

An Introduction

IPNI Best Management Practice (BMP) Process

**Supported by Plantation Intelligence
& Estate-Scale Experimentation**

Sustainable Intensification

Reduced yield gaps, increased oil yields



An Opportunity for Oil Palm

Commercially cultivated oil palm has the potential to yield up to 11 tons of crude palm oil (CPO) per hectare. Yet CPO yield in Malaysia and Indonesia—the source of more than 85% of global production—averages between 3 and 4 tons per hectare, with the best private plantation groups achieving 6–7 tons per hectare. As terms of trade deteriorate and expansion through rapid land acquisition becomes unsustainable, finding new ways to raise productivity has become a key agenda for CPO producers. Best Management Practice (BMP)—a diverse set of plantation management practices that draw on in-field experiments to derive customized intervention activities—has been put forth as a most viable strategy going forward. The idea is that by understanding existing “yield gaps” and investigating them as opportunities for intensification, a CPO producer will be able to progressively achieve higher yields and maximize the potential of its crop.

Best Management Practice

Reducing yield gaps to improve oil yields


Best Management Practice (BMP) is a management tool for assessing potential yield improvement before costly resources are allocated. A portfolio of site-specific, in-field BMP activities are first tested in small “blocks” to confirm their combined effectiveness. Those that deliver the best results are then evaluated to create a customized management program.

A BMP exercise involves observing the differences between a pair of planted blocks: a block where a BMP has been introduced, and a reference (REF) block where the current practice is maintained. By analyzing the data from several pairs of such test blocks, a plantation operator will be able to determine the most desirable combination of BMPs for a particular site.

A set of BMPs are tracked over time to ensure their results are correctly attributed. At the estate manager’s judgement, this combination of BMPs can then be adopted in more blocks, the whole plantation, or fine-tuned in Estate-Scale Experimentation (ESE). This set of BMPs, when successfully adopted, will become the new baseline and a new cycle of BMP evaluation may be initiated.

When yield-impacting factors are unclear, a study can be done on routinely-collected data of crop performance and daily operations in an analysis process called “Plantation Intelligence” (see the series booklet, *IPNI SEAP Contribution No. PS2014-2*) to identify yield driving factors.





A BMP study will allow the grower to exploit yield gaps for productivity gains.

Sustainable Intensification

Optimizing environmental resources and recalibrating external inputs to increase crop yield without jeopardizing future production is known as “**sustainable intensification**.” BMP helps both commercial plantation owners and smallholders alike to achieve sustainable intensification through a set of field-tested practices.

Two types of BMP

There are various BMPs to boost a plant's performance throughout its lifespan. BMPs may be “**yield-making**” which relate to biological growth, or “**yield-taking**” which relate to harvesting activities. Informed by data from a BMP project, a plantation owner will be able to make better investment decisions—on fertilizer and labor for example—based on in-field, commercial-scale evidence.

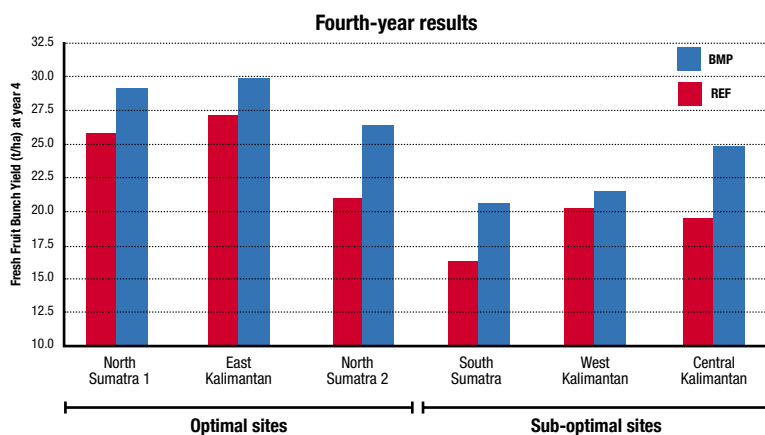
Characteristics of BMP

- Works across environments, plantation business philosophy, and genetic materials
- Benefits both plantation and smallholder production systems
- Matches the biophysical profile of a crop to its growing environment
- Focuses on “yield-making” (crop health and nutrition) and/or “yield-taking” (crop recovery) activities
- Provides comparison between new and existing practices
- Helps establish relationship between activities, investment, and yield



BMP increases yield on both optimal and sub-optimal sites

Fourth-year results from an IPNI BMP project in Indonesia indicate that BMP delivers a higher yield on both optimal and sub-optimal sites than the standard estate management practice (REF).



Source: IPNI SEAP

The Reason for BMP

Intensification: Producing more with less

The Food and Agriculture Organization (FAO) of the United Nations projected that in the next 40 years, agriculture must produce about 70% more food to meet the needs of a greater population. And it must do so while maintaining or even reducing its demand on natural resources. BMP is one way for existing producers to achieve this goal through intensification by applying agronomic principles strategically.

Field data to guide commercial operations

IPNI's BMP program is a system for plantation operators to generate the necessary knowledge to achieve efficient resource allocation. Through experimentation, plantation managers will generate a portfolio of BMPs most suitable for a particular site. The insights gained will help address issues in farm management such as fertilizer optimization and site variability.

Closing the gap between actual and potential yield

The concept of yield gap is a particularly important one for oil palm because oil palm has the potential to produce more oil per hectare per year than any other oil crops. However, many producers fail to exploit the full genetic potential of the crop. Worse still, some are experiencing declining yield.



It's the entire system that matters

For a crop to perform to its potential, the entire ecosystem, including the actions of plantation operators, must be supportive. BMP seeks to create such a nurturing environment.

Fertilizers and plant residue improve soil quality for long-term productivity.

Growing and harvesting effectively

While taking steps to produce more fruit bunches is important, producers need to also ensure that all fruit bunches actually make it to the mill. A “yield-taking” BMP on effective harvesting may be implemented in tandem with a “yield-making” BMP on nutrient management so that the full effects of a BMP program can be realized.



BMP benefits both well- and under-performing blocks

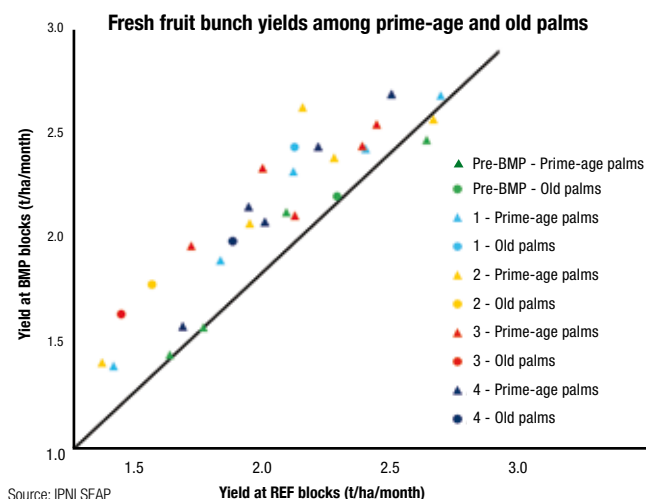
The results from IPNI's BMP projects in Indonesia since 2001 show that BMPs can raise yield at both well- and under-performing sites. BMPs governing crop recovery, canopy and nutrient management, drainage, and labor deployment proved particularly effective.

Boosting yield at all growth stages

Oil palms respond to BMP in every growth stage, from nursery to immature and mature. Palms that have reached a plateau or are even declining in their fruit-producing capability may still respond positively to BMP measures.

BMP benefits prime-age and old palms alike

BMPs increased fresh fruit bunch yields across all growth stages in practically all estates in IPNI's BMP projects in Indonesia. Sites in this project were located in five major Indonesian growing regions, and were managed by companies with different business philosophies. The diagonal 1-to-1 line represents the same yields for BMP and REF. The fact that all points are above that line illustrates the superiority of BMP over REF.



BMP

A solution for the oil palm industry

Oil palm supplies about 30% of the world's vegetable oil.¹ Demand for palm oil has grown exponentially since the 1970s, thanks to its relatively low production cost and competitive price on international markets. But the unfettered land expansion that fueled growth in the past—including into forests and peat lands—has become unsustainable and increasingly controversial.

Indonesia and **Malaysia** are the world's top producers of palm oil. They are also where any improvement in palm oil production will produce the greatest benefit. BMP, as a plantation management tool, is able to provide the essential guidance for both plantation owners and smallholders to uncover new growth opportunities.

Oil palm's relatively low growth in yield despite high growth in trade volume is itself a reason to adopt **agronomy-based plantation management practices**. The results of implementing BMP are not only higher yield but also reduced pressure on land, biodiversity, and carbon footprint.²

Another argument is especially relevant for oil palm producers. Studies have shown that many producers are not managing their crop optimally, and have failed to realize the **genetic potential** of their crop. The gap between potential and actual yield is a problem that can be managed effectively with BMP.³

Because oil palm, unlike other oilseed crops such as rapeseed, soybean, and sunflower, has a long crop cycle and the many management decisions made in the crop's early years will have a lasting impact on productivity, BMP has also been suggested because it offers a solution for **every stage of a crop's life cycle**.

IPNI consultants visit a BMP trial block. As the world's top producers of palm oil, Indonesia and Malaysia will have much to gain from any improvement in palm oil production.

¹ USDA-FAS, 2013

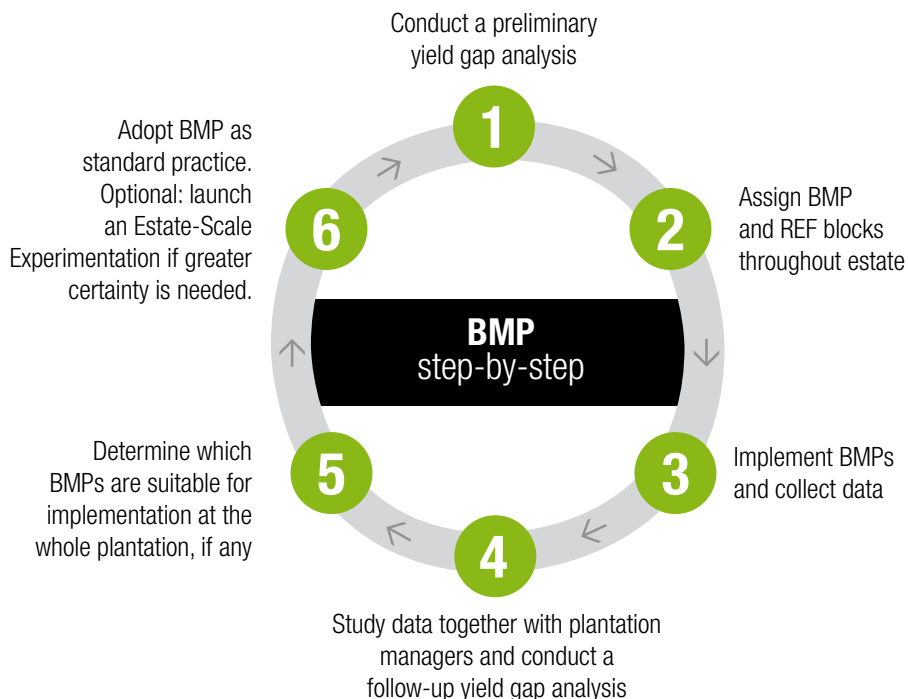
² Germer & Sauerborn, 2008

³ Corley, 2005



The Process for BMP

A BMP project involves data collection and analysis over a period of one to eight years depending on the BMPs being tested and the growth stage of the crop. It requires the commitment of plantation staff, managers, researchers, and owners. Working with the local team, IPNI's consultants will help develop a workplan that includes six key processes.



BMPs for functioning estates

For managers of a functioning estate, the more practical BMPs are those that relate to nutrient, crop, and canopy management. They can be implemented immediately with minimal disruption to the commercial operation.



A seedling is dissected to explain the impact of BMPs on leaf and flower development.

1 Preliminary yield gap analysis

The first step is to assess how a crop is performing and its production environment. Generally, oil palm plantation managers are well aware of the need to address yield gap issues.

CAUSES OF YIELD GAPS

- **Genetics and early-life deficiencies.** This refers to shortcomings that are inherent in the seed or the result of neglect during the nursery stage. The opportunity for intervention is limited to the initial set-up of a plantation and each subsequent replanting.
- **Nutrient management.** This refers to the crop's nutrient requirements throughout its lifespan and the importance of an agronomy-led management approach based on the principles of 4R Nutrient Stewardship.
- **Plantation management.** This refers to the management of the various activities in a functioning estate.

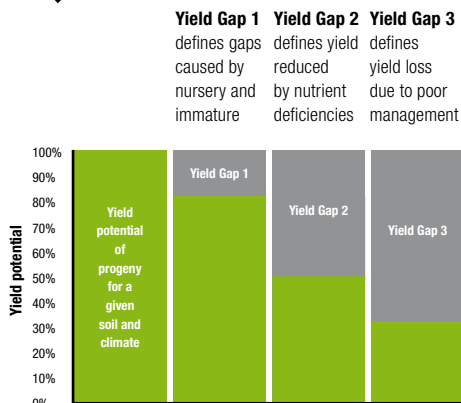
2 Selection of BMP and REF blocks

A BMP exercise will always involve a pair of comparable fields, known as “blocks.” In one, a BMP will be introduced, while its neighbor, called a “Reference” (REF) block, will continue to be managed as it has been.

As much as possible, the BMP and REF blocks must be comparable and representative of the site under evaluation. The blocks should share similar soil type, yield history, and stand and site characteristics.

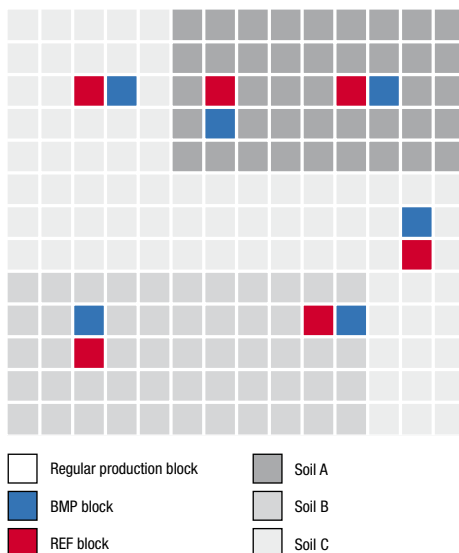
The better performing of the two will be marked for REF so that the outcome from the BMP block will not be biased by a headstart. A minimum of five pairs of BMP/REF blocks are recommended for each BMP exercise, with one BMP block in every 1,000 ha.

Yield potential and yield gaps



Selecting BMP and REF blocks

A sample estate with three soil types with one pair of BMP/REF blocks per 1,000 hectares.



3 Monitor and measure

It is important to set target standards for the BMP and REF blocks and how they will be monitored. Collection of data can proceed when a schedule of work involving both routine and non-routine activities are finalized. A commercial plantation's routine measurements may be supplemented by additional measures if a particular BMP requires more detailed analysis.



4 Follow-up yield gap analysis

When sufficient data has been collected, IPNI's consultant and the plantation management team will come together to analyze each set of data. This is a quantification and interpretation process, and is carried out in a learning dialog.

5 Optional: Estate-Scale Experimentation

After studying the data from several cycles, the plantation manager will make a judgement on whether any of the BMPs are ready for implementation at full plantation scale. If the manager is confident that most uncertainties have been eliminated, the set of BMPs may be implemented immediately throughout the entire plantation. If not, he may continue to test further with Estate-Scale Experimentation (ESE) (see the series booklet *Plantation Intelligence, IPNI SEAP Contribution No. PS2014-2*).

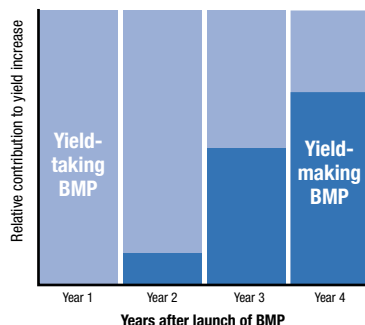
6 A new baseline for the next BMP exercise

Once an ESE is in progress and the crop is performing in line with expectations, the BMPs may be adopted as standard practice. At this stage, a plantation manager will also have the option to launch a new BMP project to further improve yield.

“Yield-making” and “Yield-taking”

Yield-making BMPs will result in more fruit bunches produced. When palms become stressed due to sub-optimal growth conditions, their biological feedback mechanism will alter the ratio of male and female flowers and induce floral abortion. Soil, water, and nutrient yield-making BMPs are crucial for floral initiation and subsequent bunch development, by preventing or removing stress situations. However, due to the 3–4 year period from floral initiation to fruit bunch ripening and harvest, there is a time lag before the impact of these BMPs can be seen in increased production.

Yield-taking BMPs will result in thorough, effective harvesting and transport to the mill. Their effect is immediate upon implementation.



Options for Change

BMPs are specific crop management activities based on agronomic principles. By testing these activities in the field, plantation operators will be able to identify those that deliver the best results for a particular site. There are some 20 BMPs that IPNI has implemented in commercial plantations since 2006*. Here are three case studies:

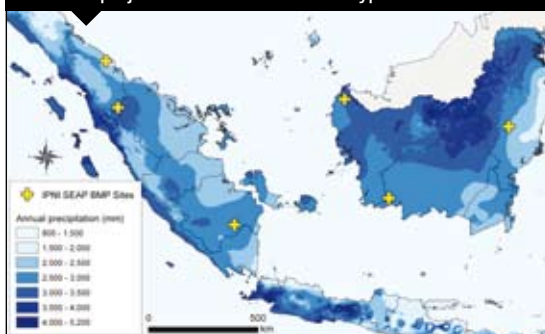
CASE STUDY 1

BMP to improve soil quality

Background

- Six oil palm plantations in Kalimantan and Sumatra
- BMP and REF blocks were tested for their soil properties such as pH, % soil organic carbon, total N, available P, and exchangeable cations before and after trials
- Period of experiment: four years
- Experiment areas cover a range of growing environments

The BMP project involved different soil types in six locations



Results and conclusions

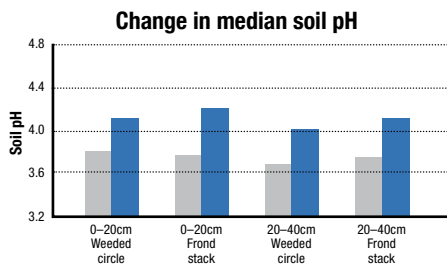
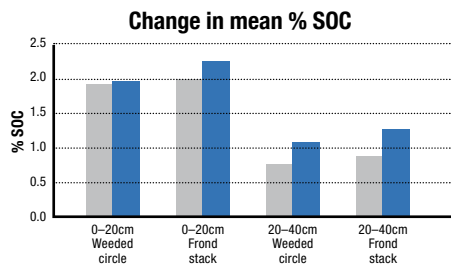
- Following the BMP project, substantial positive changes were recorded in soil properties, most notably soil pH and soil organic carbon (SOC)
- The mulching of empty fruit bunches—a nutrient-generating BMP—contributed additional nutrients to the soil
- BMPs that improve soil quality: Tailored management of fertilizers, and application of organic matter or plant residue to the soil surface in the form of empty fruit bunches (EFB; a waste product from the milling of fresh fruit bunches), pruned palm fronds, and compost
- Benefits from BMP: cost-effective yield improvement, minimized environmental impact through external inputs, and improvement in soil quality over the longer term

* Details about the BMPs and the deployment process can be found in IPNI SEAP's oil palm field handbooks and pocket guides.

BMP improves soil quality

The positive effects of BMP on soil organic carbon and soil pH.

Before BMP After BMP

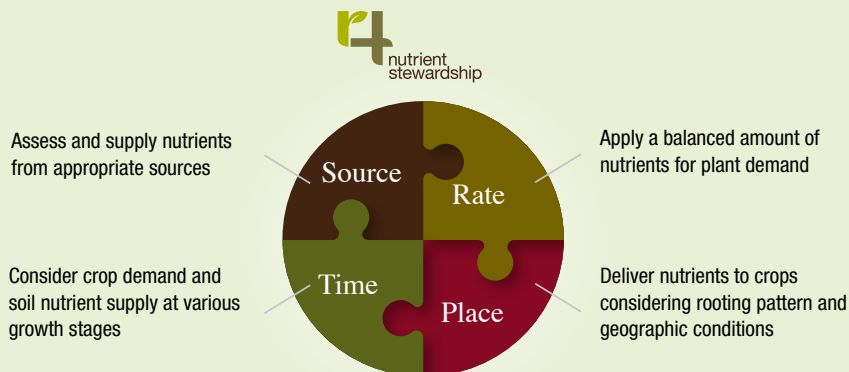


Source: IPNI SEAP and Pauli et. al., 2014

Intensification of agriculture is often thought to degrade overall environmental quality. However, with the appropriate BMPs in place, and specifically with the application of IPNI's 4R Nutrient Stewardship concept, the reverse is not only possible but routinely achievable. Soil quality can be improved even as yield is raised.

The IPNI 4R Nutrient Stewardship

Improving soil quality is part of a bigger concept promoted by IPNI. Called the 4R Nutrient Stewardship, it defines the right source, rate, time, and place for fertilizer application as those producing the economic, social, and environmental outcomes desired by all stakeholders to the plant ecosystem. The 4Rs are interconnected and interact with the surroundings of plant, soil, climate, and management. These variables must work in harmony to achieve the desired economic outcomes and sustainability.



BMP to increase oil yield

Background

- Potential palm oil (PO) yield at commercial scale has been estimated at 10–11 t/ha. Yet national average PO yields in Indonesia and Malaysia range between 3 and 4 t/ha, with the best plantation groups achieving up to 6–7 t/ha, suggesting a substantial yield gap and a great opportunity for BMP intervention

Factors considered

- Oil yields depend on the quantity of fresh fruit bunches (FFB) and the oil content of these bunches. To increase oil yields, growers can:
 - 1) Increase FFB production
 - 2) Increase the oil extraction rate (OER) of FFB
- BMPs that impact extraction rates may be management-driven (harvest intervals, ripeness criteria, transport arrangement, labor input) or agronomy-driven (planting density, fertilizer and nutrient effects, and pest and disease control)



Oil extraction of samples from commercial-harvested bunches.



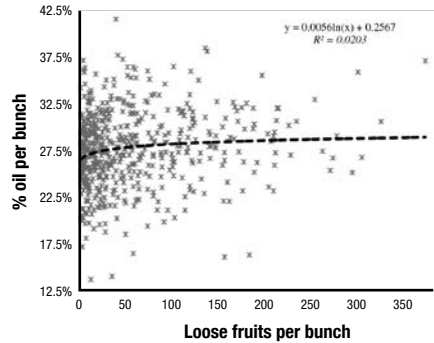
Detached oil palm fruits: Analysis of oil content of a harvested bunch must include a representative proportion of all fruits to avoid bias.

Results and conclusions

- From a BMP project at three sites in Indonesia, bunch analysis (BA) showed a slightly lower OER (−1%) as the result of a harvesting BMP, but that drop was more than made up for by a significantly higher BMP-assisted FFB yield. In this case, FFB was a more important contributor to a higher absolute yield of oil
- Oil content is maximized when an oil palm fruit is ripe and separates from a bunch (i.e. becomes a 'loose fruit'), but collection of loose fruits is difficult and losses become more likely the riper the bunches. Understanding the trade-offs between higher oil content and higher oil yield is essential when formulating the best combination of 'yield-taking' BMPs for a plantation

More oil, but also more fruit loss

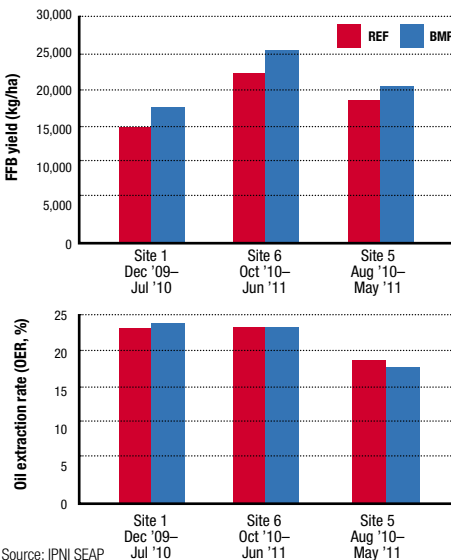
IPNI's BMP studies revealed that the gains from delaying harvest to capture the higher oil content of a riper fruit is negligible due to higher loose fruit loss.



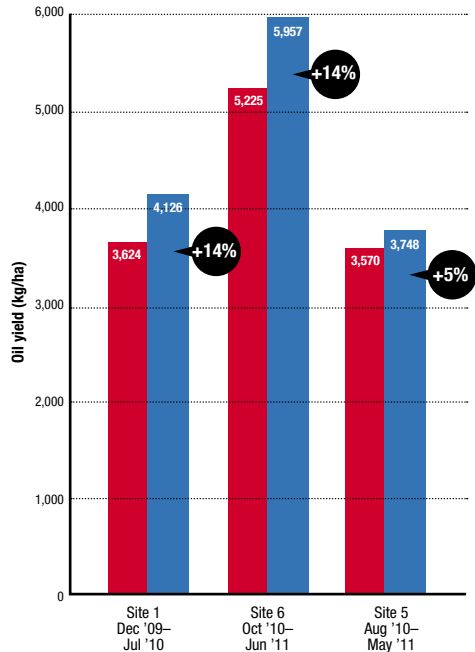
Source: IPNI SEAP

The trade-off between OER and FFB

Both oil extraction rate and fresh fruit bunch contribute to total oil yield. A BMP project will help growers understand their relationship and determine which activities to focus on.



Source: IPNI SEAP



BMP for smallholders

Background

- With the dwindling availability of land in Southeast Asia, oil palm investors are looking to West Africa as a potential location for new plantations
- West Africa's average FFB yield, at 3.4 t/ha, stands in stark contrast to that of Southeast Asia (18.5 t/ha) and Latin America (19 t/ha)
- From 1990 to 2012, Ghana's total fruit bunch production increased by 123% largely due to rapid increase in area under cultivation, but average fruit bunch yield fell from 6.5 t/ha to 5.4 t/ha
- In Ghana, oil palm demand was on the rise but fruit bunch yield was decreasing when IPNI initiated a BMP project in 2012
- The project included several plantations and 20 smallholder farms, where yield gaps are larger than in commercial plantations
- BMP tests were conducted to address the effects of sub-optimal climate conditions, soil fertility constraints, and field management



Results and conclusions

- After only 12 months, the average yield in smallholder farms rose 30% or 2.5 t/ha to 10.9 t/ha. The increase can be explained by shorter harvest intervals (16 days) and more thorough crop recovery after the installation of proper access (pruning, weeded paths) in BMP fields. This gain is a compelling argument for BMP to be implemented among smallholder farms
- Yield-taking BMPs, such as access and harvest intervals, proved to be a major factor in boosting yield
- The potential for yield-taking BMP to improve livelihoods in Ghana is tremendous, and we expect further increases from yield-making BMPs in this project in the next few years

BEFORE



A smallholder farm before a BMP-guided rehabilitation.

AFTER



Improved access after rehabilitation delivered a better yield immediately.

BMP

Doing the right thing: Nursery through maturity

Nursery phase (Project year 1)

- Source for good planting material from quality source
- Optimize growth of seedlings in nursery —two-stage nursery, good potting medium, correct spacing, adequate irrigation and nutrition, and effective pest and disease control

Land preparation (Project year 1)

- Assess and map land
- Fell existing stand
- Identify and delimit blocks
- Implement soil and water conservation measures

Planting (Project year 2)

- Ensure optimal plant spacing
- Minimize transplanting shock

Immature & planting phase (Project year 2–3)

- Guarantee optimal plant stand
- Maximize plant growth

Mature phase (Project year 4 and beyond)

- Ensure complete crop recovery
- Implement canopy management
- Implement soil, water, and nutrient management



MATURE PHASE

The Four Priorities

The following recommendations are expected to return greatest productivity increases across a wide range of planting conditions, climate, and soils:

Priority 1: Complete crop recovery through collection of all fruits and short harvesting rounds (access for harvesters, short harvesting intervals)

Priority 2: Optimal growth and fruit bunch production through canopy management (pruning, removal of unproductive palms)

Priority 3 Optimal root function and nutrient uptake through adequate moisture availability (drainage, water conservation)

Priority 4: Improvement of soil organic matter and indigenous nutrient supply through legume cover plants (note phosphorus requirements of cover plants), optimal nutrient use through complete utilization of crop residues (proper stacking of pruned fronds, empty fruit bunches, decanter cake), optimal access and erosion control through contour paths, optimal fertilizer use through weed-free areas around trees and correct fertilizer placement

What Happens Next?



At a commercial nursery.

Estate-Scale Experimentation

The final step in a BMP project calls on the plantation manager to make a judgement on whether to implement those BMPs that have proven effective on full plantation scale.

The BMP concept is about continuous improvement and sustainable intensification. After a set of BMPs has been integrated into an estate's routine activity, it becomes the baseline for the next cycle of BMP exercise. If managers are not confident enough about the effects of specific BMPs, they can opt to initiate an Estate-Scale Experimentation (ESE). See the series booklet *Plantation Intelligence*, IPNI SEAP Contribution No. PS2014-2.

Working with IPNI

A collaboration between adviser and operator



The International Plant Nutrition Institute's Southeast Asia Program (IPNI SEAP), a not-for-profit research and development organization, has developed a management program around BMPs to reduce yield gaps in mature oil palm plantations that is consistent with the principles of the Roundtable on Sustainable Palm Oil. Since July 2006, IPNI SEAP has worked with eight large plantation partners in Malaysia, Indonesia and Ghana.

All field activities are carried out and monitored by the local estate management team over several years. A central database will be established.

IPNI SEAP will provide assistance in initial surveys to determine the scope of a BMP project, training, agronomic and economic data analyses, and funding for soil and plant analyses at an accredited laboratory. It will also help plantation partners prepare the annual project report, which will include estimated increases in yield and profitability.

IPNI's ultimate goal is to assist plantation operators make an informed judgement on how they can best achieve sustainable intensification.



For more information, contact: Thomas Oberthür, Director, IPNI Southeast Asia Program at: toberthur@ipni.net

A full-page background image showing a person in a red shirt climbing a tall red ladder against a large palm tree in a plantation. Other people are visible at the base of the tree.

The BMP philosophy

Change the mindset:

- Experiment in times of high profits
- Consider nutrition an investment rather than a cost

Integrate scientific approaches:

- Implementation in a commercial environment
- Intelligent data analyses to guide agronomic activities

