Improving Mill Oil Extraction Rate under the Malaysian National Key Economic Area

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ABSTRACT

Increasing oil extraction rate (OER) to 23% by 2020 is the aim of the fourth Entry Point Project (EPP) under the palm oil National Key Economic Area (NKEA). The national OER over the years have not made significant improvements due to the inconsistent quality of fresh fruit bunches (FFB) supplied to the mills coupled with inefficient machinery installed in some old mills that had expanded but not their machinery resulting in high oil losses during operation. Several strategies were designed to ensure that the objective of NKEA is achievable. Now close monitoring of FFB quality is being implemented by adopting one mill one enforcement officer policy. As for the oil loss, strict protocol on managing oil loss at mill should be the basis for gauging oil loss. The strategies put forward by the NKEA Laboratory is a testimony to a joint understanding between the policy-maker (government) and the industry.

INTRODUCTION

Malaysian palm oil industry was the fourth largest component of the national economy in 2010 and contributes towards RM 53 billion of gross national income. Due to the limited availability of land for further development, the efficiency in production and development of downstream products were identified as vital factors in ensuring sustainability of the palm oil. These potentials have made the palm oil industry one of the National Key Economic Area (NKEA) designed by the government to increase the national income. Palm oil industry is targeted to contribute RM 125 billion gradually rising to achieve RM 178 billion national income by the year 2020.

Under the NKEA's vision, two strategic thrusts for the palm oil industry have been identified namely, upstream productivity and sustainability; and downstream expansion and sustainability. Five Entry Point Projects (EPP) under upstream productivity and sustainability will focus on improving upstream productivity generating an incremental Gross National Income (GNI) of RM 33.1 billion; and three EPP focusing on downstream expansion are targeted to generate an incremental GNI of RM 14.0 billion by 2020.

The Entry Point Project 4 (EPP4), one of the five EPP under upstream productivity and sustainability is targeted to increase oil extraction rate (OER) from current

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20.45% in 2010 to a revised 23% by 2020 by implementing strict quality-control measures at the estates and mills leading to the improvement of OER at the mills. The revised target was viewed by the industry during the NKEA workshop as more practical and achievable as compared to the old target of 25% by 2020. The new target was based on the past years performance of national average OER.

Oil Extraction Rate Trend

For the past 20 years, Malaysia's OER performance was not very impressive. Before 2004, the national OER average was below 19% and in 2004 for the first time since 10 years the national OER just managed to graze 20% mark by achieving 20.03% where it continued to linger for sometime until it reached 20.45% in 2010 (*Figure 1*). The contributing factors to the low OER performance can be attributed to controllable and uncontrollable factors. The controllable factors were low quality of FFB delivered to the mill and high oil loss resulting from the inefficiency of some old mills, whereas, the uncontrollable factors were weather, poor quality planting materials, *etc.*

Key Issues

The NKEA Laboratory had identified the key issues affecting the low OER performance. They are as follows:

Inconsistent qualities of fresh fruit bunches are delivered to palm oil mills. OER performance is influenced by the quality of FFB delivered to the mill. OER is the percentage of the weight of oil physically recovered from a known weight of FFB processed. The crude palm oil produced is a function of the determined quality of the FFB processed and the OER of the mill. Grading manual for FFB has been introduced to ensure quality FFB processed by the mill in order to achieve high OER.

Inefficient mills with relatively high oil losses to fresh fruit bunches exceeding 1.8%. Oil losses are inevitable during mechanical processing due to various factors, one among them being inefficient machinery. Normally oil losses occur in empty fruit bunches, press cake fibres, steriliser condensate, separator sludge, decanter cake, unstripped bunches and spillages. Usually, the milling oil losses due to mechanical extraction are poor

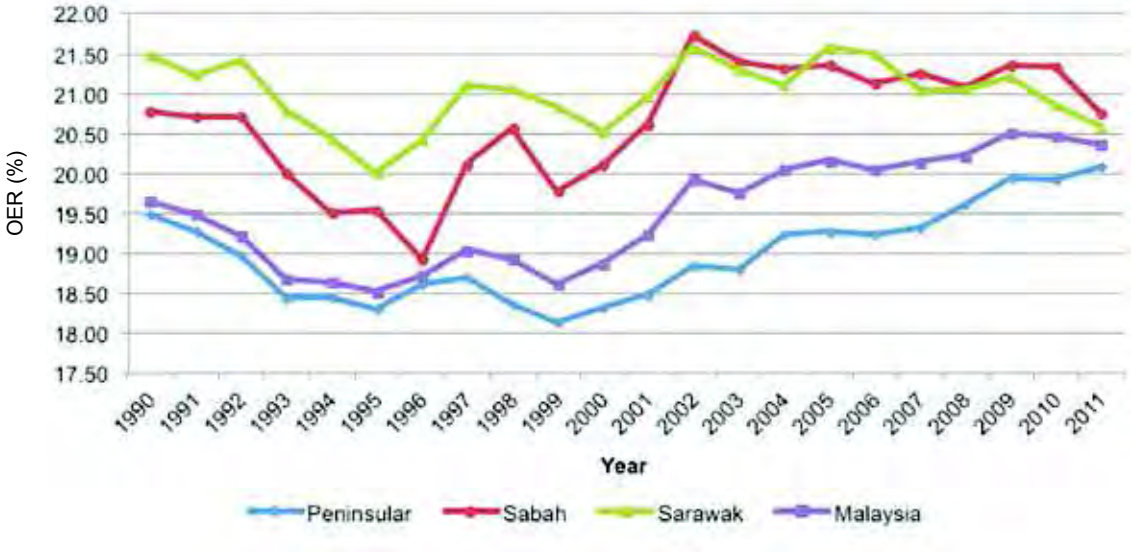

Figure 1. National average oil extraction rate (OER) trend from year 1990 to 2010 (%).

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production control and poor FFB quality. With palm product prices hovering close to the cost of production, the spotlight is on the milling process to ensure that product losses are well under control. Palm-based products, being mechanically extracted, can operate at different milling efficiencies. Losses hovering above targets can be inconspicuous and can escape detection easily. Altercations between estates and the mill at times of low OER are a serious matter with no pragmatic solution in sight. These result in stress and friction between personnel and create a dilemma for the top management. In addition, there are serious financial implications from 'poor control' of the milling process that leads to product losses.

- Insufficient boiler capacity to provide sufficient steam supply for mill operation.

  Some of the old mills have not upgraded their machineries especially boilers due to financial constraint or the 'profit over technology' attitude. Sufficient boiler capacity will improve supply of steam to maintain a stable temperature throughout the processing activities, *i.e.* sterilisation and oil recovery.

During the NKEA Laboratory discussion in September 2010, the following six strategies have been identified to address the key issues.

a. Improve the quality of FFB delivered to the mill with assistance from MPOB enforcement officers (EO);
b. Enforce proper grading of FFB consignments, based on guidelines published by MPOB;
c. Millers and FFB traders shall employ competent graders, certified by MPOB;
d. FFB price shall be based on the quality of FFB received;
e. Improve the milling efficiency; and
f. Enforce Good Milling Practice (GMP) in mills by mandating mill certification schemes like CoP or other similar standards.

Implementation

The ranking of all palm oil mills in Malaysia is based on the OER performance as well as the FFB source. The ranking exercise covers a three-year period of mill OER performance and the proportion of purchased crop to the total crop received by the mill. The rationale is that mills purchasing a high proportion of outside FFB may only achieve low OER as it has less control on quality of FFB received. The ranking exercise categorises mills as follows:

A - Mills that purchased more than or equal to 50% of their crop from outside and achieving less than 20% OER (comment: the word 'outside' crop must be included. This differentiates integrated and non-integrated mills. For *A*, it refers to non- integrated mills).
B - Subdivided into two categories: B1 - FELDA's mills.
B2 - Mills purchasing less than 50% of their total crop processed achieving more than 20% OER.
C - Mills processing 100% of its own crop (integrated mills).

Once the mill has been ranked according to this scheme, all mills regardless of their category are further clustered comprising maximum of five mills located within 50 km radius. A total of 103 clusters have been identified as shown in *Table 1.*

The ranking and cluster exercise enables MPOB to station EO at the locations where their presence would be beneficial, *e.g.* Category A mills will require EO to check on the FFB quality. For other categories, the quality off FFB intake will be closely monitored by MPOB's regional Enforcement Officers (REO) through the existing enforcement programme on zero

TABLE 1. NUMBER OF MILLS BASED ON GROUP AND CLUSTERS AS AT 31 DECEMBER 2010

State \ Category	A	B1	B2	C	Total	No. of clusters
Peninsular	100	58	59	30	247	60
Sabah	19	11	81	13	124	29
Sarawak	5	1	30	14	50	14
Malaysia	124	70	170	57	421	103

tolerance of unripe FFB. In March 2011, MPOB had employed 100 new EO to be stationed at 100 Category A mills and an additional of 86 officers were also recruited in July 2011. Details of which are given in *Table 2*.

The EO will ensure that only good quality FFB are received and processed by mills and no unripe bunches are delivered to the mills. Unripe FFB as defined in the *FFB Grading Manual* is a bunch which has black or purplish black fruits and the mesocarp is yellowish in colour. This bunch need not have any fresh sockets of detached fruitlets at the time of inspection at the mill. The sockets (if any) on the bunch are not due to normal ripening process. Study shows that in unripe FFB oil content is very low.

Safeguarding Fresh Fruit Bunches Quality

Further to stationing of EO at the mill, millers are also responsible for enforcing proper grading of incoming FFB, based on guidelines published by MPOB. Millers and dealers of FFB must employ competent graders, certified by MPOB towards safeguarding the quality of FFB.

MPOB had introduced the *FFB Grading Manual* in 1992 when the national OER was on the downtrend due to the declining quality of FFB processed. The Manual which was jointly prepared by MPOB and the industry outlined the different quality of FFB and the methodology of grading FFB. The Manual formed the basis of training of all millers, dealers and FFB producers on the standard quality requirement of FFB.

TABLE 2. TOTAL DEPLOYMENT OF ENFORCEMENT OFFICERS AS AT 30 SEPTEMBER 2011

State	1st intake	2nd intake	Total deployments	No. of mills in operation (as of 30 September 2011)	Balance
Peninsular	100	31	131	245	114
Sabah	-	50	50	123	73
Sarawak	-	5	5	52	47
Malaysia	100	86	186	420	234

However, the introduction of the Manual seem to have had little impact on the OER performance and thus, MPOB had taken further step by mandating the 5% tolerance policy on unripe FFB in 1997 and later the zero tolerance policy of unripe FFB in mid 2005 with an ambitious effort to improve the national OER. The implementation of these policies has shown positive effect on national OER when in 2009 OER was recorded at 20.49%, the highest since 1988.

Pricing of Fresh Fruit Bunches must be Based on Quality

It is pointless if efforts to produce quality FFB are not matched with a better price of FFB as a form of incentive to FFB producers. Currently, MPOB publishes the average FFB price by region based on the graded OER. However, the price only serves as a guide for negotiation puposes between buyer and seller. Currently, MPOB enforces the premium price pemium quality policy to encourage buyers to purchase FFB based on quality and to pay premium price. The policy requires dealers and millers to show their purchase price of the day based on the graded FFB.

Milling Efficiency

A total of 419 mills across Malaysia were surveyed for evaluating oil losses. The survey forms were distributed in October 2010. Mills were given two months to submit the forms. The survey classified the mills based on the total oil losses from five sampling points which are: poor performing mills (> 1.8% oil loss), average performing mills (oil loss 1.3% – 1.8%) and good performing mills (oil loss < 1.3%). However, there were a number of mills which did not submit the relevant data as requested. *Figure 2* shows the results of the survey on oil losses from 217 mills which responded.

The results show that about 58% of the mills operated with moderate efficiency, while 18% performed well. There are several factors that contributed to these such as adopting new technologies, good monitoring on the oil quality parameters, oil recovery technologies, *etc.* However, about 24% of the surveyed mills operated in poor condition and the factors contributing to this problem will be investigated.

A protocol for measuring oil losses has been prepared and presented to eight mills in the central region. The protocol will be known as *MPOB Protocol for Measuring Oil Losses*. The Protocol highlights critical points where the oil losses were significant. It also guides the mill on the correct sampling techniques at each point and the method of analysis to determine oil losses at the laboratory. It was found that the oil loss measurement methods were quite similar to the current mill laboratory practice. The Protocol focuses on five critical areas which are: empty fruit bunches, steriliser condensate, sludge water from separator, press cake fibre and percentage of un-stripped bunches.

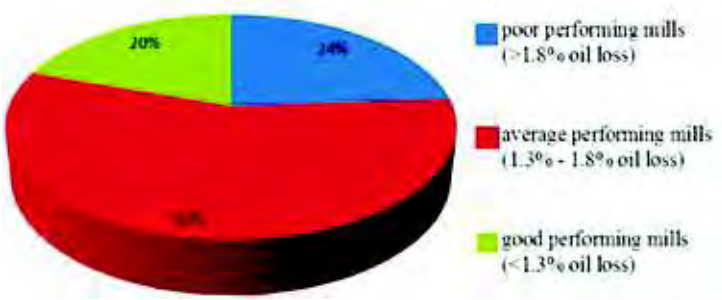

Figure 2. Survey on oil losses of oil palm mills.

Samples for oil loss determination were collected from their respective sampling points. Empty fruit bunches were sampled right after thresher / stripper from the empty bunch conveyor. Steriliser condensate was sampled from the condensate outlet to the condensate pit. Sludge water was sampled from the sludge outlet going to the sludge pit or the de-oiling tank. Press cake fibre was taken in equal parts from the three corners of each screw press outlet. The percentage of unstripped bunches were quantified by observing visually 100 consecutive empty bunches on the empty bunch conveyor. The unstripped bunch is defined as empty fruit bunch having more than 20 fruitlets still attached. *Table 3* indicates approximate oil losses in Kumpulan Guthrie palm oil mills.

Code of Practices (CoP)

This code is an improvement of MPOB's Milling Certificate of Competency Scheme, which only evaluates the mill performance and recommends some changes to improve processing efficiency. Evaluations for CoP for the mill starts from the moment the FFB arrive at the mill gate until the dispatch of crude palm oil and palm kernel from the gate.

ACHIEVEMENTS

Performance of National Average Oil Extraction Rate

As of September 2011, it was observed that the national average OER of Malaysia was on the increasing trend since April as compared to the same period in the past three years (*Figure 3*). Unfortunately, during the early quarter of 2011 the national OER had dropped to below 20%. After the stationing of EO in April 2011, the national OER showed a marginally increasing trend. Even though the average OER of 20.29% is lower than 20.43% of the previous year and 20.47% in 2009, the increasing trend is a positive achievement. As for Peninsular Malaysia, the OER achievement shows a tremendous improvement, whereas the drastic fall of OER in Sabah and Sarawak have led to a stagnating OER performance for Malaysia as shown in *Figures 4, 5* and *6*.

TABLE 3. APPROXIMATE OIL LOSS IN PALM OIL MILLS

Source	% on loss/fresh fruit bunches
Fruit trapped in empty bunches (EFB)	0.02
Unstripped bunches (USB)	0.05
Oil absorbed on the surface of EFB	0.45
Condensate from sterilisation	0.10
Nut surface after pressing	0.05
Fibre after pressing	0.55
Sludge from separator	0.45
General oil spillages or washing from Tanks	0.10
Total milling losses	1.77

Source: Ng (1993).

Figure 3. Performance of national average oil extraction rate (OER).

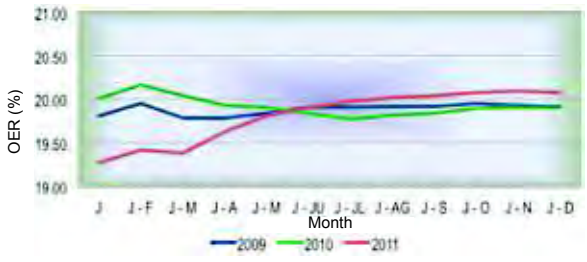

Figure 4. Performance of oil extraction rate (OER) in Peninsular Malaysia.

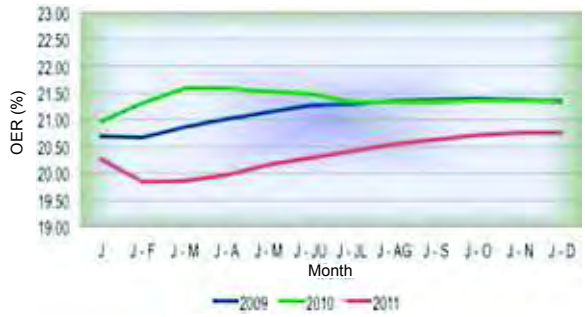

Figure 5. Performance of oil extraction rate (OER) in Sabah.

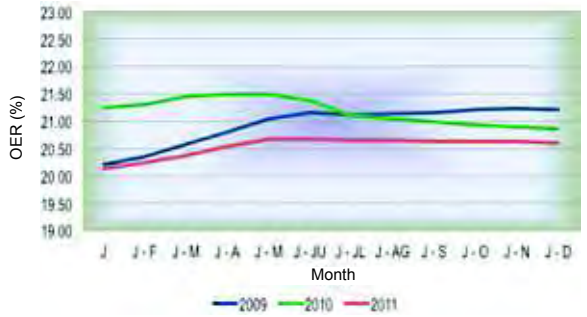

Figure 6. Performance of oil extraction rate (OER) in Sarawak.

Oil Loss Analysis Results in National Key Economic Area Mills

All the figures below show the results of oil loss analysis conducted with samples from six different Category A NKEA mills across the central region.

Oil Loss in Empty Fruit Bunches

The approximate oil loss in empty fruit bunches (EFB) was 0.45%/FFB (Ng, 1993). The results from the analysis showed that the oil loss in the EFB after stripping from six mills exceeded the approximate value and ranged between 0.59% – 1.31% /FFB (based on ratio of 23% EFB/FFB). This could be due to processing of poor quality FFB or inefficient sterilisation process.

Oil Loss in the Press Cake Fibre

Press is one of the main contributors of oil loss during the palm oil milling process. The approximate oil loss in press cake fibre from the screw press in palm oil mill was found to be 0.55%/FFB in Kumpulan Guthrie mills as reported by Ng (1993). The results from the analysis show that the oil loss in press cake fibre from six mills ranged between 0.53% - 0.63%/FFB (based on ratio of 13% fibre/FFB). The four mills under investigation exceeded the limit and this could be due to inefficient sterilisation, insufficient pressing pressure, choked cage, inadequate digester drainage or high digester blade clearance.

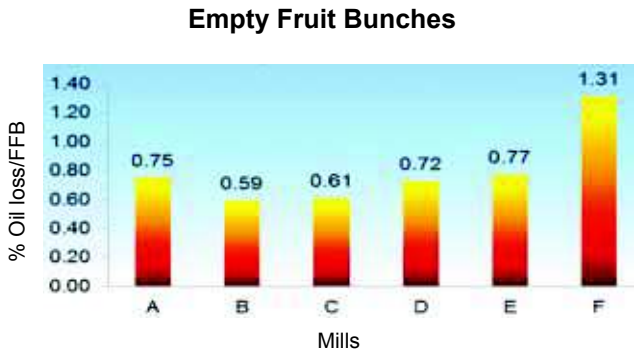

Figure 7. Percentage of oil loss to fresh fruit bunches (FFB) from empty fruit bunches (EFB).

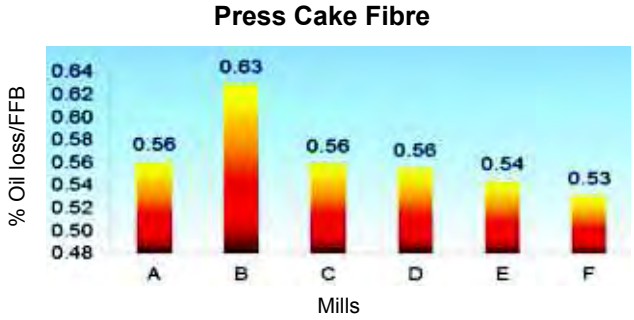

Figure 8. Percentage of oil loss to fresh fruit bunches (FFB) from press cake fibre.

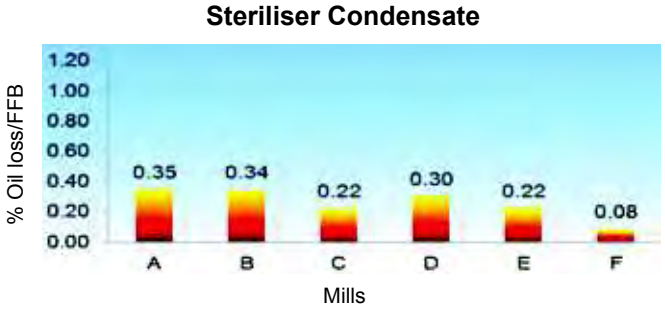

Figure 9. Percentage of oil loss to fresh fruit bunches (FFB) from steriliser condensate.

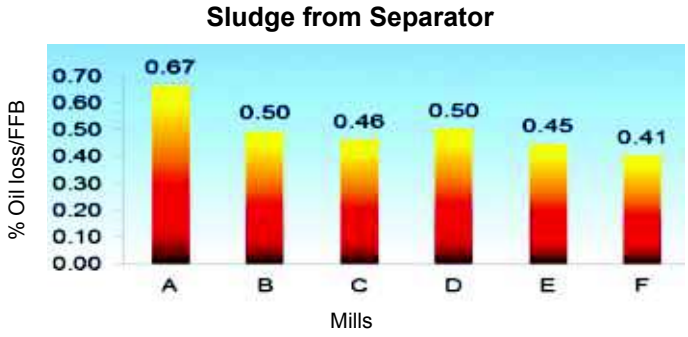

Figure 10. Percentage of oil loss to fresh fruit bunches (FFB) from sludge from separator.

Figure 11. Percentage of oil loss to fresh fruit bunches (FFB) from unstripped bunches.

TABLE 4. OIL EXTRACTION RATE (OER) AND TOTAL OIL LOSSES FROM MILLS A, B, C, D, E AND F

Mill	OER	Oil loss (%)
A	19.52	2.38
B	19.81	2.16
C	19.07	1.95
D	19.40	2.18
E	19.38	2.08
F	19.84	2.38

Oil Loss in Steriliser Condensate

The approximate oil loss from steriliser condensate in palm oil mill was 0.10% /FFB (Ng, 1993). The results from the analysis show that the oil loss in steriliser condensate in these five mills exceeded the approximate value ranging between 0.08% – 0.35%/FFB (based on ratio of 20% condensate/FFB). Only one mill met the limit while other mills exceeded and this problem could be again due to inefficient sterilisation process.

Oil Loss in Sludge from Separator

The approximate oil loss in the sludge from sludge separator in palm oil mill as reported by Ng (1993) was 0.45%/FFB. The results from the analysis show that the oil loss in sludge from separator in six mills exceeded the approximate value except for Mill F which had 0.41% oil loss to FFB. The other mills had oil losses ranging between 0.45 to 0.67 %/FFB. Higher oil loss in sludge could possibly be due to inadequate heating temperature during clarification process.

Oil Loss in Unstripped Bunches

The approximate oil loss from unstripped bunches in palm oil mill was 0.05%/FFB (Ng, 1993). The results from the analysis showed that the oil loss caused by untripped bunches in six mills exceeded the approximate value. The figure shows that oil loss in unstripped bunches ranged from 0.05% to 0.1%/FFB (calculated via the percentage of unstripped bunches). However, it is not possible to measure the actual val-

TABLE 5. RECOVERY SYSTEM IN MILLS A, B, C, D AND E

Mill	USB crusher	Double threshing	EFB press	
			Yes	No
A	/	/	-	/
B	/	/	/	-
C	/	/	/	-
D	/	/	/	-
E	/	/	-	/
F	/	/	-	/

Note: USB – unstripped bunches. EFB – empty fruit bunches.

ue of oil loss in unstripped bunches accurately as unstripped bunches have various amounts of loose fruits attached to it.

From all these data, the total oil losses from the six mills were calculated (*Table 4*). All mills fell under the poor performing mills category with total oil loss exceeding 1.8%. These high losses were mostly contributed by EFB and steriliser condensate. *Table 5* shows the oil recovery systems used in all six mills involved. It was found that mills without empty bunch press, generally experienced high oil losses (ranging from 2.08% to 2.38%/FFB).

Additional Revenue Generated by Reducing Oil Losses

Mill capacity : 60 t hr^{-1}
Processing (hr) : 20 hr per day
Days of processing : 300 days
Total fresh fruit bunches (FFB) = 60 x 20 x 300
Processed per year = 360 000 t FFB yr^{-1}
Recovery of oil = 0.2%
Total additional oil recovered per year = 720
With the price of crude palm oil = RM 3000
Additional revenue generated is RM 2.2 million.

CONCLUSION

The strategies lay down by the NKEA Laboratory under EPP4 warrant the increase of OER to 23% by 2020 from the current 2010 level of 20.45% by year 2020, total OER increase from 2010 to 2020 is targeted about 2.55%. The two-pronged approach of increasing OER and reducing oil losses at mills will be the main focus of MPOB work programme for achieving the target. As for increasing OER, quality of FFB supply to the mill is the main focus of EPP4, the policy of one mill one EO will discourage the movement of unripe FFB in the FFB market and will make the unripe FFB a product with no value. Preliminary result of EPP4 had showed positive improvement of OER but it is too early to claim success in the strategy. Nevertheless, no one can deny that the strategy is on the right track. However, by using better planting material for replanting and practicing Good Agricultural Practices (GAP) *e.g.* loose fruit collection, no harvesting of unripe bunches could increase the OER for about 2.35%.

As for the oil losses, the protocol to measure oil losses introduced by MPOB will standardise the procedures for measuring oil loss during processing and the mills

TABLE 6. REVENUE GENERATED BY INCREASING OIL EXTRACTION RATE (OER)

OER increases	FFB processed (t)	CPO produced (t)	Revenue (RM mil.)	
			RM 2700 Based	RM 3000 Based
1.00	83 090 935	830 909	2 243.46	2 492.73
0.70	83 090 935	581 637	1 570.42	1 774.91
0.50	83 090 935	415 455	1 121.73	1 246.36
0.30	83 090 935	249 273	673.04	747.82
0.10	83 090 935	83 091	224.35	249.27
0.07	83 090 935	58 164	157.04	174.49
0.05	83 090 935	41 545	112.17	124.64
0.03	83 090 935	24 927	67.30	74.78
0.01	83 090 935	8 309	22.43	24.93

Note: CPO – crude palm oil.

should work towards reducing the losses. It will be an uphill task for MPOB to increase OER and achieve the target as stated in the NKEA mission. It is targeted that by implementing effective oil recovery system coupled with upgrading of boiler capacity will reduce oil losses from 1.8% to 1.6% (0.2%) by year 2020. *Table 6* shows the revenue generated by increasing OER. Nevertheless, with the commitment from the palm oil industry, together we can make this dream come true.

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