2005, an increase of about 6.9% from 2004. Hence, we project production this year to be about 15.4 million tonnes.

It is projected that production will continue to increase in the future. In 2010, production is expected to increase to 18.7 million tonnes, an increase of 20.9% during the five-year period, and to 20.15 million tonnes in 2015 and to 21.8 million tonnes in 2020.

Table 4 also shows production in short-term for 2006. Production is estimated to be around 15.9 million tonnes, a marginal increase of about 3.3% from 2005. The yield is estimated to be about 4.09 t/ha while the matured area about 3.9 million hectares.

MALAYSIAN PALM OIL PRICE AND FORECAST

As shown in *Figure 2*, prices of Malaysian CPO at Rotterdam market have been fluctuating from quarter to quarter. In the first quarter of 1990, price of palm oil was USD 278/t. Toward fourth quarter of 1993, price gradually increased to USD 367/t while fluctuating along the way. Since then price suddenly surged, making a sudden change in the trend to reach USD 680/t in the fourth quarter of 1994. Price again fluctuated in the range of USD 500 to USD 700/t from 1994 to 1998. From 1998 to 2001 (second quarter), price again made a sudden downward jump in price, reaching USD 246/t in the second quarter of 2001. From 2001 until now, it looks like price of palm oil started to recover from its low in 2001. This similar pattern is also illustrated by the soyabean oil price series. Both indicate that there is high volatility in prices of oils and fats generally in the world market.

A detailed analysis of the palm oil series indicates that there were two significant points where we believe there could be structural breaks in the series. The first one is at the 1993 point of time (third

TABLE 4. LONG-TERM FORECAST OF MALAYSIAN PALM OIL PRODUCTION

Year	CPO production (million tonnes)	Production growth (%)
2002	11.909	*0.89*
2003	13.355	*12.1*
2004	13.976	*4.65*
	Forecast	
2005 (2006)	15.434 (15.9)	*10.16 (3.02)*
2010	18.656	**20.9**
2015	20.147	**8.0**
2020	21.814	**8.3**

Notes: Number in bold is the five-year production growth (%).
Number in italic is the annual production growth (%).

quarter with USD 356/t) and the second one is at the fourth quarter of 1998 with USD 679/t. A test on the structural breaks had been carried out using the Chow breakpoint test and Chow forecast test. Both tests showed that there were significant structural changes in palm oil series.

If the series has breaks, the chance is that it is non-stationary. To model non-stationary series using ordinary linear regression (OLS) method where fixed parameter coefficients will be estimated is not an appropriate approach because there will be a violation of one of the classical assumptions of OLS. Under OLS, fixed coefficients will be estimated and a straight line will be applied throughout the sample period where in actual fact the price series is non-stationary. Theoretically, the approach produces the best fitted straight line for the series by minimizing the sum of squares of errors (between the actual price and the predicted price). If the series is non-stationary the sum of squares of errors could be very big, thus, the model loses its forecasting power.

The approach (OLS) is the traditional method of finding a relationship for the variable to be explained, for example price of palm oil, using appropriate explanatory variables. Since price is determined by the supply and demand factors, one of the appropriate explanatory variables is the price of substitute which in this case is soyabean oil price. This is a very popular variable and many economics forecasters use price of substitute to explain price of the commodity to be analysed. Ending stocks of oils and fats and consumption of oils and fats are other variables that need to be considered. However, these two variables will not be used directly but will be converted into a ratio called stock-usage ratio (SUR).

$$SUR_t = \frac{endstok_t}{consumption_t}, \quad \ldots\ldots\ldots(4)$$

where
$endstok_t$ = ending stocks of oils and fats at time t, and
$consumption_t$ = consumption of oils and fats at time t

A low SUR at one point of time compared to its value in the previous time means stock of oils and fats is very low compared to consumption and a movement to a low SUR will indicate a better price for palm oil (an improvement) due to the decrease in stock volume of oils and fats. If the opposite happens, it has an indication of poor price performance or price to decline.

All the variables (except stock-usage-ratio) need to be transformed into natural logarithm since they are non-stationary. They become stationary after the transformation. Thus, the OLS model is specified as:

$$CPOP_t = \beta_1 * SBOP_t + \beta_2 * CPOP_{t-1} + \beta_3 * SUR_t + \alpha, \quad \ldots\ldots\ldots(5)$$

where $CPOP_t$ = natural log of price of palm oil at time t,
$SBOP_t$ = natural log of price of soyabean oil at time t,
SUR_t = oils and fats stock-usage ratio at time t,
β_1, β_2, β_3 and α are coefficients to be estimated

The sample data to be used for estimating the model ranged from 1990:1 to 2002:4. The estimation yielded an equation as below:

$$CPOP_t = \underset{(5.77)}{0.334} * SBOP_t + \underset{(11.16)}{0.6618} * CPOP_{t-1} - \underset{(-0.088)}{0.000177} * SUR_t \quad \ldots\ldots\ldots(6)$$

R^2 = 0.92; D.W. = 1.29, RMSE =0.127, MAE=0.107, MAPE=1.78
U-Theil statistic = 0.01
Bias proportion = 0.0017,
Variance proportion = 0.619
Covariance proportion = 0.379
Numbers in parenthesis are the *t*-statistics.

The model is quite a perfect fit for the actual scenario based on the high R^2 and D.W statistic of 1.29. All the variables are very significant except the stock-usage ratio (SUR) with small t-statistic of -0.088. They, however, have correct signs as expected. The model has small root mean squared error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). It can be used to forecast price of palm oil.

Another method which is considered as a more challenging one is the time varying parameter (TVP) model for forecasting palm oil price. The same regression model (Equation 5) is applied. Nevertheless, the coefficients of the

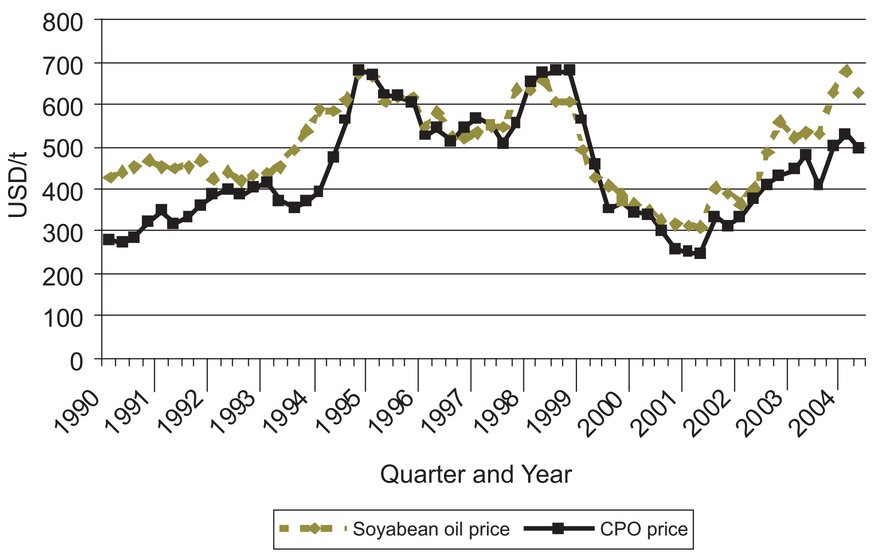

Figure 2. Prices of Malaysian palm oil and soyabean oil (USD/t).

parameters are allowed to vary according to time, unlike the OLS approach which treats the coefficients as constant numbers in the sample period. Hence, the coefficients of TVP model will keep on changing according to time.

Although the same explanatory variables are used in the TVP model, they are firstly transformed into a state space form which will then be suitable to be estimated by the Kalman Filter (KF) approach. Therefore, the state space form of the above model is as follows:

$$CPOP_t = \alpha + \beta_1 SOP_t + \beta_2 SUR_t + \xi \quad \text{...............(7)}$$

where the variables are defined as before, the β_1 and β_2 are the state variables which are assumed to follow autoregressive process of order one,

i.e. $\beta_1 = \phi\beta_{1t-1} + R_t\delta_{t-1}$, and ....(8)
$\beta_2 = \phi\beta_{2t-1} + R_t\delta_{t-1}$ ....(9)

In matrix form, Equations 7, 8 and 9 can be represented as:

$Z_t = Hx_t + V_t$, ...(10)
$x_t = Ax_{t-1} + Bu_{t-1} + W_{t-1}$ ....(11)

where Z_t is a [1 x 1] matrix containing price of palm oil variable,
H is [2 x 1] matrix of parameters. It might change with each time step or measurement,
x_t is [1 x 2] matrix of coefficient parameters,
Equation 10 is called the measurement or observation equation while Equation 11 is called transition equation,
W_t and V_t are process noise and measurement noise respectively. They are independent of each other (white noises). Both of them follow a normal probability distribution. *i.e.*, P(W) ~ N(0,Q) and P(V) ~ N(0,R), where Q and R are the covariances of the transition or process and measurement respectively.

In the state space form, we can use the KF algorithm to estimate the state. The algorithm is a set of mathematical equations that provides an efficient computational (recursive) means to estimate the state of a process, in a way that minimizes the mean of the squared error. It can be divided into two sets of equations, namely time update equations and measurement update equations as shown in *Figure 3*.

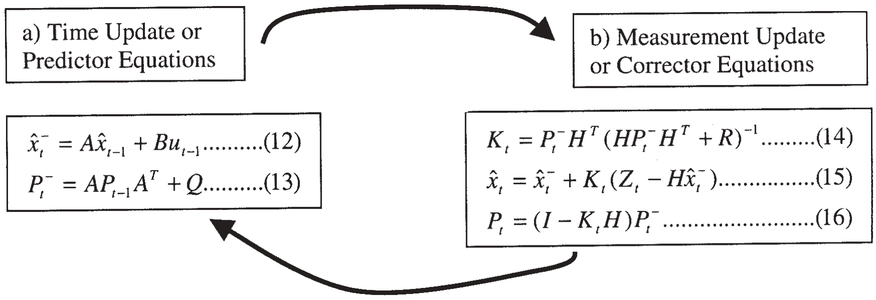

Figure 3. The Kalman Filter algorithm.

The set of time update equations project the state (Equation 12) and covariance (Equation 13) estimates forward from time step *t-1* to step *t* using its own past information. Once the estimates are obtained and a new actual observation or measurement Z_t is available, the state is corrected using the predicted estimates and the measurement Z_t. Predicting and correcting the state variable complete one round of time and measurement update pair.

The process is repeated after the completion of each round. This time we use the previous state estimates to project or predict the new estimates. We can see that the KF process uses a form of feedback control; the filter estimates the process state at some time and then obtains feedback in the form of noisy measurement.

Estimation of the TVP model by the KF algorithm, using sample data from 1990:1 to 2002:4 yielded an equation as follows:

$CPOP_t = -93.8493 + \beta_1 SBOP_t + \beta_2 SUR_t$, where the state variables are
$\hat{\beta}_{1t|t-1} = \theta\hat{\beta}_{1t-1}$ and $\hat{\beta}_{2t|t-1} = \theta\hat{\beta}_{2t-1}$
RMSE = 0.0044

Between the two models based on OLS and TVP approach, it can be seen that the latter produced a smaller RMSE, meaning it has a better forecasting power and in most of the time, the forecast prices were very close to the actual prices. As a result, the TVP model is preferred to OLS model and has been used in this paper.

The model then has been used to carry out ex-post forecast from 2003:1 to 2005:2 (*Table 5*) and later ex-ante forecast for the period of 2005:3 to 2006:4 (*Table 6*).

It can be seen very clearly that the out of sample forecasts were very close to the actual price of palm oil. The model under-

TABLE 5. EX-POST FORECAST OF MALAYSIAN PALM OIL PRICE (USD/t) BY TVP MODEL

Year	Quarter	Actual CPO price	Forecast price	Forecast error
2003	1	445	442	3
	2	479	473	6
	3	408	398	10
	4	499	472	27
2004	1	527	499	28
	2	497	489	8
	3	432	444	-12
	4	429	434	-5
2005	1	416	425	-9
	2	422	418	4

TABLE 6. EX-ANTE FORECAST OF MALAYSIAN PALM OIL PRICE (USD/t) BY TVP MODEL

Year	Quarter	Actual CPO price	Forecast price	Forecast error
2005	3	416	425	-9
	4	422	418	4
2006	1	439	430	9
	2	-	395	-
	3	-	413	-
	4	-	445	-

estimated the price from as low as USD 28/t in the first quarter of 2004 and overestimated it from as high as USD 12/t in the third quarter of the same year.

Table 6 shows the ex-ante forecast for the third quarter of 2005 until fourth quarter of 2006. *Table 6* shows that future price of palm oil in short-term will be strengthened and firmed with prices ranging from USD 416 in the third quarter of 2005 to USD 445 in the fourth quarter of 2006.

CONCLUSION

Malaysia has been recognized as the world leader in palm oil, due to it being the biggest producer and exporter of the commodity in the world. Production of palm oil by the country has been increasing in the past and is expected to increase at a slower rate in future than before. This means that Malaysia's premier positions as the world's biggest producer and exporter will be challenged in future. Due to this, it is important for the country to monitor its future production and future direction of palm oil price.

Production of palm oil is estimated to reach 15.4 million tonnes in 2005 and 15.9 million tonnes in 2006. In long-term, it may reach 21.8 million tonnes. Price of palm oil is expected to be more strengthened and more firmed in 2006 while maintaining its volatility.

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