Palm Oil Mills and Oil Extraction Ratio

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Palm oil mills do not make palm oil. Oil is made in the field. Plantation management can maximize the oil content of the bunches by good agricultural practices. Palm Oil mills however, can reduce the oil losses to a minimum but not eliminate them entirely.

INTRODUCTION

This article is intended to clear the misconception that the palm oil mills are solely responsible for the oil extraction ratios. Many plantation owners and investors surprisingly are led to believe the myth that efficiently operated mills are capable of extraction ratios far in excess of the actual oil content of the bunch itself. Can the plantation management be so ignorant that they actually believe the mill is capable of synthesizing oil from the biomass that they send to the mill. It is unlikely that they believe in it. Nevertheless, it is not unusual to hear comments like a certain mill operates efficiently (efficient manager) compared to another mill (inefficient manager) coming from them. The basis is of course the efficiently operated mill gives 21% and the inefficiently operated mill gives only 18% oil extraction rate (OER) despite the glaring fact the former mill has 1.8% oil loss to fresh fruit bunch (FFB) compared to the less fortunate mill giving only 1.3%. Even the mill managers who later become controllers or directors think alike as can be seen by the way they set OER targets for the mills under them. The figures seem to be plucked from the air rather than based on scientific principle.

Let us analyse the various factors affecting the mill OER. The mill OER is very much related to the following factors and possibly other unknown factors:

- fruit type - *i.e. dura, tenera etc.* Although DxP is the planting material predominantly planted in Malaysia, there are significant quality variations from one breeder to another. The percentage of *dura* contamination also varies from one plantation to another and possibly from one field to another and these have significant impact on the mill OER.
- age of the palm. There are differing views on this. Palm age may or may not have a significant impact on the oil content of the fruit other than the heavy loss of loose fruits in the field due to the scattering effect of the fruits to a wider area in the field resulting from the landing of usually very large bunches from the tall palms.
- pollination efficiency. This affects both OER and kernel extraction rate (KER). Under pollinated bunches will give low

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fruit content in bunches. Heavy rainfall can reduce pollination efficiency as the weevils may take cover in heavy downpour and reduce their pollination activity.

- bunch ripeness. It is a well acknowledged fact that ripe bunches have more oil content in them than the unripe ones. The oil content in the crop is proportional to the percentage of ripe bunches in them. The newly recruited harvesters are sometimes unable to detect ripe bunches and during their initial job engagement tend to harvest unripe and under ripe bunches.
- loose fruit collection. The loose fruits in the field is generally expected to be in the region of 10%-12% and well operated plantations may deliver about 8% but there are plantations which deliver as low as 2% loose fruits to the mills and such mills have to be content with OER performance.
- the trash content. The loose fruit consignment delivered to the mills may sometimes contain as much as 30% trash and the additional weight of the trash in the form of sand and stones will depress the mill OER significantly. No system of weight compensation exists yet in any plantation company. Most plantations appear to be comfortable with the bonus offering of the extra weight added on their actual bunch weight.
- fertilizer application. During lean periods of depressed palm oil pricing, the small plantation companies tend to cut fertilizer application by half like one application instead of the two applications for the year. This lowers the mesocarp thickness of the fruit and the resulting consequence is low OER.
- soil type where the palm is planted. This is related to the fertilizer available for the palm. In some soils, the plant nutrition is already present in large quantities like volcanic soils in which case higher yield and good mesocarp development can be expected.
- intensity of rainfall in the field. Palms thrive well if there is sufficient rainfall throughout the year. Very low rainfall can depress the OER a few months later. Hence, the impact on OER is significant.

The mill management has absolutely no control over any of the above factors. The plantation management is fully aware of these factors, yet they seem to be closing their eyes on these. As most of the top management positions, like directors level, have been and still are exclusively reserved for the plantation personnel, perhaps this misconception is a convenient tool to continue the culture.

Oil extraction ratio of a fruit bunch depends on:

- all the above factors; and
- the mill oil extraction efficiency.

The mill oil extraction efficiency of a mill is determined by analysing the various oil losses during processing. The typical data of a well-operated mill are given in *Table 1*.

The desired values are necessarily the lowest in the range and do not think that it is impossible to achieve them as there are such performers in Malaysia.

TABLE 1. SOURCES OF OIL LOSSES IN A PALM OIL MILL (% to FFB)

No.	Source of oil losses in	Desired values	Typical range
1	Sterilizer condensate	0.10	0.10 – 0.12
2	Empty fruit bunches	0.40	0.40 – 0.45
3	Press cake fibre	0.37	0.08 – 0.10
4	Nuts	0.08	0.10 – 0.12
5	Separator sludge	0.45	0.45 – 0.60
6	Spillage in the mill	0.00	0.00
	Total	1.30	1.30 – 1.87

The oil loss in spillage is measured by the sampling the mill effluent leaving the mill to the effluent ponds. The difference between this value and the total oil losses in the mill is classified as spillage even though physically no such spillage need to occur in the mill. However, occasionally spillage may take place arising from leakage, tank overflows, cleaning of machines *etc*.

OIL LOSS COMPUTATION TECHNIQUES

The oil losses appearing in the mill process control records can be very confusing to planters, the owners of the company and anyone else other than the millers. These values are absolutely useless to them as they fail to convey any message to them. It can only serve the mill for implementing remedial actions in process control. The owner only wants to know the OER and the oil loss as a percentage to the FFB processed. He is not interested in knowing the oil losses as a percentage to dry matter as he cannot translate them into ringgit and sen. The oil loss presented as a percentage to dry matter can only serve to frighten the owner.

In this context, it is interesting to note that some laboratory supervisors and to some extent even the mill managers do not seem to know how to convert oil losses expressed as percentage of dry matter to percentage of the FFB processed. In this computation, a number of assumptions are made and they can cause errors in the values obtained. The usual assumptions (not necessarily very accurate) are the ratio of different components of the bunch as a percentage by weight to the FFB processed and they are given in *Table 2*.

TABLE 2. APPROXIMATE RATIOS OF FRESH FRUIT BUNCH (FFB) COMPONENTS

No.	Bunch components	% to FFB	Say
1	Sterilizer condensate	10 - 15	10
2	EFB	21 - 23	23
3	Cyclone fibre	12 - 14	13
4	Nut	11 - 13	12
5	Oil	19 - 21	20

METHOD TO DETERMINE OIL CONTENT OF FRESH FRUIT BUNCHES

The most practical method of determining the oil content of FFB is to compute the mill oil extraction ratio and add to this, all the known oil losses expressed as a percentage of FFB. This is so because of the very large variation of FFB received by the mill each day. A statistically significant sample size required to extract oil in the laboratory is very large and as such not practical.

If the potential oil content of a bunch is 25%, why no palm oil mills are capable of achieving this ratio? This is due to oil loss in the plantation and mill.

Oil Extraction in a Palm Oil Mill

At present, palm oil is extracted from FFB by mechanical means. All liquids from the FFB are squeezed out and the oil separated from the solids and other liquid matter. As the oil extraction process is basically mechanical one, we can never achieve an extraction efficiency of 100% unlike solvent extraction process that can give 100% oil extraction.

Mills with oil losses at 1.3% and an extraction ratio of 20% can get an extraction ratio of about 94% but some studies have shown that the maximum possible extraction efficiency in a mill seldom exceeds 92%. The oil extraction ratio in the mill depends on the oil content in a FFB bunch and the oil loss in the mill. Mill management has no control on the total oil content in a bunch, they can only control the oil loss.

Therefore, the only way to measure the efficiency of a palm oil mill is by examining the oil loss in the mill, and not by the oil extraction ratio. This means that a mill with a lower oil extraction ratio is not necessarily more efficient than a mill with a higher oil extraction ratio.

To illustrate the above, a graph oil loss and oil extraction ratio of a mill is shown in *Figure 1*.

In *Figure 1*, we can see that the variation of oil loss in the mill (solid line) is not related to the oil extraction ratio (dotted line). The oil extraction ratio (dotted line is very closely related to

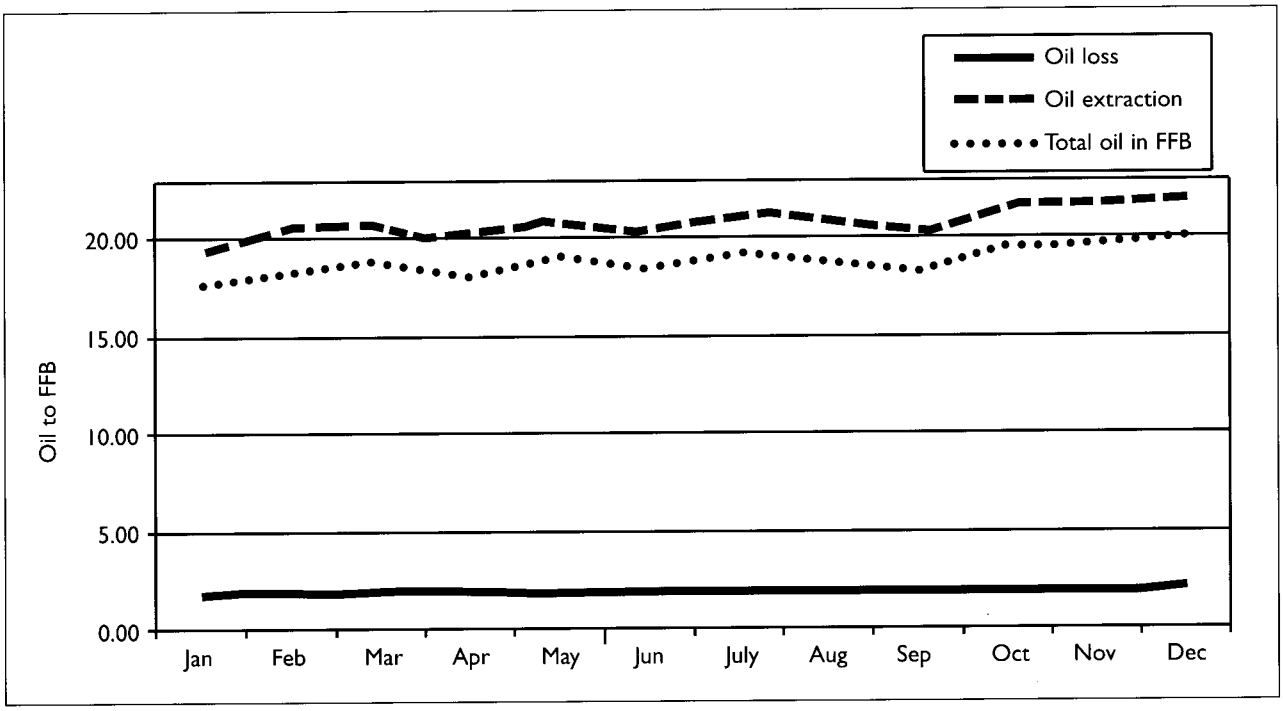

Figure 1. Oil extraction and oil loss.

the total oil in FFB (broken line). The mill manager is responsible for the solid line and the plantation manager responsible for the broken and dotted lines. If the above is true, why palm oil mill managers do not calculate the total oil loss to FFB?

There are a few reasons and these could be:

- mill managers do not know how to calculate the total oil losses to FFB;
- mill owners do not want to spend money for process control equipment required to measure mass flow that is required to calculate oil loss to FFB; and
- mill managers do not have a clear understanding of palm oil processing and process control.

The author would like to suggest to mill owners and senior plantation management to look at the real causes and responsibilities of low oil extraction to enable them to focus on the correct issues to increase oil extraction ratio in the industry. Finger pointing at others does not produce the correct results.

Mill managers should strive to upgrade their knowledge on process control or suffer the consequence of being blamed for things that they have no control of. Excellent process control knowledge is available from many publications. ■

TABLE 3. MONTHLY OIL LOSSES AND OIL EXTRACTION RATE (OER) IN A MILL

Months	Oil loss to FFB (a)	OER % (b)	Total oil to FFB (a) + (b)
January	1.80	17.67	19.47
February	1.90	18.50	20.40
March	1.92	18.80	20.72
April	1.95	18.06	20.01
May	1.80	19.05	20.85
June	1.75	18.53	20.28
July	1.89	19.21	21.10
August	1.87	18.80	20.67
September	1.91	18.26	20.17
October	1.92	19.50	21.42
November	1.90	19.80	21.70
December	2.00	20.12	22.12

States	Oil extracting ratios			Kernel extraction ratios	
	2002	2003	Drop	2002	2003
Johor	19.22	18.62	0.60	5.96	5.91
Kedah	19.63	18.73	0.90	5.74	5.59
Kelantan	19.42	19.76	+0.34	5.75	5.65
Melaka	19.69	19.16	0.53	5.80	5.78
Negeri Sembilan	19.10	18.54	0.56	5.51	5.54
Pahang	19.19	19.06	0.13	5.67	5.61
Pulau Pinang	19.05	18.10	0.95	5.24	5.39
Perak	19.26	18.59	0.67	5.67	5.54
Selangor	19.37	18.50	0.87	6.00	5.78
Terengganu	19.36	19.15	0.21	5.96	5.95
Peninsular Malaysia	**19.24**	**18.77**	**0.47**	**5.80**	**5.74**
Sabah	22.31	21.45	0.86	5.06	5.01
Sarawak	21.56	21.38	0.18	4.60	4.61
Sabah & Sarawak	**22.19**	**21.44**	**0.75**	**4.99**	**4.94**
Malaysia	**20.40**	**19.74**	**0.66**	**5.48**	**5.41**

Despite much efforts by MPOB to boost up the mill oil extraction rate (OER) in Malaysia, the OER dropped from 19.24% in 2002 to 18.77% in Pen. Malaysia in 2003 - a drop of nearly 0.5%. Even though the Sabah OER looks good compared to Pen. Malaysia, the OER drop has been significant at 0.86%.

The acute labour shortage and floods seem to have caused in some mills fresh fruit bunch evacuation problems especially towards the end of the year, resulting in large quantities of uncollected loose fruits in the flooded fields. The high free fatty acid (FFA) production oil in some Sabah mills bear testimony to this. One way to address the problems appears to be to change the harvesting standards just before the onset of wet season to ensure that the ripe bunches are harvested in time to minimize loose fruits scattering in the field, especially the tall palm areas. It is impossible to recover the fresh loose fruits in flooded fields and when the field become dry after a week, the loose fruits collected are bound to have FFA often exceeding 20%. A pro-active approach can reduce this recurring loss of loose fruits.

Millers in Sabah are urged to give their comments or constructive suggestions on how to address the issue of OER depression, which most likely has been caused by the loss of fresh loose fruits in rainy season or the inability to recover them due to the acute labour shortage. Millers may have other explanations for the depressed OER faced by Sabah, in which case let us hear them so that we all can learn from them. *Make this* Palm Oil Engineering Bulletin *an interactive vehicle to exchange knowledge in milling.* ■