ESTIMATING OIL CONTENT OF COMMERCIALLY HARVESTED OIL PALM FRESH FRUIT BUNCHES – A STEP TOWARDS INCREASING PALM OIL YIELDS

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INTRODUCTION

Intensifying oil yield depends on: (a) increasing the FFB yield; (b) increasing the oil content of the FFB; and (c) extracting more of the oil from the FFB, i.e. improving the extraction efficiency rather than oil extraction rate (OER) *per se*. FFB is graded for criteria affecting the mill process and OER, but there is no estimate of potential OER. Mills process FFB of unknown oil contents from many sources, then estimate the OER based on the amount of oil they produce. Thus, FFB yield can be attributed to specific blocks, but not the OER, so growers can and do manage their plantations to optimize FFB yield, but not oil yield. There is no total oil balance at the mill to reconcile measures of oil arriving in the FFB with oil produced after milling. Hence, extraction efficiency of mills is determined using estimated losses in the milling process (Adzmi *et al*., 2012). The Southeast Asia Program of the International Plant Nutrition Institute (IPNI SEAP) recently showed that best management practices (BMP) that maximize FFB yield do not necessarily maximize OER although oil yield is higher (Oberthür *et al.*, 2012). The methodologies adapted by IPNI SEAP for assessing FFB from commercial-scale harvesting can be used to estimate oil recovery efficiency for the oil production process from the field to the mill.

MATERIALS AND METHODS

Data from three BMP project sites in Indonesia (Oberthür *et al.*, 2012) was analyzed. At each site, five pairs of commercial blocks had been evaluated for four years. In each pair, best management practices (BMP) for maximum FFB yield was implemented in one block; the other block was a reference (REF) block managed using standard estate practices (Donough *et al.*, 2010). The final year's FFB yield data was considered. Harvesting was done on a 7-day interval and a minimum ripeness standard of 1-5 loose fruit (LF) before harvest. Harvest audits were done monthly to estimate (a) number of LF lost per bunch, (b) percentage of unharvested palms, and (c) percentage of unripe bunches. A bunch analysis (BA) procedure (Oberthür *et al.*, 2012) was used to estimate oil content (OC) of harvested FFB before any harvest losses occurred. Only ripe bunches (i.e. bunches with at least 1 LF), were analyzed, giving an estimate of the OC of ripe FFB. Bunches were sampled as described by Oberthür *et al.* (2012) to obtain a representative sample of each occasion of harvest. The mean OC value of the sample of ripe bunches was taken as the OC value (before any losses) for the total weight of FFB of the entire harvest on that occasion. Over 4,300 ripe bunches were analyzed from the 15 blocks.

RESULTS AND DISCUSSION

FFB yield averaged 28.8 tons ha^{-1} (Table 1) for the three sites. Harvest losses occurred even with the strict BMP harvesting regime. Using data from harvest audits and BA, the quantum of lost FFB can be estimated. Adding the estimated crop lost to actual yield gives an approximation of potential FFB available for harvest. This allows FFB recovery efficiency to be calculated as an objective measure of the effectiveness of crop recovery in the plantation (Table 1).

TABLE 1. ANNUAL FRESH FRUIT BUNCH (FFB) YIELD AND RECOVERY EFFICIENCY AT 3 SITES IN INDONESIA

	Site A	Site B	Site C	Average
Actual annual FFB yield (kg/ha)	28,800	25,100	32,500	28,800
Actual annual no. of bunches (/ha)	1,396	1,362	2,072	1,610
Estimated uncollected LF[1] weight (kg/ha)[2]	68	44	82	65
Estimated FFB weight of unharvested palms (kg/ha)[3]	176	78	418	224
Potential annual FFB yield (kg/ha)	29,044	25,222	33,000	29,089
FFB recovery efficiency (%)	99.2%	99.5%	98.5%	99.0%

1 – loose fruit; 2 – derived from harvest audit & bunch analysis data; 3 – derived from harvest audit data, block statistics & yield of harvested palms

Crop lost can be expressed in terms of oil using BA data (Table 2). A lower oil content was assumed for unripe bunches (30% less than ripe bunch OC, based on Wood *et al.*, 1987). Estimated potential oil (EPO, Table 2) is calculated using potential FFB yield (Table 1) and ripe bunches OC. Estimated recovered oil (ERO, Table 2) in harvested FFB is obtained after deducting the estimated oil lost. Field oil recovery efficiency (FORE, Table 2) measures crop recovery effectiveness in the plantation in terms of oil, and an estimate of pre-milling oil content (EOC, Table 2) of harvested FFB is obtained.

TABLE 2. ANNUAL OIL YIELD, OIL RECOVERY EFFICIENCY, AND OIL CONTENT IN HARVESTED CROP AT 3 SITES IN INDONESIA

	Site A	Site B	Site C	Average
Estimated oil content (%)[1]	27.05%	21.11%	27.37%	25.18%
Estimated potential oil, EPO (kg/ha)[2]	7,856	5,323	9,034	7,404
Oil loss in uncollected LF (kg/ha)[3]	28	15	34	26
Oil loss in FFB of unharvested palms (kg/ha)[4]	48	16	114	59
Oil loss in unripe FFB (kg/ha)[5]	12	2	9	8
Estimated recovered oil, ERO (kg/ha)	7,769	5,290	8,875	7,312
Field Oil Recovery Efficiency, FORE (%)[6]	98.9%	99.4%	98.2%	98.8%
Estimated oil content (EOC) of recovered FFB (%)[7]	26.98%	21.08%	27.31%	25.12%

1– from bunch analysis (BA); 2 – based on potential FFB yield, assumes no crop loss and all bunches are ripe; 3 – based on oil content of loose fruit (LF) from BA;
4 – assumes all FFB from unharvested palms are ripe; 5 – assumes unripe bunch oil content 30% below ripe bunches; 6 – ERO as % of EPO; 7 – ERO as % of actual recovered FFB (Table 1)

At the mill process, the total weight of oil produced from a given weight of FFB gives the actual OER. The difference between OER and EOC represents oil lost during milling. Mill oil recovery efficiency (MORE) is the ratio of oil produced to the oil contained in the FFB recovered from the field, i.e. the ERO (Table 2). With BA and harvest audit data, plantations can thus assess the efficiency of their crop recovery process. With known estimates of ERO of FFB sources contributing to a palm oil mill, better assessment of milling performance becomes possible based on the MORE rather than evaluations based purely on OER.

CONCLUSION

1) Plantations can do Bunch Analysis (BA) without sophisticated laboratories, to obtain estimates of the oil yield of individual blocks.
2) BA and harvest audit data provides estimates of potential and recoverable oil, allowing a measure of oil recovery efficiency in the field (FORE).
3) Estimates of oil content (EOC) of FFB arriving at mills allow measurement of mill performance in terms of oil recovery efficiency (MORE).
4) EOC of incoming FFB permits payments based on product contents to growers, encouraging them to improve FORE.
5) A more holistic analysis of the plantation and mill in overall oil recovery using FORE and MORE will foster better overall achievement.

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