Identification and elimination of yield gaps in oil palm plantations in Indonesia

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Outline of presentation

- Context
- Theory of yield gap management and best management practices (BMPs)
- Practical implementation
- Conclusions and perspective
CONTEXT - Challenges and opportunities

- Demand for vegetable oil to double by 2050 (Corley, 2009)
- At current yield an extra 12M ha of oil palm needed
- Increasingly stringent environmental controls
  - Crop carbon footprint
  - Forest displacement for new development
Why focus on yield intensification?

- **For the grower**
  - Maximize return on investment
  - Increase IRR and reduce payback period
  - Improved public profile

- **For the public and NGOs**
  - Efficient use of land occupied by oil palm
  - Spare land (and rainforest) for other uses
BACKGROUND - Site yield potential

- In Indonesia and Malaysia \(~35 \text{ t ha}^{-1}\) of fresh fruit bunches = \(8 \text{ t ha}^{-1}\) of oil?
- Derived from
  - Fertilizer trials
  - Blocks under long term best management
How to optimize three production phases?

- Shorten time to maturity and peak yield
- Prolong plateau phase
- Reduce rate of decline

After Ng, 1976
Measure change in frequency of yields for soil x palm age groups over time

Reduce variability and increase yield!
Oil palm productivity is very sensitive to environmental stress.
An interval of >36 months elapses between the formation of a flower and the production of a ripe bunch!

Source: Donough, 2008
Potential yield of a progeny under a given soil type and climate

Yield (\% potential)

Y-a  Y-n  Y-mey  Y-max

Yield potential of progeny for a given soil and climate
Yield gap 1 caused by deficiencies in planting technique

Yield potential of progeny for a given soil and climate

Maximum economic yield
Causes of Yield Gap 1?

- Poor plantation establishment
  - Poor nursery technique and culling
  - Erosion and compaction at land clearing
  - Incorrect planting density or inaccurate lining
  - Failure to replace unproductive palms
  - Poor gap filling at planting
  - Gaps due to palm death
  - Failure to establish legume cover plants
Yield gap 2 caused by nutrient deficiencies

Yield potential of progeny for a given soil and climate

Maximum economic yield

Yield reduced because of nutrient deficiencies

Yield gap 1

Yield gap 2

Yield (potential)
Causes of Yield Gap 2?

- Nutrient constraints
  - Failure to take account of soil variability
  - Faulty leaf sampling
  - Insufficient field inspection to corroborate results of leaf analysis
  - Failure to use long term data trends
  - Failure to make spatial analysis of nutritional trends
Yield gap 3 caused by poor management

- Yield gap 1: Maximum economic yield
- Yield gap 2: Yield reduced because of nutrient deficiencies
- Yield gap 3: Yield reduced because of poor management

Yield potential of progeny for a given soil and climate

Yield (% potential)

40 50 60 70 80 90 100

Y-a  Y-n  Y-mey  Y-max
Causes of Yield Gap 3?

- Poor harvesting and management
  - Inadequate infrastructure (mill-to-palm access)
  - Poor round control
  - Poor harvest supervision
  - Failure to implement fertilizer and crop residue application programmes accurately
  - Human resource management
SITE ASSESSMENT - Plot frequency of yields

Focus more attention on blocks with greatest scope for improvement.
Spatial analysis of yield gaps: Are blocks with large yield gaps dispersed or clustered?

Source: Gfroerer, 2009
PRACTICAL IMPLEMENTATION of BMPs

- Pilot phase runs for four years
- Evaluation
  - Productivity
  - Cost benefit analysis
  - Changes required in management
- Broad scale implementation (may begin after one year)
Fertilizer use efficiency is increased with proper spreading
Agronomic database provides quantitative basis for yield maximization

<table>
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<th>Company</th>
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<td>DFH 02/07/199</td>
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<td>Previous crop: 2nd forest</td>
<td>Land clearing: Full Man</td>
<td>Density: 135</td>
<td>Area: 46.4 ha</td>
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Manager’s comments

Source: Gfroerer, 2009
Excellent standards of management in place in a BMP block

- Healthy leaf canopy
- Sufficient ground cover
- Full access
- Complete crop recovery
RESULTS AND CONCLUSIONS
Comparison of BMP and non-BMP blocks over five years

Yield (t ha\(^{-1}\))

Bunch weight (kg)

Bunch number

Year

01 02 03 04 05

01 02 03 04 05

01 02 03 04 05
Results from six sites in Indonesia

- Average yield increase of 3.2 t ha⁻¹ (range 0.4 – 6 t ha⁻¹)
- Average increase in bunch number (114 bunch ha⁻¹) and bunch weight (+1 kg)
- Less difference between sites after BMP implementation

**Table:**

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Source: Donough, 2009
BMP works on degraded lands
(anthropic savanna of *Imperata cylindrica*)
Scaling up

- Only where pilot phase reveals economically worthwhile yield improvement
- Stepwise implementation in 1,000-1,500 ha blocks
- Identify all constraints and plan their removal
Conclusions

- Determine potential yield for all sites
- Goal of management is to minimize the gap between achievable and actual yield
- BMP is a step-wise process to close yield gaps
  - Small scale pilot phase
  - Scale up once evidence of gaps available
- Maximum economic yield is the key to profitability and competitiveness
Thank you for your attention!

Tropical Crop Consultants Ltd

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