# Improving CPO DOBI Values — A Practical Approach

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**RINGKASAN**

*Sebuah kilang minyak sawit dipilih untuk kajian memperbaiki nilai indeks pemerosotan pelunturan (DOBI) minyak sawit mentah (MSM) yang dihasilkan. Kesan piawaian buah masak, kualiti buah tandan baru (BTB) semasa penghantaran, pensterilan dan parameter pemprosesan terhadap nilai DOBI dikaji.*

*Kilang berkenaan menghasilkan MSM dengan nilai DOBI >3.0 secara konsisten sepanjang tempoh kajian. Nilai DOBI minimum dalam tempoh ini ialah 3.34 dan nilai maksimum 3.54. Ini melambangkan nilai MSM yang dihasilkan. Proses pensterilan ialah 20/20/30/30 psig selama 70 minit.*

*Memandangkan bahawa hasil sedemikian didapati walaupun 35% dari BTB yang diproses adalah dari penanam persendirian, SLDB yakin bahawa pengoptimuman proses pensterilan sedemikian mampu menghasilkan peningkatan kualiti MSM dan nilai DOBI 3.0 yang konsisten boleh dicapai.*

## INTRODUCTION

Since the study by Tan *et al.* (1982) in using discriminant function analysis to distinguish crude palm oil from sludge palm oil, the concept has evolved into being the unofficially accepted standard in the quality assessment of crude palm oil by millers, refiners and researchers alike. In its present form the discriminant function is related to an arbitrary scale qualifying crude palm oil into sludge oil, poor, fair, good and excellent oils. By definition, the discriminant function is predominantly dependent on DOBI value. It was logical to concentrate on DOBI in any attempt to improve crude palm oil quality. A similar view is prevalent in the industry and statutory bodies, with PORLA presently conducting a nationwide survey over a six month period to investigate DOBI values of crude palm oil in mills.

As a quality conscious plantation group with seven palm oil mills, quality inspections were routine in Sabah Land Development Board, but DOBI and DF evaluations were limited in scope with only one spectrophotometer available, a Varian Tectron UV 634S, located at the group's centralized laboratory. Spectrophotometric analysis was limited to palm oil despatches and one off samples from our mills. Historical data indicated wide fluctuations within mills. However, noticeably, some mills produced a better quality crude palm oil in general. Strangely, one of our mills located close to town and a refiner, consistently produced a poorer grade of oil than some of the group's more isolated mills, where oil despatches could only be made once a month by barging operations. This mill is a 40 tonnes/hr mill commissioned in 1972 and of the conventional design. With the group's emphasis on FFB quality and

**Sabah Land Development Board*

FFB grading over the past three years and the subsequent standards achieved by our estates, the quality of FFB delivered to the mill could not be faulted in total.

This particular mill was selected for some investigative work with the aim of improving the DOBI value of crude palm oil produced. These began in mid-1990 with results more forthcoming with the first unit of the group's planned purchase of DOBI analyzers, (Shimadzu UV-1201), for every one of its mills, arriving. The effects of ripeness standards, FFB quality on delivery, sterilization and processing parameters on DOBI value were assessed.

## EFFECT OF FFB QUALITY ON DOBI

### Ripeness Standard

The ripeness standards practised in Sabah Land Development Board since 1988 is presented in *Appendix I*, which has since formed the basis of standards adopted by PORLA nationwide recently.

### Methods

The analytical aspects of the data presented were carried out by a team of five mill laboratory assistants and a laboratory analyst under the supervision of the group's quality control superintendent. Direct supervision was ensured from the selection of bunches on palms till analysis.

The stripping of fruitlets from fresh fruit bunches was carried out by the use of cutters progressing from the spikelets at the ranchis till the isolation of the fruitlet. In extracting oil from fruitlets, the mesocarp was sliced with sharp blades with such slicing being limited to three slices per fruitlet. These slices were mechanically squeezed, the extract then being centrifuged to separate the oil for immediate analysis. In the methods described above, organization to minimize elapsed time was emphasized. This required adequate manpower, equipment and a systematic approach. The results sought were indicative trends and were not necessarily absolute.

### Deterioration in Fresh Fruit Bunches

The quality of FFB made avaible for milling was investigated. Fruit bunches in three categories *i.e.*, "underripe", "ripe" and "overripe", based on the group's ripeness standard, were harvested under supervision. Fruitlets in each of the categories were stripped from the bunches with care, and divided into two groups of outer and inner fruitlets. The differentiation of outer and inner fruitlets was based on the predominance of colour, outer being predominantly reddish while inner being predominantly yellowish. The results in *Table 1* confirms reported findings that oil extracted from "overripe" and "underripe" fruits have a lower DOBI value. This establishes the need for stringent harvesting practices, the important of ripeness standards and FFB grading in providing the necessary feedback to achieve desired harvesting standards. Carotene content in inner fruits were significantly lower contributing to low DOBI in all three categories investigated.

"Ripe" FFB harvested under close supervision were carefully stripped from bunches and sub-sampled into 14 batches of 1 kg each. The sub-samples were left in the open under some shade, to simulate field conditions. Daily, at the appointed hour, oil was extracted from a complete sub-sample and analyzed. The results, summarized in *Table 2*, though not conclusive, indicate a deterioration effect on DOBI with time, in line with previous findings. The duration between the harvesting of the bunch to its milling has a definite bearing on DOBI.

## TABLE 1. OIL QUALITY FRESH FRUIT BUNCHES

| | Under-Ripe | | | | | | | | Ripe | | | | | | | | Over-Ripe | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Outer | | | | Inner | | | | Outer | | | | Inner | | | | Outer | | | | Inner | | | |
| | $E^{1\%}_{269}$ | $E^{1\%}_{446}$ | Caro-tene | DOBI | $E^{1\%}_{269}$ | $E^{1\%}_{446}$ | Caro-tene | DOBI | $E^{1\%}_{269}$ | $E^{1\%}_{446}$ | Caro-tene | DOBI | $E^{1\%}_{269}$ | $E^{1\%}_{446}$ | Caro-tene | DOBI | $E^{1\%}_{269}$ | $E^{1\%}_{446}$ | Caro-tene | DOBI | $E^{1\%}_{269}$ | $E^{1\%}_{446}$ | Caro-tene | DOBI |
| | 0.540 | 0.992 | 373 | 1.84 | 0.412 | 0.575 | 214 | 1.40 | 0.675 | 1.353 | 549 | 2.27 | 0.316 | 0.706 | 265 | 2.23 | 0.771 | 1.973 | 740 | 2.56 | 0.322 | 0.696 | 261 | 2.16 |
| | 0.547 | 0.839 | 318 | 1.53 | 0.254 | 0.359 | 168 | 1.43 | 0.705 | 1.973 | 831 | 2.81 | 0.398 | 0.675 | 287 | 1.70 | 0.518 | 1.376 | 690 | 2.66 | 0.404 | 0.842 | 325 | 2.08 |
| | – | – | – | – | – | – | – | – | 0.334 | 0.991 | 492 | 2.97 | 0.204 | 0.574 | 275 | 2.81 | 0.394 | 1.290 | 559 | 3.29 | 0.212 | 0.679 | 284 | 3.20 |
| | 0.314 | 0.639 | 223 | 2.04 | 0.155 | 0.312 | 145 | 2.01 | 0.444 | 0.131 | 436 | 2.55 | 0.318 | 0.818 | 270 | 2.51 | 0.305 | 1.054 | 888 | 3.46 | 0.355 | 1.042 | 457 | 3.11 |
| | 0.248 | 0.616 | 231 | 2.17 | 0.158 | 0.286 | 108 | 1.81 | 0.460 | 1.548 | 654 | 3.37 | 0.254 | 0.879 | 332 | 3.46 | 0.356 | 1.070 | 588 | 3.01 | 0.218 | 0.694 | 251 | 3.00 |
| | 0.304 | 0.535 | 202 | 1.76 | 0.167 | 0.224 | 93 | 1.34 | 0.359 | 1.248 | 545 | 3.48 | 0.250 | 0.676 | 271 | 2.70 | 0.340 | 0.845 | 340 | 2.49 | 0.216 | 0.478 | 192 | 2.21 |
| | 0.442 | 1.054 | 415 | 2.50 | 0.296 | 0.742 | 274 | 2.51 | 0.446 | 1.586 | 652 | 3.56 | 0.290 | 0.740 | 302 | 2.55 | – | – | – | – | – | – | – | – |
| Max. | | | | 1.53 | | | | 1.34 | | | | 2.27 | | | | 1.70 | | | | 2.49 | | | | 2.08 |
| Min | | | | 2.50 | | | | 2.51 | | | | 3.56 | | | | 3.46 | | | | 3.46 | | | | 2.16 |
| Average | | | | 1.97 | | | | 1.75 | | | | 3.00 | | | | 2.57 | | | | 2.84 | | | | 2.51 |

**TABLE 2. DETERIORATION OF OIL QUALITY IN FRUITLETS WITH TIME**

| Day | Date | DOBI | PV meq/K | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| 1 | 27.9.90 | 2.77 | 5.31 | 0.672 | 908 | 18 |
| 2 | 28.9.90 | 2.73 | 4.36 | 0.670 | 823 | 17 |
| 3 | 29.9.90 | 3.00 | 10.29 | 0.605 | 698 | 22 |
| 4 | 30.9.90 | 2.92 | 6.84 | 0.568 | 664 | 20 |
| 5 | 1.10.90 | 2.46 | 11.68 | 0.679 | 674 | 14 |
| 6 | 2.10.90 | 2.56 | 15.07 | 0.756 | 715 | 16 |
| 7 | 3.10.90 | 2.41 | 13.86 | 0.736 | 671 | 13 |
| 8 | 4.10.90 | 2.55 | 13.98 | 0.674 | 679 | 16 |
| 9 | 5.10.90 | 2.63 | 8.31 | 0.604 | 735 | 16 |
| 10 | 6.10.90 | 3.60 | 5.02 | 0.430 | 673 | 31 |
| 11 | 7.10.90 | 2.49 | 7.63 | 0.546 | 682 | 14 |
| 12 | 8.10.90 | 1.93 | 5.87 | 0.952 | 750 | 5 |
| 13 | 9.10.90 | 2.47 | 4.23 | 0.679 | 675 | 13 |
| 14 | 10.10.90 | 1.74 | 4.08 | 1.102 | 759 | 1 |

FFA readings in this instance would be rendered meaningless unless the fruitlets were sterilized prior to analysis. Without sterilization the bruising of the fruitlets in slicing the mesocarp would increase the FFA. In the abovementioned test a descending FFA trend of 35% to 4% would have been evident and the descending trend attributed to the softening of the mesocarp with time and hence offering less resistance to bruising.

## EFFECT OF MILLING ON DOBI

### Sterilization

In the foregoing description of sterilization cycles, time indicated reflects time elapsed between initial charge of steam to final exhaustion. Every sterilization cycle included an initial ten minute period of deaeration and condensate removal with a five minute condensate drain at the end of the cycle. A continuous partial bleed of condensate was maintained between the period. A 0/20/40 cycle indicates a two peak cycle, the first peaks exhausted at 20 psig and a second peaks with holding time at 40 psig till blow off at the end of cycle time. A 0/20/20/30 cycle would mean a three peak cycle with two peaks of 20 psig and holding time at 30 psig till exhaust.

To obtain an idea of the effect of sterilization on DOBI, freshly harvested "ripe" FFB was stripped and sub-sampled into twelve samples of 1 kg each. Four batches of three samples each were used in this test. The first is subjected to immediate analysis and the other three, analysis after single, double and triple peak sterilization. *Table 3* relates data obtained. The effect on oil quality is prominent. Carotene destruction is of the order of 200 ppm while a DOBI value reduction of 0.7 is experienced.

Identical tests carried out with segregation of "inner" and "outer" fruitlets indicated similar trends in both sets of fruitlets.

**TABLE 3. EFFECT OF STERILIZATION ON DOBI VALUES**

| Sampling Point | Test No. | DOBI | PV meq/K | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Immediate | 1 | 3.32 | 1.75 | 0.530 | 697 | 26 |
| | 2 | 3.49 | 1.19 | 0.506 | 692 | 29 |
| | 3 | 3.67 | 0.87 | 0.452 | 697 | 32 |
| | AVG | 3.49 | 1.27 | 0.496 | 695 | 29 |
| Single Peak 0/40 70 min. | 1 | 2.79 | 0 | 0.362 | 416 | 18 |
| | 2 | 2.86 | 0 | 0.434 | 439 | 19 |
| | 3 | 2.71 | 0 | 0.432 | 479 | 17 |
| | AVG | 2.79 | 0 | 0.409 | 445 | 18 |
| Double Peak 0/20/40 70 min. | 1 | 2.79 | 0 | 0.451 | 511 | 18 |
| | 2 | 2.81 | 0 | 0.442 | 506 | 18 |
| | 3 | 2.80 | 0 | 0.496 | 512 | 18 |
| | AVG | 2.80 | 0 | 0.463 | 510 | 18 |
| Triple Peak 0/20/20/40 | 1 | 2.98 | 0 | 0.466 | 488 | 21 |
| | 2 | 2.54 | 0 | 0.526 | 493 | 14 |
| | 3 | 2.84 | 0 | 0.348 | 468 | 19 |
| 70 min. | AVG | 2.79 | 0 | 0.447 | 483 | 18 |

## Processing

The quality of oil in the various stages of processing was also monitored over a number of days. Samples were taken three hours after the commencement of processing with a total of four samples in a day at hourly intervals. Sufficient quantities were taken simultaneously at fixed sample points, hourly, centrifuged properly to obtain clean oil and analyzed immediately. The averaged results are tabulated in *Table 4*. Temperatures were also recorded in an attempt to correlate quality deterioration with process temperatures. However the degree of deterioration from digestion to pre-storage tank was not as pronounced so as to warrant continuation of the attempt to relate deterioration to process temperatures.

## IMPROVING DOBI VALUES

### Assessment

From the aforesaid it becomes very apparent that the following factors have a direct effect in the quality of oil produced ex-mill.

a. FFB quality and ripeness standards
b. Time between harvest and processing
c. Sterilization
d. Rest of milling process

Of these, sterilization was felt to be a major factor and one within the control of the mill. Researchers have been calling for the lowest possible temperatures and the shortest time to be employed in the sterilization process. The industry in general,

**TABLE 4a. OIL QUALITY AT STAGES OF MILL PROCESS**

| Date: 28.9.90 Sampling Point | FFA | DOBI | PV meq/k | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Ex-Digester | 2.48 | 3.12 | 0 | 0.376 | 487 | 23 |
| Ex-Press | 2.46 | 3.07 | 0 | 0.463 | 532 | 22 |
| Ex-Vibrating Screen | 2.63 | 3.26 | 0 | 0.427 | 547 | 25 |
| Ex-C.S. Tank | 2.47 | 2.86 | 0 | 0.388 | 493 | 19 |
| Pre-Sludge | 2.79 | 3.55 | 0 | 0.468 | 551 | 30 |
| Pre-Pure Oil Tank | 2.50 | 2.74 | 0 | 0.473 | 483 | 17 |
| Ex-Separator | 2.78 | 2.40 | 0 | 0.467 | 532 | 11 |
| Ex-Purifier | 2.53 | 2.40 | 0 | 0.532 | 489 | 11 |
| Pre-Storage Tank | 2.60 | 2.64 | 0 | 0.456 | 462 | 15 |

| Date: 29.9.90 Sampling Point | FFA | DOBI | PV meq/k | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Ex-Digester | 2.14 | 2.65 | 0 | 0.430 | 436 | 15 |
| Ex-Press | 1.97 | 3.01 | 0 | 0.406 | 458 | 21 |
| Ex-Vibrating Screen | 2.24 | 3.07 | 0 | 0.384 | 473 | 22 |
| Ex-C.S. Tank | 2.24 | 2.75 | 0 | 0.410 | 466 | 17 |
| Pre-Sludge | 2.32 | 2.53 | 0 | 0.520 | 478 | 13 |
| Pre-Pure Oil Tank | 2.14 | 2.52 | 0 | 0.463 | 453 | 13 |
| Ex-Separator | 2.35 | 2.58 | 0 | 0.434 | 471 | 14 |
| Ex-Purifier | 2.40 | 2.56 | 0.44 | 0.490 | 449 | 14 |
| Pre-Storage Tank | 2.41 | 2.51 | 0.51 | 0.520 | 445 | 13 |

| Date: 30.9.90 Sampling Point | FFA | DOBI | PV meq/k | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Ex-Digester | 2.08 | 2.94 | 0 | 0.362 | 425 | 20 |
| Ex-Press | 2.29 | 2.87 | 0 | 0.403 | 468 | 19 |
| Ex-Vibrating Screen | 2.32 | 3.14 | 0 | 0.362 | 461 | 23 |
| Ex-C.S. Tank | 2.34 | 2.84 | 0.49 | 0.430 | 459 | 18 |
| Pre-Sludge | 2.83 | 2.85 | 0 | 0.452 | 463 | 18 |
| Pre-Pure Oil Tank | 2.28 | 2.72 | 0.44 | 0.389 | 464 | 16 |
| Ex-Separator | 2.52 | 2.81 | 0 | 0.437 | 468 | 18 |
| Ex-Purifier | 2.41 | 2.67 | 0.58 | 0.468 | 446 | 16 |
| Pre-Storage Tank | 2.37 | 2.52 | 0.56 | 0.518 | 442 | 13 |

**TABLE 4b. OIL QUALITY AT STAGES OF MILL PROCESS**

| DATE: 4.10.90 Sampling Point | FFA | DOBI | PV meq/k | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Ex-Digester | 2.76 | 2.43 | 1.24 | 0.460 | 454 | 12 |
| Ex-Press | 2.80 | 3.12 | 0.61 | 0.339 | 497 | 23 |
| Ex-Vibrating Screen | 2.77 | 2.81 | 0.50 | 0.474 | 509 | 18 |
| Ex-C.S. Tank | 2.93 | 2.98 | 0.66 | 0.390 | 484 | 21 |
| Pre-Sludge | 3.06 | 2.85 | 0.98 | 0.410 | 428 | 18 |
| Pre-Pure Oil Tank | 2.51 | 3.02 | 1.95 | 0.430 | 459 | 21 |
| Ex-Separator | 3.14 | 2.92 | 1.16 | 0.547 | 490 | 20 |
| Ex-Purifier | 2.73 | 3.10 | 1.02 | 0.419 | 492 | 22 |
| Pre-Storage Tank | 2.71 | 2.84 | 1.30 | 0.585 | 593 | 18 |

| Date: 5.10.90 Sampling Point | FFA | DOBI | PV meq/k | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Ex-Digester | 2.06 | 2.49 | 0 | 0.443 | 450 | 13 |
| Ex-Press | 2.27 | 2.99 | 0 | 0.435 | 508 | 21 |
| Ex-Vibrating Screen | 2.09 | 3.04 | 0 | 0.436 | 500 | 21 |
| Ex-C.S. Tank | 2.78 | 2.72 | 0 | 0.443 | 490 | 16 |
| Pre-Sludge | 3.45 | 3.01 | 0 | 0.382 | 492 | 21 |
| Pre-Pure Oil Tank | 3.32 | 2.01 | 1.00 | 0.662 | 462 | 5 |
| Ex-Separator | 2.35 | 2.67 | 0 | 0.332 | 496 | 15 |
| Ex-Purifier | 2.60 | 2.46 | 0.58 | 0.568 | 477 | 12 |
| Pre-Storage Tank | 2.59 | 2.49 | 0.65 | 0.479 | 473 | 13 |

| Date: 6.10.90 Sampling Point | FFA | DOBI | PV meq/k | $E^{1\%}_{269}$ | Carotene ppm | DF |
|---|---|---|---|---|---|---|
| Ex-Digester | 2.01 | 2.80 | 0 | 0.418 | 429 | 18 |
| Ex-Press | 2.26 | 2.91 | 0.69 | 0.452 | 505 | 19 |
| Ex-Vibrating Screen | 2.33 | 3.29 | 0 | 0.405 | 520 | 25 |
| Ex-C.S. Tank | 3.30 | 2.88 | 0.66 | 0.430 | 532 | 19 |
| Pre-Sludge | 3.02 | 3.68 | 0 | 0.338 | 505 | 32 |
| Pre-Pure Oil Tank | 3.57 | 2.03 | 1.18 | 0.620 | 451 | 5 |
| Ex-Separator | 2.64 | 3.01 | 0 | 0.459 | 534 | 21 |
| Ex-Purifier | 3.07 | 2.85 | 0.57 | 0.462 | 477 | 18 |
| Pre-Storage Tank | 3.09 | 2.38 | 0.45 | 0.478 | 465 | 11 |

TABLE 5. STERILIZATION AND DOBI

| | DobiValue | | Sterilization | | Stripping Efficiency | Extraction Rate C.P.O | | P.K. | | Cracking Efficiency | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | C.O. Tank | Prod. Oil | Cycle Press. | Cycle Time | % | Today | To Date | Today | To Date | Nut Basis | Kernel Basis |
| 24.9 | 2.83 | 2.65 | 20/20/30 | 80 | 98.50 | 21.11 | 21.33 | 5.81 | 5.81 | 92.70 | 95.80 |
| 25.9 | 3.14 | 2.99 | 20/20/30 | 80 | 95.00 | 21.41 | 21.33 | 5.60 | 5.80 | 91.20 | 94.60 |
| 26.9 | 3.11 | 3.04 | 20/20/30 | 80 | 99.00 | 21.45 | 21.34 | 5.81 | 5.80 | 89.80 | 93.90 |
| 27.9 | 3.12 | 2.95 | 20/20/30 | 80 | 98.50 | 21.53 | 21.35 | 5.84 | 5.80 | 90.10 | 94.20 |
| **28.9** | ***2.58*** | ***2.62*** | ***20/20/40*** | **80** | **90.50** | ***21.43*** | ***21.35*** | ***5.83*** | ***5.80*** | **91.70** | **95.00** |
| **29.9** | **2.34** | **2.48** | **20/20/40** | **80** | **91.50** | **21.21** | **21.34** | **5.81** | **5.80** | **91.50** | **94.90** |
| 30.9 | 3.37 | 3.10 | 20/20/30 | 80 | 92.50 | 21.00 | 21.33 | 5.80 | 5.80 | 91.20 | 95.00 |
| 4.10 | 3.10 | 2.99 | 20/20/30 | 80 | 93.00 | 21.46 | 21.46 | 5.82 | 5.82 | 91.80 | 94.80 |
| 5.10 | 3.36 | 3.32 | 20/20/30 | 80 | 91.00 | 21.24 | 21.35 | 5.81 | 5.82 | 93.80 | 95.60 |
| 7.10 | 3.30 | 2.98 | 20/20/30 | 80 | 98.50 | 21.35 | 21.35 | 5.81 | 5.82 | 93.20 | 95.30 |
| 8.10 | 3.32 | 3.05 | 20/20/30 | 80 | 91.00 | 21.55 | 21.41 | 6.12 | 5.90 | 93.60 | 95.70 |
| 9.10 | 3.12 | 2.82 | 20/20/30 | 80 | 93.50 | 21.43 | 21.41 | 5.80 | 5.88 | 93.00 | 95.10 |
| 10.10 | 3.20 | 2.62 | 20/20/30 | 80 | 95.00 | 21.54 | 21.43 | 5.80 | 5.87 | 91.60 | 95.00 |
| 11.10 | 2.98 | 2.73 | 20/20/30 | 70 | 94.50 | 21.23 | 21.41 | 5.81 | 5.87 | 92.00 | 95.00 |
| 12.10 | 3.20 | 3.27 | 20/20/30/30 | 70 | 94.00 | 21.50 | 21.42 | 5.81 | 5.86 | 93.00 | 95.60 |
| 14.10 | 3.33 | 3.10 | 20/20/30/30 | 70 | 93.50 | 21.54 | 21.44 | 5.82 | 5.85 | 92.20 | 95.30 |
| 15.10 | 2.90 | 3.00 | 20/20/30/30 | 70 | 99.00 | 21.63 | 21.56 | 5.81 | 5.85 | 93.00 | 96.10 |
| 16.10 | 3.38 | 3.16 | 20/20/30/30 | 70 | 95.00 | 21.71 | 21.48 | 5.80 | 5.84 | 92.50 | 95.30 |
| 17.10 | 3.39 | 3.01 | 20/20/30/30 | 70 | 99.00 | 21.45 | 21.48 | 5.80 | 5.84 | 92.90 | 96.40 |
| 18.10 | 3.26 | 3.05 | 20/20/30/30 | 70 | 94.50 | 21.50 | 21.48 | 5.80 | 5.84 | 92.40 | 95.70 |
| 19 10 | 3.20 | 3.09 | 20/20/30/30 | 70 | 99.00 | 21.54 | 21.48 | 5.82 | 5.84 | 92.60 | 95.50 |
| 21.10 | 3.20 | 3.02 | 20/20/30/30 | 70 | 98.50 | 21.55 | 21.49 | 5.81 | 5.84 | 92.30 | 95.20 |
| 22.10 | 3.15 | 3.03 | 20/20/30/30 | 70 | 94.50 | 21.60 | 21.49 | 5.84 | 5.84 | 92.10 | 95.10 |

however has not responded. The ingrained concept of "thoroughly ccoking the fruits", relative to maximum pressures and time, is still prevalent.

## Sterilization Regime

Having established the effect on DOBI in a triple peak sterilization of 20/20/40 psig over 80 min in the initial trials, a triple peak regime of 0/20/30 psig, and 80 min duration, was attempted and production oil quality monitored. Simultaneously a more intensive monitoring (in addition to routine frequencies) of bunch stripping and nut cracking efficiencies were carried out, commencing 24.9.1991 and ending 27.9.1991. The results are presented in *Table 5* and show an improved quality in the oil produced with DOBI values averaging 3.0.

On reverting to the original sterilization regime of 20/20/40 psig over 80 min for the following two days *i.e.* 28.9.1991 and 29.9.1991, the negative effect on DOBI is immediately noticeable. Reduced DOBI values averaging 2.5 were obtained.

On reverting to sterilization regimes of 20/20/30 psig and 80 min, as of the 30.9.1991, the improvement in DOBI value is again apparent. This regime was adhered to till the 11.10.1991 when cycle time was reduced to 70 min.

On 12.10.1991 the sterilization regime was altered to a four peak regime of 20/20/30/30 psig for 70 min. This was done to counter difficulties experienced in nut cracking, which is discussed in detail later. The 70 min cycle seemed to produce improved results over the 80 min cycle with DOBI of production oil averaging >3.0.

Throughout the exercise stripping efficiencies were normal, daily fluctuations looked alarming, but with weekly and monthly reporting figures normal at between 97%-98%. Every aspect of processing including efficiencies and losses were noted to be stable during the period with the exception of nut cracking.

The mill in question has two process lines of 20 tonnes/hr capacity each. Both lines are identical in design and utilize a ripple mill each. However Line 1 still incorporates a dry nut cracking system, where nuts are dried in nut silos prior to cracking. Line 2, has been altered to a wet nut cracking system, where nut directly from the polishing drum

**TABLE 6a. CRACKING EFFICIENCY DURING TEST PERIOD — LINE 1**

| Date | % Total Nut Basis: Total Nut | Uncr. Nut % | P. Cr. Nut % | Cr. Eff. % | % Total Kernel Basis: Total Kernel | Kernel In Uc. Nut % | Kernel P. Cr. Nut % | Cr. Eff. % |
|---|---|---|---|---|---|---|---|---|
| 4.10.91 | 1000 | 1.80 | 6.90 | 91.30 | 571 | 1.00 | 4.20 | 94.80 |
| 5.10.91 | 1000 | 2.00 | 6.50 | 91.50 | 561 | 0.90 | 4.10 | 95.00 |
| 7.10.91 | 1000 | 2.10 | 6.60 | 91.30 | 562 | 1.10 | 3.90 | 95.00 |
| 8.10.91 | 1000 | 3.10 | 8.30 | 88.60 | 577 | 1.60 | 4.50 | 93.90 |
| 9.10.91 | 1000 | 2.60 | 7.60 | 89.80 | 573 | 1.70 | 4.70 | 93.60 |
| 10.10.91 | 1000 | 2.90 | 12.40 | 84.70 | 619 | 1.60 | 6.90 | 91.50 |
| 11.10.91 | 1000 | 1.80 | 6.40 | 91.80 | 572 | 1.00 | 4.10 | 94.90 |
| 12.10.91 | 1000 | 1.50 | 5.50 | 93.00 | 566 | 0.80 | 3.10 | 96.10 |
| 13.10.91 | 1000 | 1.90 | 6.30 | 91.80 | 580 | 1.00 | 3.90 | 95.10 |
| 15.10.91 | 1000 | 1.80 | 6.40 | 91.80 | 583 | 0.90 | 4.10 | 95.00 |
| 16.10.91 | 1000 | 1.90 | 5.80 | 92.30 | 571 | 1.00 | 3.80 | 95.20 |
| 17.10.91 | 1000 | 1.80 | 5.50 | 92.70 | 577 | 0.90 | 4.50 | 94.60 |
| 18.10.91 | 1000 | 1.70 | 5.90 | 92.40 | 561 | 0.80 | 3.70 | 95.50 |
| 19.10.91 | 1000 | 1.90 | 6.10 | 92.00 | 565 | 1.00 | 4.00 | 95.00 |
| 21.10.91 | 1000 | 2.10 | 6.30 | 91.60 | 582 | 1.20 | 3.80 | 95.00 |
| 22.10.91 | 1000 | 2.00 | 5.90 | 92.10 | 548 | 1.10 | 3.50 | 95.40 |
| 23.10.91 | 1000 | 1.80 | 6.00 | 92.20 | 555 | 1.00 | 2.90 | 96.10 |
| 24.10.91 | 1000 | 1.80 | 6.40 | 91.80 | 555 | 1.00 | 2.80 | 96.20 |
| 25.10.91 | 1000 | 1.60 | 5.60 | 92.80 | 578 | 0.90 | 3.60 | 95.50 |
| 26.10.91 | 1000 | 1.40 | 5.40 | 93.20 | 552 | 0.80 | 3.50 | 95.70 |
| 28.10.91 | 1000 | 1.70 | 5.70 | 92.60 | 557 | 0.90 | 3.10 | 96.00 |
| 29.10.91 | 1000 | 1.60 | 5.40 | 93.00 | 564 | 0.90 | 3.40 | 95.70 |
| 30.10.91 | 1000 | 1.40 | 4.60 | 94.00 | 567 | 0.80 | 3.20 | 96.00 |
| 31.10.91 | 1000 | 1.70 | 4.30 | 94.00 | 563 | 0.90 | 3.00 | 96.10 |

Legend for *Tables 6a, 6b, 7a, 7b*
Uncr. – Uncracked
P.Cr. – Partially Cracked
Cr. Eff. – Cracked Efficiency
In Uc. – Including Uncracked

is cracked. Cracking efficiencies on both lines have generally been similar, both on a total nut and total kernel basis. During the exercise a marginal reduction in cracking efficiencies was note with an increase in part-cracked nuts. *Tables 6 (a)* and *(b)* reflect efficiencies in Lines 1 and 2 respectively, during the trial period in October. It was noticed that a large proportion of kernels had shell fragments adhering resulting in a high dirt content in packed kernel. This was thought to be due to the inadequate desiccation of kernels in the sterilization process. The switch to four peak 20/20/30/30 psig sterilization regime did not produce any significant improvements.

Instead of backtracking and loosing out on the achievements obtained in CPO quality we worked on improving the efficiency at the ripple mill. This was achieved by increasing the thickness of the inner row of rods on the rotor. As can be seen from

**TABLE 6b. CRACKING EFFICIENCY DURING TEST PERIOD — LINE II**

| Date | % Total Nut Basis | | | | % Total Kernel Basis | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Nut | Uncr. Nut % | P. Cr. Nut % | Cr. Eff. % | Total Kernel | Kernel In Uc. Nut % | Kernel P. Cr. Nut % | Cr. Eff. % |
| 4.10.91 | 1000 | 1.80 | 6.40 | 91.80 | 564 | 1.00 | 4.20 | 94.80 |
| 5.10.91 | 1000 | 1.40 | 4.80 | 93.80 | 573 | 1.00 | 3.40 | 95.60 |
| 7.10.91 | 1000 | 1.70 | 5.10 | 93.20 | 573 | 1.10 | 3.60 | 95.30 |
| 8.10.91 | 1000 | 1.50 | 4.90 | 93.60 | 568 | 0.80 | 3.50 | 95.70 |
| 9.10.91 | 1000 | 1.70 | 5.30 | 93.00 | 575 | 1.00 | 3.90 | 95.10 |
| 10.10.91 | 1000 | 1.60 | 6.80 | 91.60 | 585 | 0.90 | 4.10 | 95.00 |
| 11.10.91 | 1000 | 1.80 | 6.20 | 92.00 | 593 | 1.00 | 4.00 | 95.00 |
| 12.10.91 | 1000 | 1.70 | 5.30 | 93.00 | 574 | 1.00 | 3.40 | 95.60 |
| 14.10.91 | 1000 | 1.90 | 5.90 | 92.20 | 585 | 0.90 | 3.80 | 95.30 |
| 15.10.91 | 1000 | 1.60 | 5.40 | 93.00 | 549 | 0.80 | 3.10 | 96.10 |
| 16.10.91 | 1000 | 1.70 | 5.80 | 92.50 | 570 | 1.00 | 3.70 | 95.30 |
| 17.10.91 | 1000 | 1.50 | 5.60 | 92.90 | 541 | 1.00 | 2.60 | 96.40 |
| 18.10.91 | 1000 | 1.70 | 5.90 | 92.40 | 571 | 0.90 | 3.40 | 95.70 |
| 19.10.91 | 1000 | 1.80 | 5.60 | 92.60 | 565 | 1.00 | 3.50 | 95.50 |
| 21.10.91 | 1000 | 1.90 | 5.80 | 92.30 | 568 | 1.00 | 3.80 | 95.20 |
| 22.10.91 | 1000 | 1.70 | 6.20 | 92.10 | 563 | 0.80 | 4.10 | 95.10 |
| 23.10.91 | 1000 | 1.80 | 5.10 | 93.10 | 543 | 0.70 | 3.90 | 95.40 |
| 24.10.91 | 1000 | 1.60 | 5.80 | 92.60 | 567 | 0.90 | 4.00 | 95.10 |
| 25.10.91 | 1000 | 1.50 | 5.30 | 93.20 | 549 | 1.00 | 3.00 | 96.00 |
| 26.10.91 | 1000 | 1.40 | 5.20 | 93.40 | 552 | 0.80 | 3.60 | 95.60 |
| 28.10.91 | 1000 | 1.60 | 5.40 | 93.00 | 539 | 0.90 | 3.70 | 95.40 |
| 29.10.91 | 1000 | 1.50 | 5.30 | 93.20 | 542 | 0.60 | 3.10 | 96.30 |
| 30.10.91 | 1000 | 1.30 | 4.10 | 94.60 | 546 | 0.70 | 2.90 | 96.40 |
| 31.10.91 | 1000 | 1.40 | 4.30 | 94.30 | 529 | 0.80 | 3.00 | 96.20 |

*Tables 7 (a)* and *(b)* depicting relevant data for the month of November 1991, cracking efficiencies have improved to acceptable levels.

**TABLE 7a. CRACKING EFFICIENCY AFTER MODIFICATIONS — LINE I**

| Date | % Total Nut Basis | | | | % Total Kernel Basis | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Nut | Uncr. Nut % | P. Cr. Nut % | Cr. Eff. % | Total Kernel | Kernel In Uc. Nut % | Kernel P. Cr. Nut % | Cr. Eff. % |
| 4.11.91 | 1000 | 1.30 | 5.40 | 93.30 | 560 | 0.70 | 3.30 | 96.00 |
| 5.11.91 | 1000 | 1.40 | 5.60 | 93.00 | 566 | 0.80 | 3.70 | 95.50 |
| 6.11.91 | 1000 | 1.30 | 5.50 | 93.20 | 562 | 0.70 | 3.40 | 95.90 |
| 7.11.91 | 1000 | 1.40 | 5.10 | 93.50 | 543 | 0.80 | 3.20 | 96.00 |
| 8.11.91 | 1000 | 1.30 | 5.20 | 93.10 | 551 | 0.70 | 3.40 | 95.90 |
| 9.11.91 | 1000 | 1.20 | 5.60 | 93.20 | 562 | 0.70 | 3.70 | 95.60 |
| 11.11.91 | 1000 | 1.10 | 4.80 | 94.10 | 542 | 0.60 | 3.20 | 96.20 |
| 12.11.91 | 1000 | 1.20 | 4.60 | 94.20 | 549 | 0.80 | 3.10 | 96.10 |
| 13.11.91 | 1000 | 1.30 | 4.90 | 93.80 | 559 | 0.90 | 3.40 | 95.70 |
| 14.11.91 | 1000 | 1.30 | 5.10 | 93.60 | 565 | 0.80 | 3.60 | 95.60 |
| 15.11.91 | 1000 | 1.20 | 4.40 | 94.40 | 549 | 0.70 | 2.90 | 96.40 |
| 16.11.91 | 1000 | 1.30 | 4.30 | 94.40 | 542 | 0.70 | 2.80 | 96.50 |
| 18.11.91 | 1000 | 1.20 | 4.20 | 94.60 | 523 | 0.70 | 2.90 | 96.40 |
| 19.11.91 | 1000 | 1.20 | 4.40 | 94.40 | 556 | 0.70 | 3.00 | 96.30 |
| 20.11.91 | 1000 | 1.30 | 4.10 | 94.60 | 549 | 0.70 | 2.80 | 96.50 |
| 21.11.91 | 1000 | 1.30 | 4.20 | 94.50 | 554 | 0.80 | 2.90 | 96.30 |
| 22.11.91 | 1000 | 1.20 | 4.10 | 94.70 | 558 | 0.80 | 3.00 | 96.20 |
| 23.11.91 | 1000 | 1.10 | 4.30 | 94.60 | 549 | 0.70 | 2.80 | 96.50 |
| 25.11.91 | 1000 | 1.30 | 3.80 | 94.90 | 585 | 0.60 | 2.70 | 96.70 |
| 26.11.91 | 1000 | 1.20 | 4.00 | 94.80 | 556 | 0.80 | 2.90 | 96.30 |
| 27.11.91 | 1000 | 1.30 | 4.10 | 94.60 | 559 | 0.70 | 3.00 | 96.30 |
| 28.11.91 | 1000 | 1.30 | 4.00 | 94.70 | 559 | 0.80 | 3.00 | 96.20 |
| 29.11.91 | 1000 | 1.30 | 4.00 | 94.70 | 549 | 0.70 | 3.10 | 96.20 |
| 30.11.91 | 1000 | 1.20 | 4.10 | 94.70 | 559 | 0.80 | 3.00 | 96.20 |

TABLE 7b. CRACKING EFFICIENCY AFTER MODIFICATIONS — LINE II

| Date | Total Nut Basis % | | | | Total Kernel Basis % | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Nut | Uncr. Nut % | P. Cr. Nut % | Cr. Eff. % | Total Kernel | Kernel In Uc. Nut % | Kernel P. Cr. Nut % | Cr. Eff. % |
| 4.11.91 | 1000 | 1.20 | 5.90 | 92.90 | 605 | 0.50 | 3.50 | 96.00 |
| 5.11.91 | 1000 | 1.40 | 5.40 | 93.20 | 569 | 0.80 | 3.10 | 96.10 |
| 6.11.91 | 1000 | 1.20 | 5.20 | 93.60 | 567 | 0.70 | 3.80 | 95.50 |
| 8.11.91 | 1000 | 1.30 | 5.30 | 93.40 | 576 | 0.60 | 3.60 | 95.80 |
| 9.11.91 | 1000 | 1.20 | 4.20 | 94.60 | 563 | 0.70 | 3.00 | 96.30 |
| 11.11.91 | 1000 | 1.20 | 4.50 | 94.30 | 557 | 0.70 | 3.70 | 96.20 |
| 12.11.91 | 1000 | 1.30 | 4.60 | 94.10 | 559 | 0.60 | 3.00 | 96.40 |
| 13.11.91 | 1000 | 1.20 | 4.40 | 94.40 | 565 | 0.70 | 3.10 | 96.20 |
| 14.11.91 | 1000 | 1.30 | 4.30 | 94.40 | 554 | 0.80 | 3.00 | 96.20 |
| 15.11.91 | 1000 | 1.40 | 4.10 | 94.50 | 548 | 0.70 | 2.80 | 96.50 |
| 16.11.91 | 1000 | 1.20 | 4.40 | 94.40 | 545 | 0.80 | 3.00 | 96.20 |
| 18.11.91 | 1000 | 1.30 | 4.30 | 94.40 | 564 | 0.70 | 2.90 | 96.40 |
| 19.11.91 | 1000 | 1.20 | 4.20 | 94.60 | 558 | 0.70 | 3.00 | 96.30 |
| 20.11.91 | 1000 | 1.20 | 4.30 | 94.50 | 565 | 0.70 | 2.80 | 96.50 |
| 21.11.91 | 1000 | 1.30 | 4.10 | 94.60 | 560 | 0.80 | 2.70 | 96.50 |
| 22.11.91 | 1000 | 1.30 | 4.20 | 94.50 | 554 | 0.70 | 2.60 | 96.70 |
| 23.11.91 | 1000 | 1.20 | 4.30 | 94.50 | 554 | 0.60 | 2.80 | 96.60 |
| 25.11.91 | 1000 | 1.10 | 4.00 | 94.90 | 590 | 0.80 | 2.70 | 96.50 |
| 26.11.91 | 1000 | 1.20 | 4.20 | 94.60 | 598 | 0.80 | 2.90 | 96.30 |
| 27.11.91 | 1000 | 1.30 | 4.10 | 94.60 | 599 | 0.80 | 3.00 | 96.20 |
| 28.11.91 | 1000 | 1.30 | 4.00 | 94.70 | 559 | 0.70 | 2.90 | 96.40 |
| 29.11.91 | 1000 | 1.40 | 4.20 | 94.40 | 560 | 0.60 | 3.10 | 96.30 |
| 30.11.91 | 1000 | 1.20 | 4.10 | 94.70 | 565 | 0.70 | 3.00 | 96.30 |

## CONCLUSION

The mill produced CPO with a DOBI value of >3.0 consistently during the test period. Due to CPO stock constraints at the mill only one 500 tonne tank could be emptied for segregation purposes. Filling of this tank commenced 1/11/1991 and was filled by 10/11/1991. For this duration tank samples yielded a minimum DOBI value of 3.34 and a maximum of 3.54, giving an indication of the quality of CPO produced in the period. The mill continues operations with the 20/20/30/30 psig sterilization regime of 70 min.

Considering that the aforementioned results were achieved in a mill where 35% of FFB processed is contributed by private growers, Sabah Land Development Board is confident that such optimization of sterilization regimes will result in an improvement of the quality of CPO produced, consistent DOBI values of 3.0 being achievable.

## ACKNOWLEDGEMENT

The authors thank Sabah Land Development Board for permission to publish this paper and record their appreciation to Mr. Rod Wong, COPE, Sabah Land Development Board, for his guidance and involvement in the project.

## APPENDIX I

### GRADING STANDARD — SABAH LAND DEVELOPMENT BOARD

Categories of fresh fruit bunches are as follows:—

| | | |
|---|---|---|
| A. | UNRIPE | : FFB with no outer fruitlets detached. |
| B. | UNDERRIPE | : FFB with less than ten (10) outer fruitlets detached. |
| C. | RIPE | : FFB with more than ten (10), but with less than 75% of outer loose fruits detached. |
| D. | OVERRIPE | : FFB with more than 75%, but with less than 100% of outer fruitlets detached. |
| E. | ROTTEN | : FFB with 100% outer loose fruits and up to 50% of inner loose fruits detached. |
| F. | EMPTY | : FFB with little (<20) or no fruitlets attached. |
| G. | OFB | : FFB that more than two days old upon receipt at the mill. |
| H. | LONG STALK | : FFB with length of stalks greater than 30 cm. above the first fruitlet formed on the bunch. |
| I. | LOOSE FRUIT | : The quantity of loose fruits presented with the load of FFB. |