

Key Principles of Crop and Nutrient Management in Oil Palm

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There are substantial opportunities for the oil palm industry to increase productivity on planted land, considering the scarcity of suitable land for further expansion in Southeast Asia. We propose a framework for an ecological intensification of oil palm production, summarizing key crop and nutrient management principles.

Driven by an increasing demand for oil palm products, crude palm and kernel oil production in Malaysia, Indonesia, and Thailand increased by 92% from 12.5 million metric tons (M t) in 1993 to 24.0 M t in 2002 (FAOSTAT). Production increases were largely caused by an expansion in the area under harvest in Malaysia and Indonesia, while crude palm oil yields have stagnated in the two countries in the last 20 years (**Figure 1**).

Major environmental challenges in further increasing palm oil production in Southeast Asia include limitations in area expansion and an increasing scrutiny by the public demanding ecological palm oil production. Future productivity increases must be achieved from crop management intensification on land already under oil palm because area expansion is now only possible in less favorable environments, both in terms of resource quality and infrastructure.

Changes in palm oil demand, environment, and socio-economic conditions are expected to drive changes in the management of oil palm estates in Southeast Asia. The rapid development of oil palm production in the region has revealed a shortage of qualified management staff, an apparent scarcity of labor due to alternative employment opportunities and associated increases in labor cost, and the requirement for

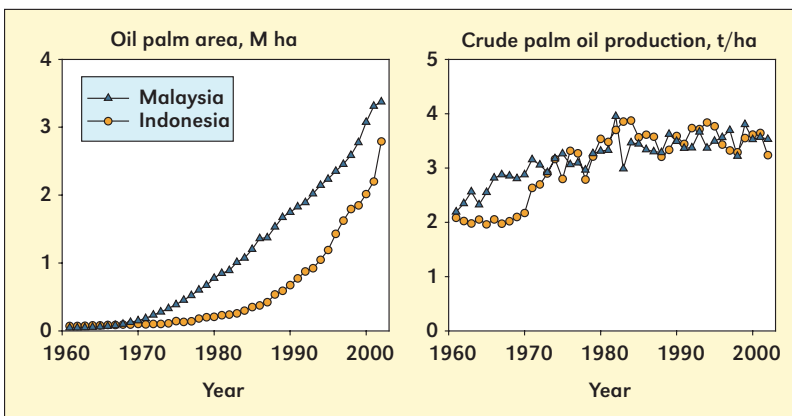


Figure 1. Oil palm area and production of crude palm oil in Malaysia and Indonesia in 1960-2002. Data source: FAO (www.fao.org).

regional migration of labor. To maintain regional productivity advantages in palm oil production compared to the global production of other vegetable oils, sizes of cooperatives or estates are likely to increase while a smaller, more knowledgeable work force will need to employ more advanced technologies.

Oil palm growers and researchers have made substantial progress in recent years to develop standardized, optimal crop and nutrient management practices that promise high productivity and profitability through efficient and effective use of inputs and resources. These practices and associated readily available, more 'knowledge-intensive' technologies have recently been summarized into five major crop and nutrient management principles (Witt et al., 2005).

Principle 1:

Decision making based on relevant information.



The key to optimal resource management is to understand the spatial and temporal variability of factors that influence production. The contribution of factors to productivity needs to be quantified and analyzed in time and space to identify the variability in fruit bunch production that can be managed. The proposed framework for an ecological intensification therefore aims to guide decision makers in their identification of key constraints to increasing productivity through quantification of relevant production indices and consequent analysis of gathered data. Thus the Agronomic Management Information System (AMIS) is used to devise strategies that can evolve as constraints to productivity increases are removed. AMIS requires tools for data collection, an adequate database management system, integrated analytical procedures, and mapping facilities to analyze data over time and space. Outputs include reports, maps, tools, and guidelines for a step-wise implementation of strategies for productivity enhancement based on need or capacity. Complete documentation is further required to obtain the international certification for ISO 9001 and 14001 for Quality and Environmental Management Systems.

Principle 2:

Development of management units based on soil and plant surveys.



It is a standard practice in oil palm plantation management to extrapolate estimates of relevant plant and soil parameters measured below the block scale to larger areas or management units. Sampling requirements for estimating the values of relevant parameters depend on the homogeneity of the management unit of interest and have been well established, for example, for leaf sampling units (Foster, 2003). The first step in the development of management units is a proper land and soil survey providing information on the expected site-specific yield potential affected by the soil resource base, the occurrence and extent of soil problems, and the likely cost of corrective measures. A detailed

summary of a land evaluation classification system for oil palm providing the criteria and class limits for land and soil is provided by Paramanathan (2003). Boundaries of management units for fertilizer application would need to be defined based on a minimum set of available biophysical characteristics that determine uniformity of yield potential, yield stability, indigenous nutrient supply, soil constraints, leaf nutrient status and deficiency symptoms, and an expected response to fertilizer within the management unit. We propose to use soil maps (e.g., soil texture), topography, watershed, block boundaries, (long-term) yield statistics, palm age, drainage, and other existing and readily available information as a starting point for the delineation of management units.

Principle 3:

Best management practices for optimal economic yield.

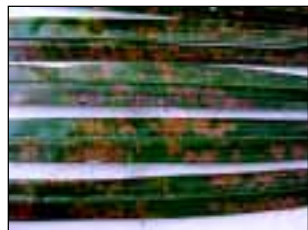
A limited number of blocks with best management practices (BMPs) strategically placed in a plantation provide a useful tool to: i) determine site-specific attainable yield under optimal management conditions (Griffiths et al., 2002), ii) estimate peak crop production (% annual crop in a single month) for planning mill capacity requirements, iii) demonstrate the effect of management practices on crop performance and soil improvement, iv) train staff on the implementation of new practices, and v) test new technologies. Under BMP conditions, yield is only limited by climate, planting material, and site-specific natural resources such as soil texture, rooting depth, or water. Priorities need to be identified based on a proper inventory of planting conditions, and management practices are rated according to the greatest impact expected. Changing a limited number of management practices in BMP blocks allows a quantitative analysis of the interaction of different management factors on yield. Yield gaps between BMP and surrounding blocks can be directly linked to differences in crop recovery, canopy and nutrient management, drainage, and other BMPs. The BMP blocks serve both as benchmark and demonstration for training and required standards of field upkeep and maintenance in line with standards described in the oil palm publications by the Southeast Asia Program (SEAP) of PPI/PPIC-IPI >[website: www.seap.sg](http://www.seap.sg)<.



Principle 4:

Plant-based determination of nutrient needs.

Nutrient deficiencies and associated nutrient needs of oil palms are largely based on an evaluation of the current nutritional status from plant tissue analysis. Such fertilizer systems ...including the choice of tissue for sampling, leaf sampling units, palms for sampling, and time of sampling...have been described in great detail elsewhere (Foster, 2003; Fairhurst et al., 2005). Foster (2003) provides an extensive review of the interpretation of leaf analysis results including the problem of variation in optimum leaf nutrient levels, the prediction of optimum leaf nutrient levels, the relationship of total leaf cations and palm



age, and the prediction of yield response from leaf nutrient analysis results.

We propose to integrate the examination of foliar tissue analysis with other plant based indicators of nutrient deficiencies over time and space such as leaf deficiency symptoms, yield, vegetative growth, and ground vegetation. Such opportunities arise only when relevant data have been carefully stored in an adequate database management system with associated analytical tools (e.g., OMP 8, www.agrisoft-systems.de) providing the decisionmaker with rapid overviews of likely nutrient deficiencies.

Principle 5:

‘Need-based’ fertilizer use for effective use of nutrients.



The key objective in ‘need-based’ fertilizer management is the effective use of nutrients. That requires both preventive and corrective measures to manage nutrients efficiently, sustain the soil resource base, and increase the profitability of palm oil production. Much progress has been made in recent years to develop site-specific solutions as compared to blanket fertilizer applications (Goh et al., 2003). Research has largely focused on improving the foliar diagnosis of oil palm, which has become the most widely used strategy to detect and overcome nutrient deficiencies. For specific-site conditions, reliable predictions of nutrient needs can be made because yield responses to individual fertilizers are highly correlated with nutrient levels, except for boron (B). Generic concepts have been devised for the interpretation of leaf analysis results, particularly in identifying optimal leaf nutrient levels and yield responses from leaf analysis considering the interaction of nutrients. Fertilizer recommendations are then developed based on foliar diagnosis supported by multi-factorial fertilizer trials. The major purpose of multi-factorial fertilizer response trials is to obtain estimates of yield responses to nutrients, to observe changes in leaf nutrient status, to estimate recovery efficiencies of applied fertilizer nutrients, and to evaluate the nutrient interaction when more than one nutrient is included in the trial. While multi-factorial fertilizer trials will be required to obtain more detailed information on nutrient interactions and nutrient use efficiencies, smaller estates might seek alternative approaches to fine-tune fertilizer nutrient recommendations. There is clearly a need to explore new site-specific concepts to optimize fertilizer nutrient use considering yield gap analysis, benchmark yields in BMP blocks with embedded nutrient omission plots to determine nutrient limited yield, and estimates of agronomic efficiency (yield increase per unit fertilizer nutrient applied).

OilPalmPlatform

The principles of crop and nutrient management along with evolving strategies for their implementation are promoted through the Oil Palm Platform (www.oil-palm.info). The platform builds on efforts of

individual oil palm agronomists and technical experts from various companies and organizations interested in the integration of information, tools, and technologies. Members share a common vision that oil palm estates need to be economically feasible as well as socially and environmentally responsible to become part of a sustainable future of the oil palm industry. The ecological intensification of crop and nutrient management offers substantial opportunities to achieve this goal.

The PPI/PPIC-IPI Southeast Asia Program (SEAP) continues its long tradition of supporting planters through research, training, technology development, and publications in partnership with leading institutions and companies. The Oil Palm Platform provides an opportunity to further strengthen our efforts in directly collaborating with estates in the evaluation, adaptation, and improvement of technologies promoted by the Oil Palm Platform. **BC**

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