Implementation of Best Management Practices in an Oil Palm Rehabilitation Project

By William Griffiths and T.H. Fairhurst

Implementation of best management practices (BMPs), including soil phosphorus (P) recapitalization, resulted in a rapid increase in palm nutrient status and yield in the first year following implementation in South Sumatra. On the highly weathered and low soil P status soils of the region, high yields can only be expected where soil P deficiency has first been corrected by a large one-time application of reactive rock phosphate (RRP).

PT Asiatic Persada (PTAP) is an 8,500 ha oil palm rehabilitation project in Jambi Province, South Sumatra, Indonesia, where the area planted to oil palm exceeds 250,000 ha. Most soils in the plantation are Ultisols with very low soil P and potassium (K) status (**Figure 1**).

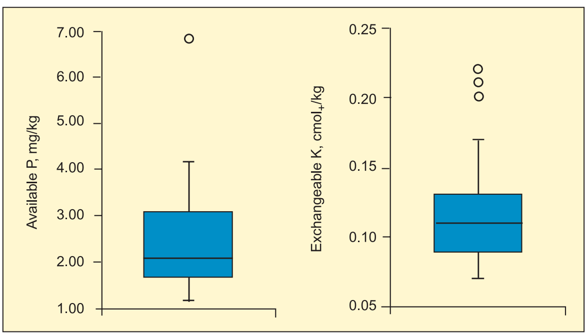

Figure 1. Soil P and K status in PT Asiatic Persada (n=39).

The topography is typical of Jambi Province with a rolling landscape and moderate to steep slopes intersected with small creeks and rivers. The plantation was planted between 1988-1989 but required extensive rehabilitation when acquired by its present owners in 1999. In some areas, fertilizer had not been applied and palms had not been harvested for several years, and ground cover consisted of mainly hard weeds such as Straits rhododendron (*Melastoma malabathricum*), tropical bracken (*Dicranopteris linearis*), and alang-alang (*Imperata cylindrical*). See **Photo 1**.

Photo 1.

In 2001, BMPs were introduced with several objectives. First was to determine the site-specific yield potential under optimal management conditions where yield is limited only by climate and the potential of the planting material. There was a need to demonstrate to plantation staff the required standards of field upkeep and maintenance in line with standards described in the PPI/PPIC oil palm field handbooks (Rankine and Fairhurst, 1999a; Rankine and Fairhurst, 1999b; Rankine and Fairhurst, 1999c). Use of BMPs helped us investigate the effect of a one-time application of RRP to correct soil P deficiency.

Seven representative fields, each about 30 ha and comprising a total of 210 ha, were selected for rehabilitation. Work commenced in

October 2001, in the following step-wise sequence. All woody weed growth was removed and harvest paths and palm circles were established by hand weeding and spraying herbicide (**Photo 2**). Soil conservation measures (platforms, contour paths) were installed to reduce soil erosion losses and surface water run-off (**Photo 3**). Field drains and improved drain outlets were installed in areas affected by temporary and permanent inundation. Supply palms were planted to bring the field to a complete stand of palms. There was a one-time 300 kg P_2O_5/ha application of RRP over the palm inter-rows (**Photo 4**). About 40 t/ha empty fruit bunches (EFB) were applied to improve soil physical properties, supply nutrients, and prevent the loss of applied P fertilizer in surface water run-off (**Photo 5**). Shade tolerant legume cover plants (LCP) (*Calopogonium caerulium*) were established by planting cuttings between each palm (**Photo 6**). Corrective pruning removed unproductive fronds and improved access for harvesting.

Photo 2.

Photo 3.

Photo 4.

Photo 5.

Photo 6.

Except for the ameliorative application of RRP, standard estate fertilizer recommendations were used in the BMP fields: 1.4 kg nitrogen (N)/palm as urea; 0.9 kg P_2O_5/palm as RRP; 1.95 kg K_2O/palm as potassium chloride (KCl); and 0.07 kg magnesium oxide (MgO)/palm as kieserite. Strong interactions were expected between the different procedures. For example, LCP are highly responsive to P fertilizer and thus an application of RRP is expected to increase biological N fixation through increased biomass production in the LCP. Phosphorus fertilizer is comparatively immobile in soil and large losses of surface applied RRP can be expected due to surface wash on sloping land. Thus, an application of EFB mulch not only provides nutrients and a mulch layer, but also helps to reduce losses of surface applied RRP. Installing soil conservation measures, which also facilitate harvesting and crop removal, further reduced losses of fertilizer nutrients.

In some fields, there was a need to fill in large gaps in the palm stand and thus a full return on the rehabilitation effort can only be expected when these supply palms come into production after 24 to 30 months. Nitrogen deficiency symptoms were observed in low lying areas adjacent to creeks and rivers in some BMP fields and field drains were installed to remove standing water and thus improve the availability of soil indigenous N.

Yield. Bunch weight and yield were larger in the BMP fields at the start of BMP implementation. However, on average, yields in BMP fields increased by 6.1 t/ha (58%) in 2002 compared with an average increase of 3.1 t/ha (31%) for all fields in PTAP (**Table 1**). The greater increase in yield in BMP fields was explained by larger increases in bunch number and bunch weight when compared with the estate average. Since there is a time lag of 36 to 40 months between the initiation of a flower and the production of a fruit bunch, the full effect of rehabilitation

Table 1. Mean yield components in BMP fields and PTAP, 2001-2002.

	Bunch weight, kg		Bunch production, number/palm		Yield, t/ha	
Year	BMP fields	Estate average	BMP fields	Estate average	BMP fields	Estate average
2001	13.3	11.6	7	7	10.4	8.9
2002	15.8	13.0	10	8	16.5	12.0
Increase	2.5	1.4	3	1	6.1	3.1
%	19	12	43	14	58	31

cannot be expected until three years after the implementation of BMPs.

Increased yield was explained mainly by the effect of improved nutrient management and better crop care on the number and weight of bunches produced. The oil palm is very sensitive to stress resulting from poor management, drought, and nutrient deficiencies. When crop care is improved, the short-term effect is an increase in bunch weight because a greater assimilate supply allows for improved bunch development. The long-term effect of stress alleviation is to reduce the number of flowers lost due to floral abortion and increase the ratio of female to total flowers (termed the sex ratio) and thus increase the number of flower initiates that result in the production of a harvestable bunch. One field exceeded the estimated attainable yield for PTAP and it is expected that five of the seven BMP fields will reach the attainable yield of 25 t/ha fruit bunches in 2003.

Nutrient status. There was a large improvement in palm nutrient status for N, P, K, and Mg in all BMP blocks in 2002 compared with 2001. There is no evidence of nutrient deficiencies (**Table 2**).

There was a large increase in leaf N, P, and K status from deficiency in 2001 to sufficiency in 2002. To maintain the required palm nutrient status in 2003 and in anticipation of greater yields in 2003, the N fertilizer rate will be adjusted to 1.6 kg N. Since P deficiency has now been corrected, the P application rate will be decreased to 0.3 kg P_2O_5; K rates will be maintained at 1.95 kg K_2O/palm in anticipation of increased yield.

Ground cover. Shade tolerant, N-fixing LCP can be established from cuttings under mature palms. Growth of the LCP was more rapid after the one-time application of RRP and EFB mulch. Since the supply of EFB is limited, PTAP will investigate techniques to establish LCP without empty bunch mulching by increasing the initial supply of NPK fertilizer nutrients to LCP cuttings. An alternative and promising LCP is *Mucuna bracteata*. Seedlings have been grown in a nursery and planted out in the field. These plots and areas planted with *C. caerulium*, but without empty bunch mulching, will be monitored closely to determine whether *M. bracteata* and *C. caerulium* can be established without applying a mulch.

Table 2. Leaf nutrient levels in BMP fields before and after rehabilitation.

	Leaf nutrient status (Frond 17), % dry matter					As % total leaf bases	
	N	P	K	Mg	Total leaf bases	K	Mg
2001	2.33	0.130	0.85	0.28	71	30	32
2002	2.67	0.165	1.08	0.30	78	35	32

Pernicious weeds have practically disappeared from BMP fields due to the combined effect of LCP, EFB, and improved soil P status following the remedial application of rock phosphate.

Pruning and canopy management. As the yield increases, it will be important to monitor the palm canopy closely to ensure that sufficient leaves are retained on each tree, but that dead fronds are removed during harvesting and by periodic pruning. Ideally, five spirals of eight leaves or 40 leaves/palm should be maintained on all mature palms. Unproductive palms in the BMP fields will be marked, monitored, and removed to reduce competition with productive palms. Supply palms will require careful maintenance and adequate N, P, and K fertilizer inputs to ensure that they come in to bearing 24 to 30 months after planting.

Economic returns. The average yield increase in BMP blocks in 2002 was +6.0 t/ha FFB [1.32 t crude palm oil (CPO), 0.22% oil extraction rate (OER) at US$480/t], which resulted in an increase in revenue of US$634/ha. This compares with the average yield increase for PTAP of 3 t/ha FFB (0.66 t CPO, 0.22% OER) giving a revenue of US$316/ha (i.e., a net increase in revenue of US$154/ha).

Thus, rehabilitation costs of about US$100/ha were more than offset by the increase in revenue in the first year after rehabilitation.

Discussion and Conclusions

The implementation of BMPs in selected fields in PTAP resulted in a much greater rate of yield recovery. PTAP plans to incorporate the techniques used in BMP fields over about 1,500 ha of the remaining part of the estate. We have shown that the integrated use of RRP, EFB mulch, and shade tolerant cover plants are a cost effective method to rehabilitate low nutrient status soils planted to oil palm. **BCI**

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