# 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

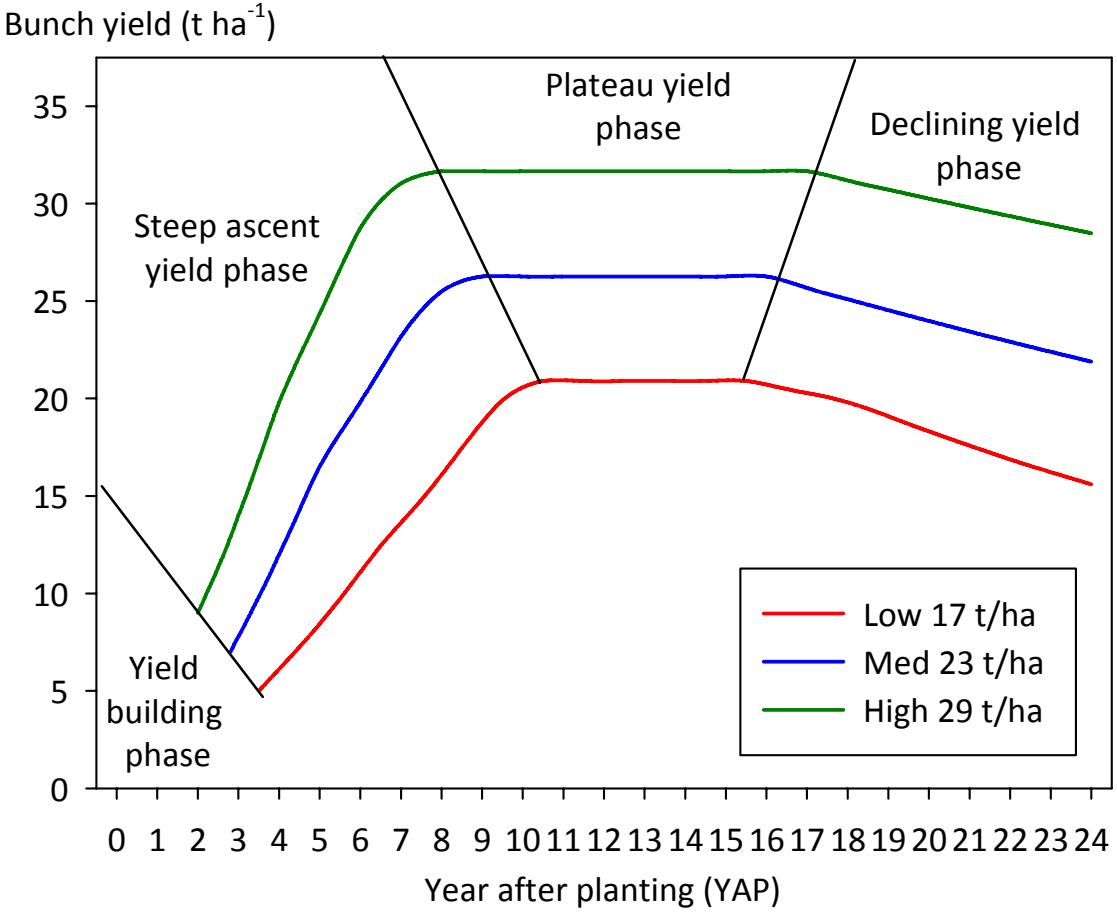
# Why focus on yield intensification?

- **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 t $ha^{-1}$ of fresh fruit bunches = 8 t $ha^{-1}$ of oil?
- Derived from
  - Fertilizer trials
  - Blocks under long term best management

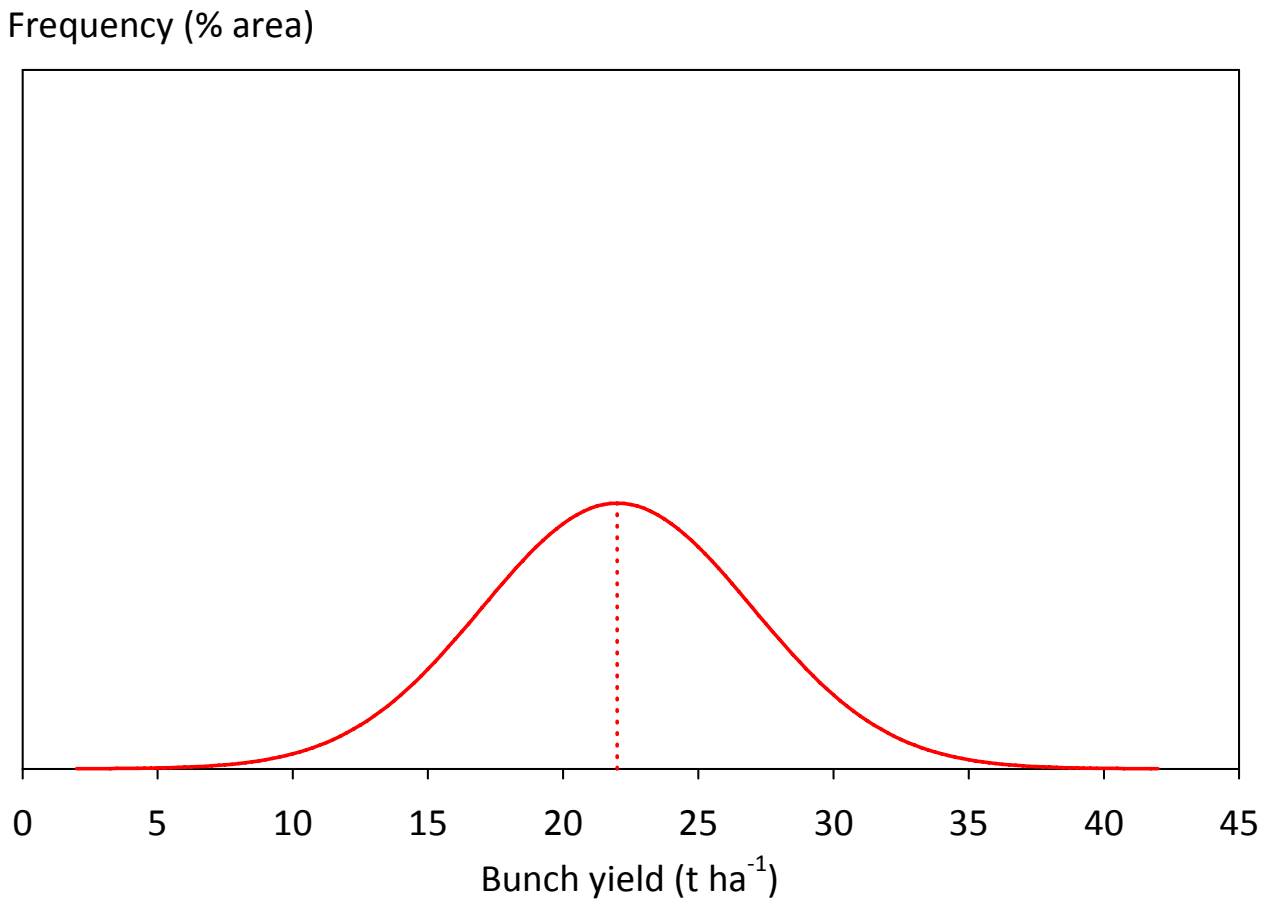
# How to optimize three production phases?



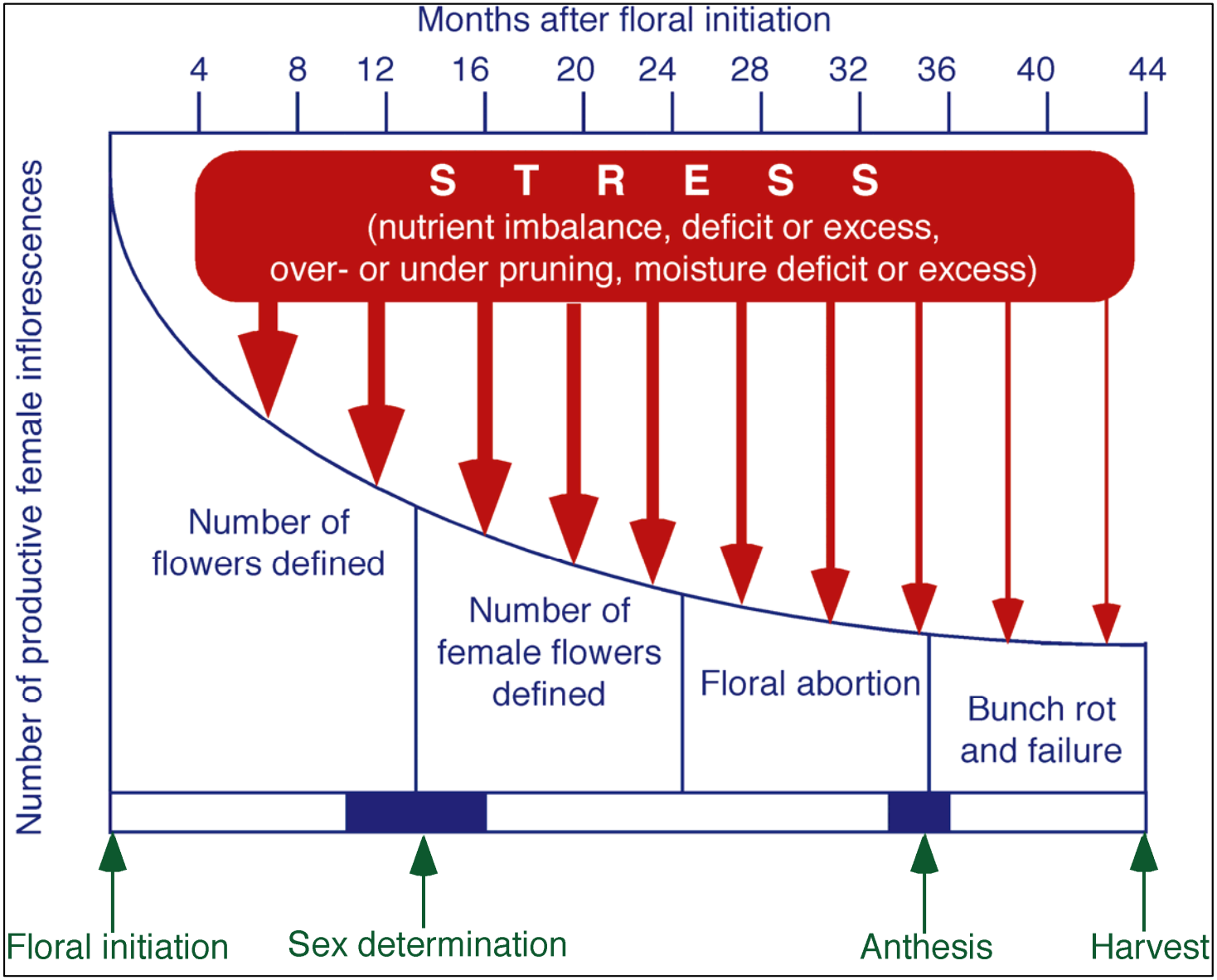

- Shorten time to maturity and peak yield
- Prolong plateau phase
- Reduce rate of decline

After Ng, 1976

# Measure change in frequency of yields for soil x palm age groups over time




Reduce variability and increase yield!

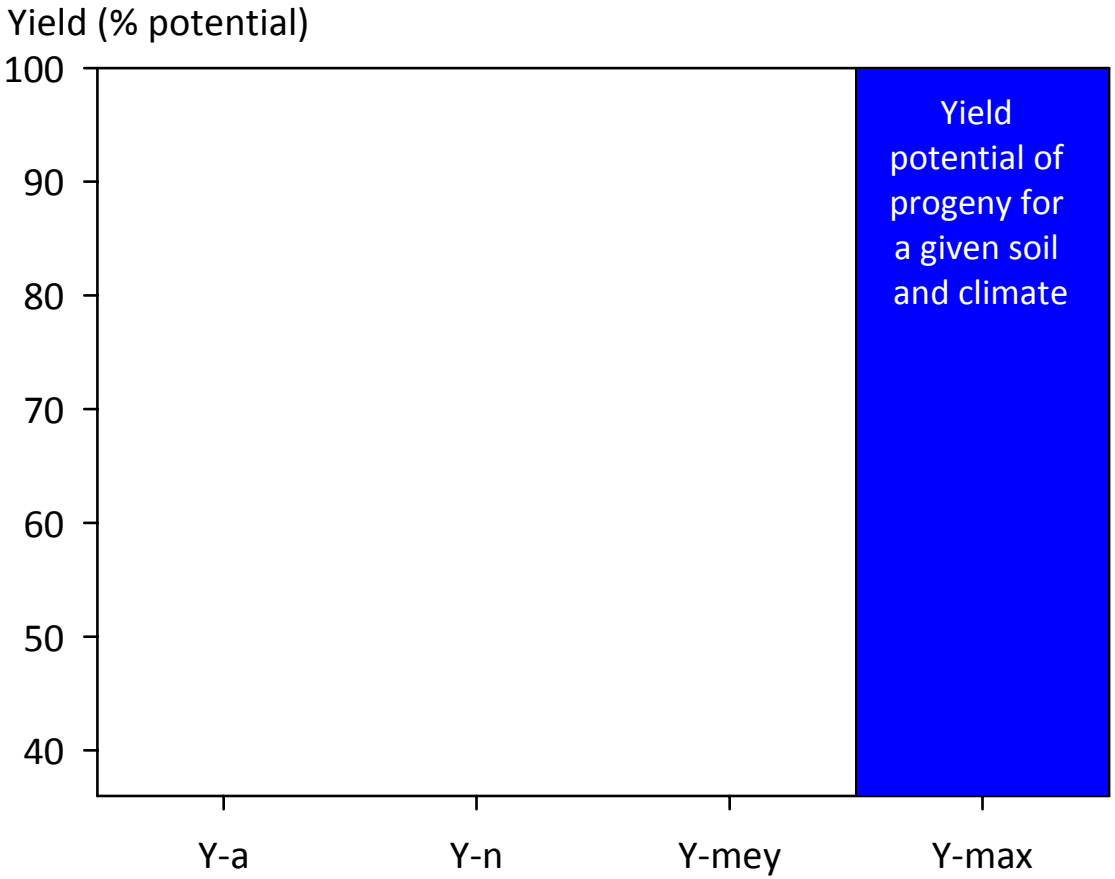



Oil palm productivity is very sensitive to environmental stress

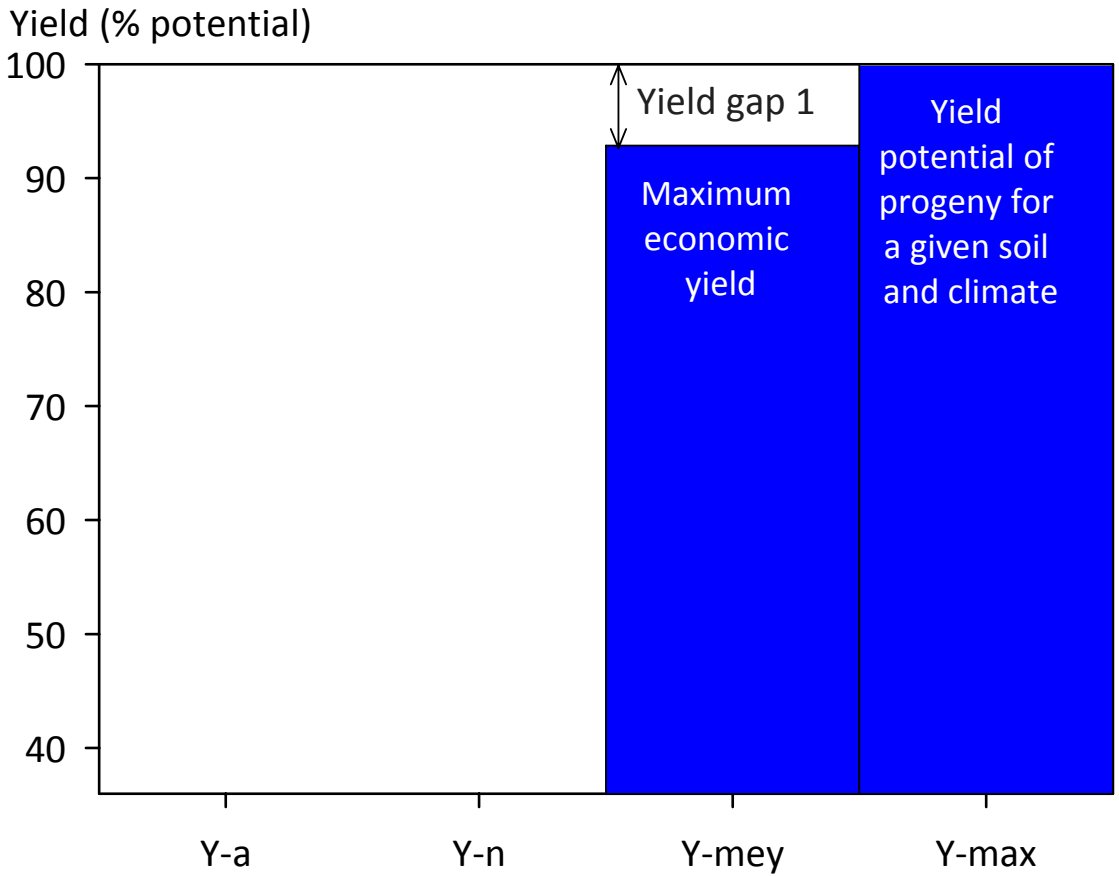
An interval of >36 months elapses between the formation of a flower and the production of a ripe bunch!

Source: Donough, 2008

# Potential yield of a progeny under a given soil type and climate



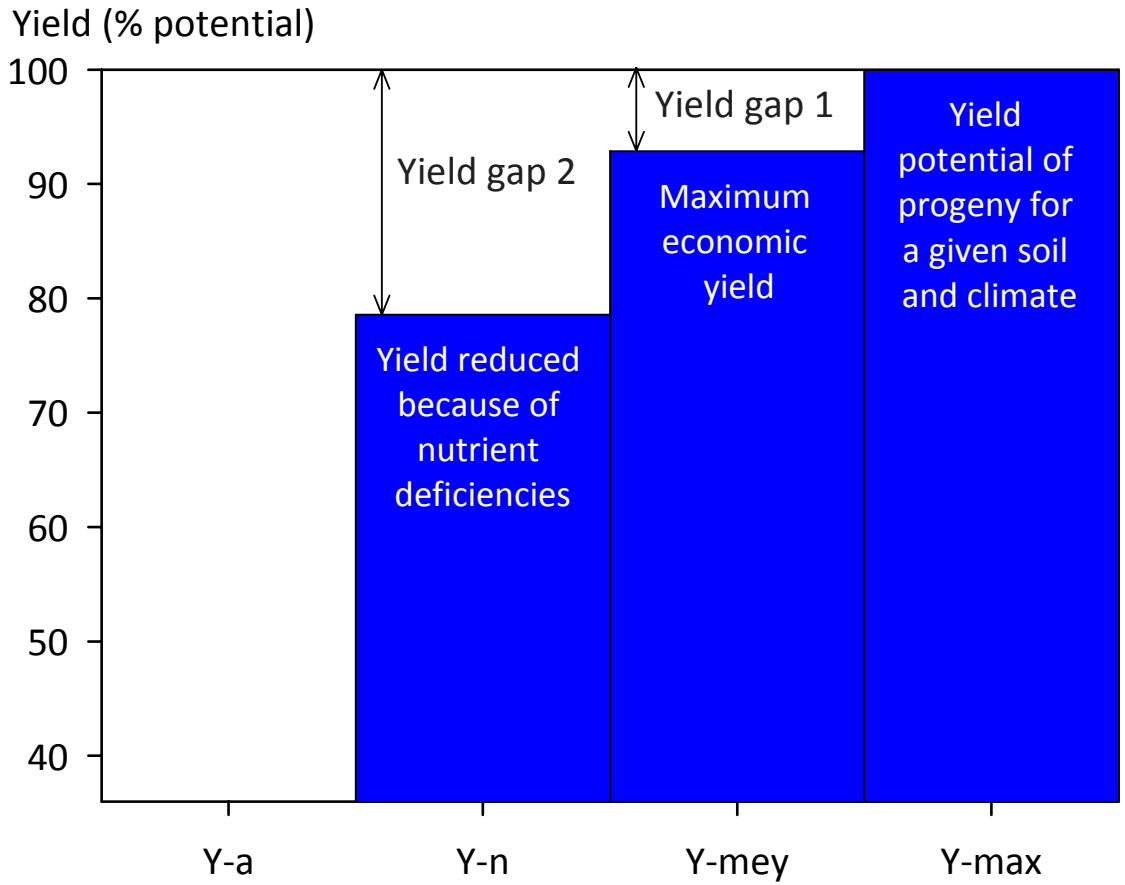
# Yield gap 1 caused by deficiencies in planting technique



# 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

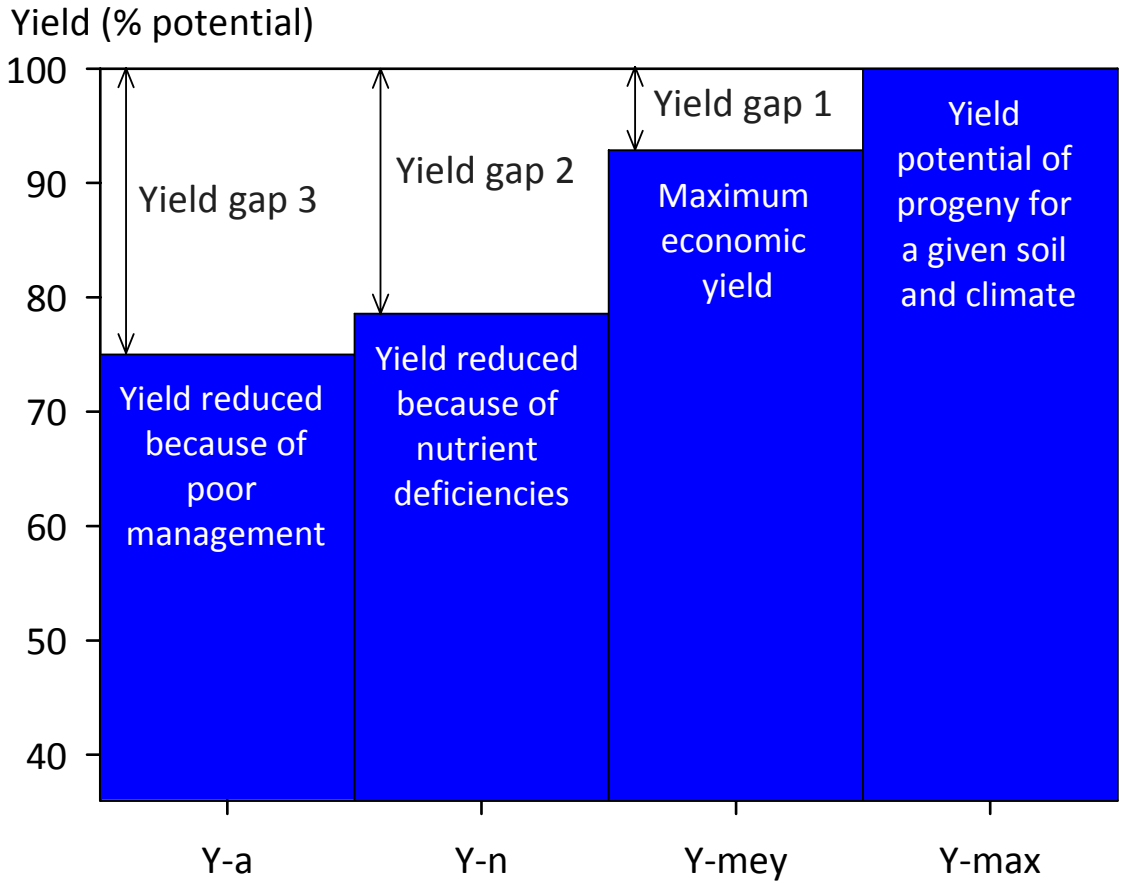
# Yield gap 2 caused by nutrient deficiencies



# 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

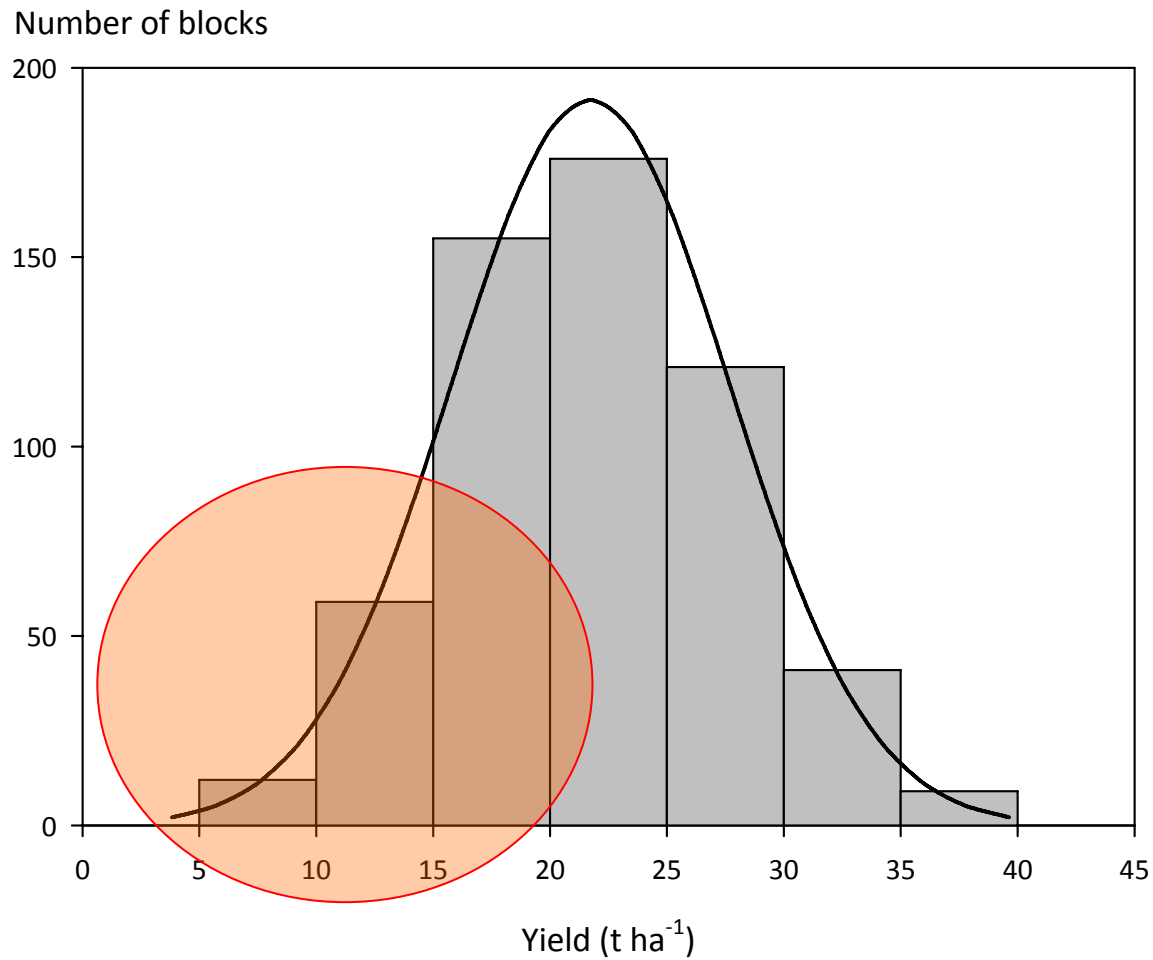
# Yield gap 3 caused by poor management



# Causes of Yield Gap 3?

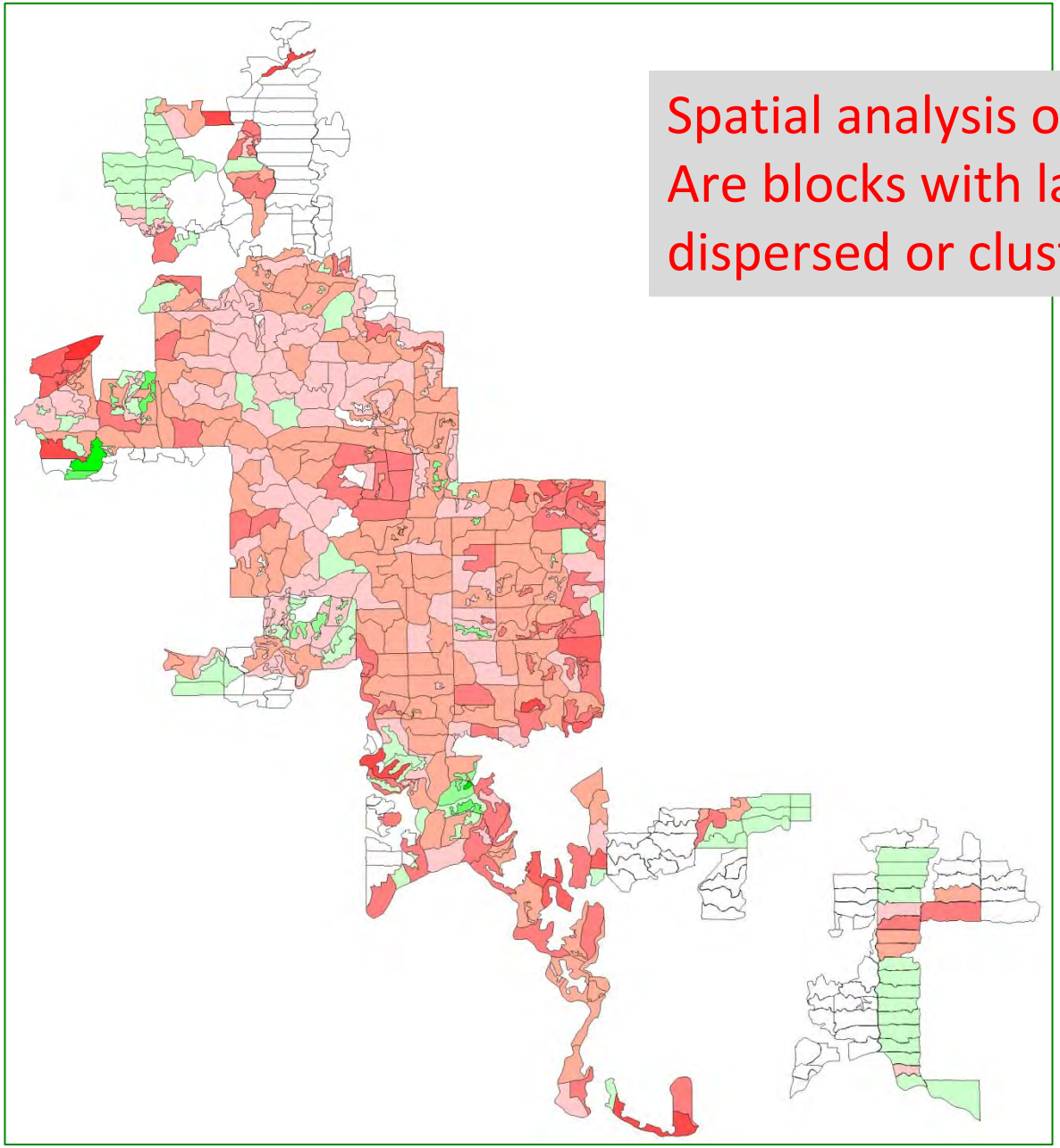
- **Poor harvesting and management**
  - Inadequate infrastructure (mill-to-palm access)
  - Poor round control
  - Poor harvest supervision
  - Failure to implement fertilizer and crop residue application programmes accurately
  - Human resource management

# 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?



Yield gap 2005
t/ha

| | | | | |
|---|---|---|---|---|
| > 35 | | | | (0) |
| 30 | to | | 35 | (0) |
| 25 | to | | 30 | (1) |
| 20 | to | | 25 | (1) |
| 15 | to | | 20 | (0) |
| 10 | to | | 15 | (3) |
| 5 | to | | 10 | (10) |
| > 0 | to | | 5 | (77) |
| 0 | | | | (105) |
| -5 | to | < | 0 | (117) |
| -10 | to | | -5 | (151) |
| -15 | to | | -10 | (61) |
| -20 | to | | -15 | (12) |
| -25 | to | | -20 | (6) |
| -30 | to | | -25 | (2) |
| -35 | to | | -30 | (0) |
| < -35 | | | | (0) |

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

Company **Asiatic Persada** BMP: **BMP02** Division **DD** Block **309A**

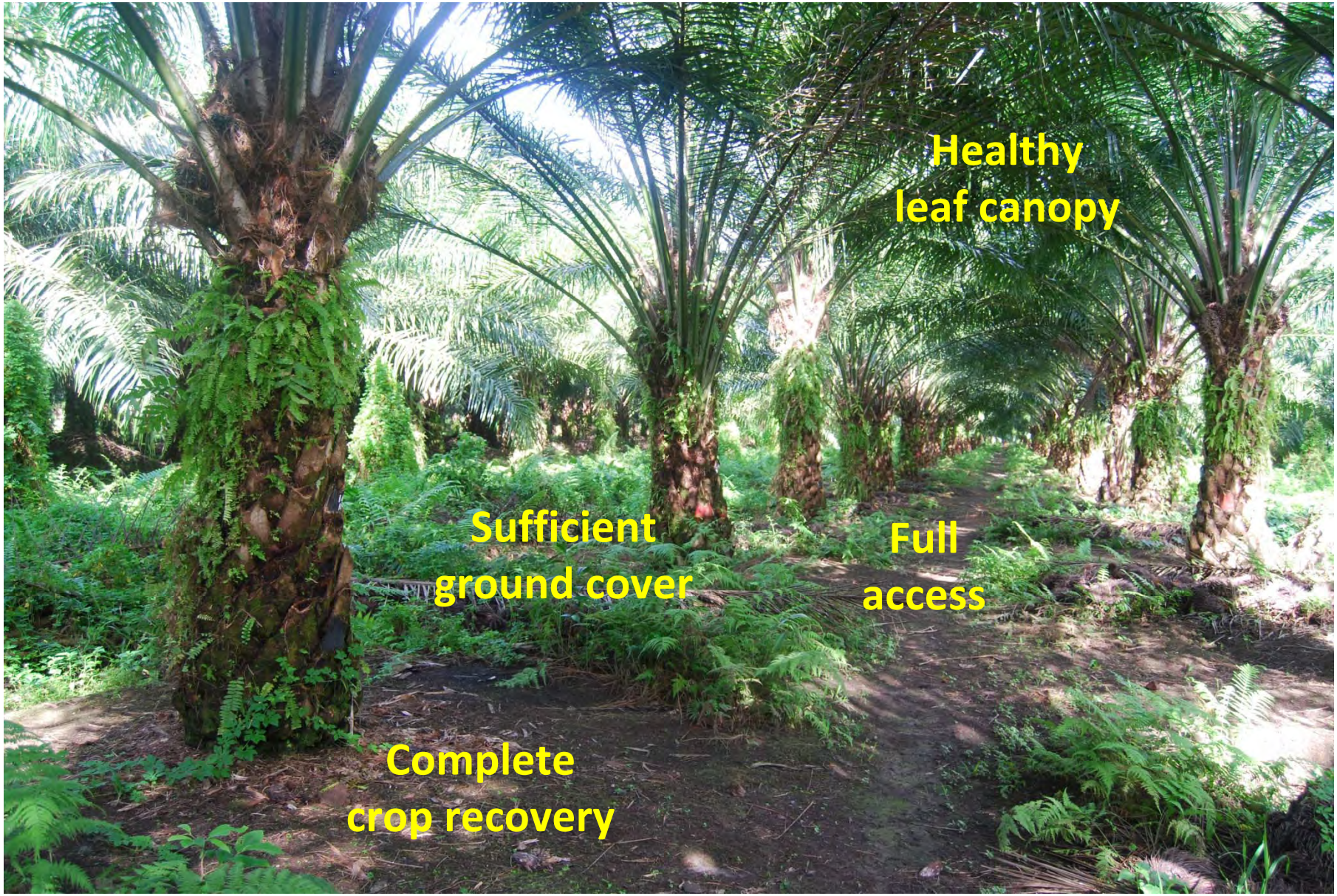
Soil: BMP Topography: Hilly YOP 1989 YAP 17 DFH 02/07/199 MFH: 30

Previous crop: 2nd forest Land clearing: Full Man Density: 135 Area: 46.4 ha

| Yield data | | | | | | | Fertilizer inputs (kg/palm) | | | | | | | | | | Leaf analysis (% dry matter) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | N | | P2O5 | | K2O | | MgO | | B | | N | | P | | K | | Mg | | B | | PCS | PH | SPH |
| Yr | YAP | Pot | Act | Gap | BW | BN | A | R | A | R | A | R | A | R | A | R | L | D | L | L | Rc | D | L | D | L | D | cm2 | m | p/ha |
| 05 | 17 | 25 | 28 | 2.8 | 23 | 10 | 1.4 | 1.4 | 1.0 | 0.9 | 2.4 | 2.4 | 0.3 | 0.3 | 0.09 | 0.10 | 2.6 | 1 | 0.16 | 1.2 | 1.5 | 1 | 0.2 | 1 | 17 | 1 | 66 | 6.5 | 130 |
| 04 | 16 | 25 | 27 | 2.0 | 20 | 12 | 1.6 | 1.6 | 0.7 | 0.7 | 2.5 | 2.5 | 0.5 | 0.5 | 0.10 | 0.10 | 2.7 | | 0.15 | 1.1 | 1.7 | 1 | 0.17 | 1 | 10 | 1 | 72 | 6.2 | 130 |
| 03 | 15 | 25 | 18 | -7.0 | 17 | 10 | 0.9 | 1.0 | 0.4 | 0.9 | 1.2 | 1.4 | 0.0 | 0.0 | 0.03 | 0.04 | 2.5 | | 0.15 | 1.1 | 2 | 3 | 0.16 | 3 | 20 | 1 | 36 | 6.3 | 130 |
| 02 | 14 | 25 | 15 | -10.0 | 14 | 11 | 1.7 | 1.4 | 1.4 | 0.9 | 1.3 | 2.0 | 0.1 | 0.1 | 0.06 | 0.05 | 2.7 | | 0.18 | 1.2 | 1.5 | | 0.29 | | 7 | | 54 | | 95 |

Manager's comments

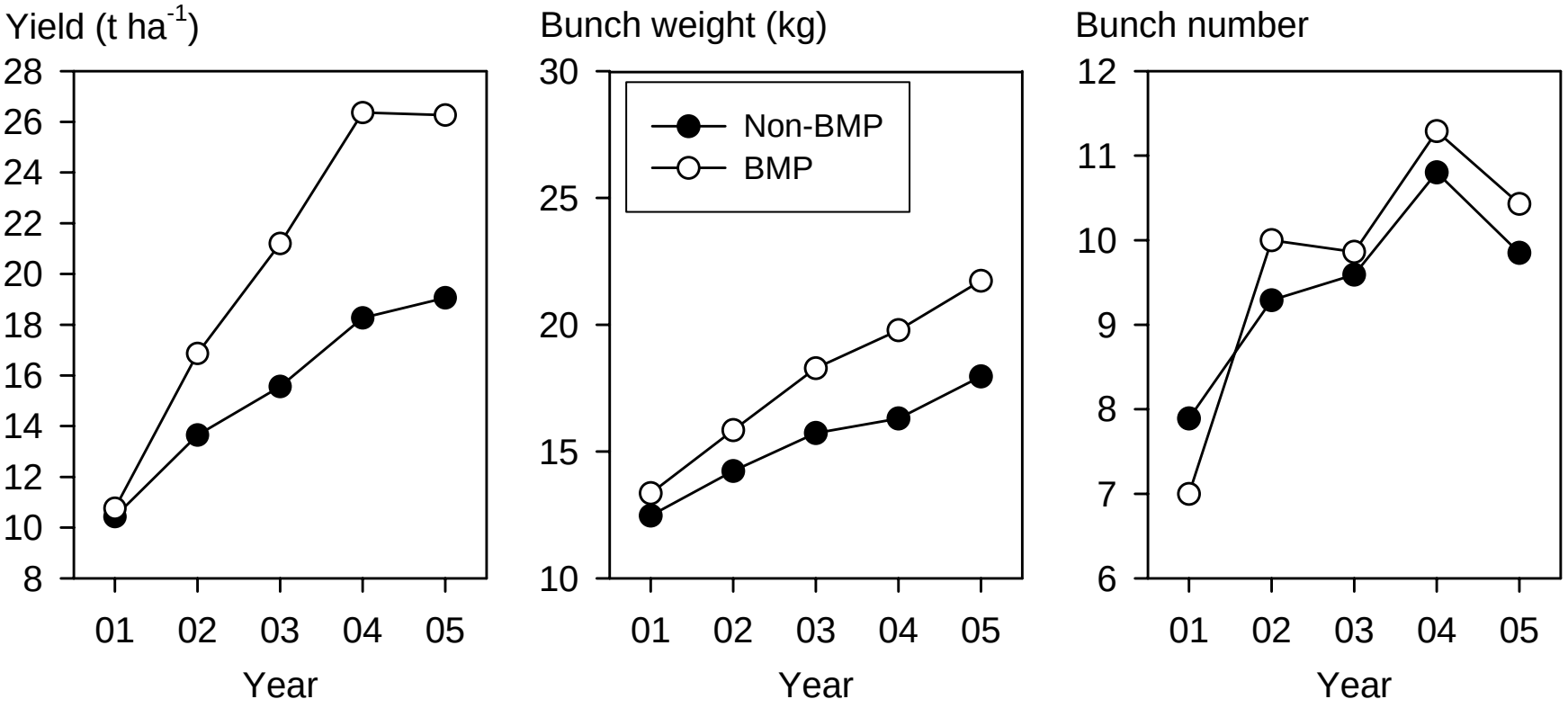
Source: Gfroerer, 2009




Excellent standards of management in place in a BMP block

# RESULTS AND CONCLUSIONS

# Comparison of BMP and non-BMP blocks over five years



# Results from six sites in Indonesia

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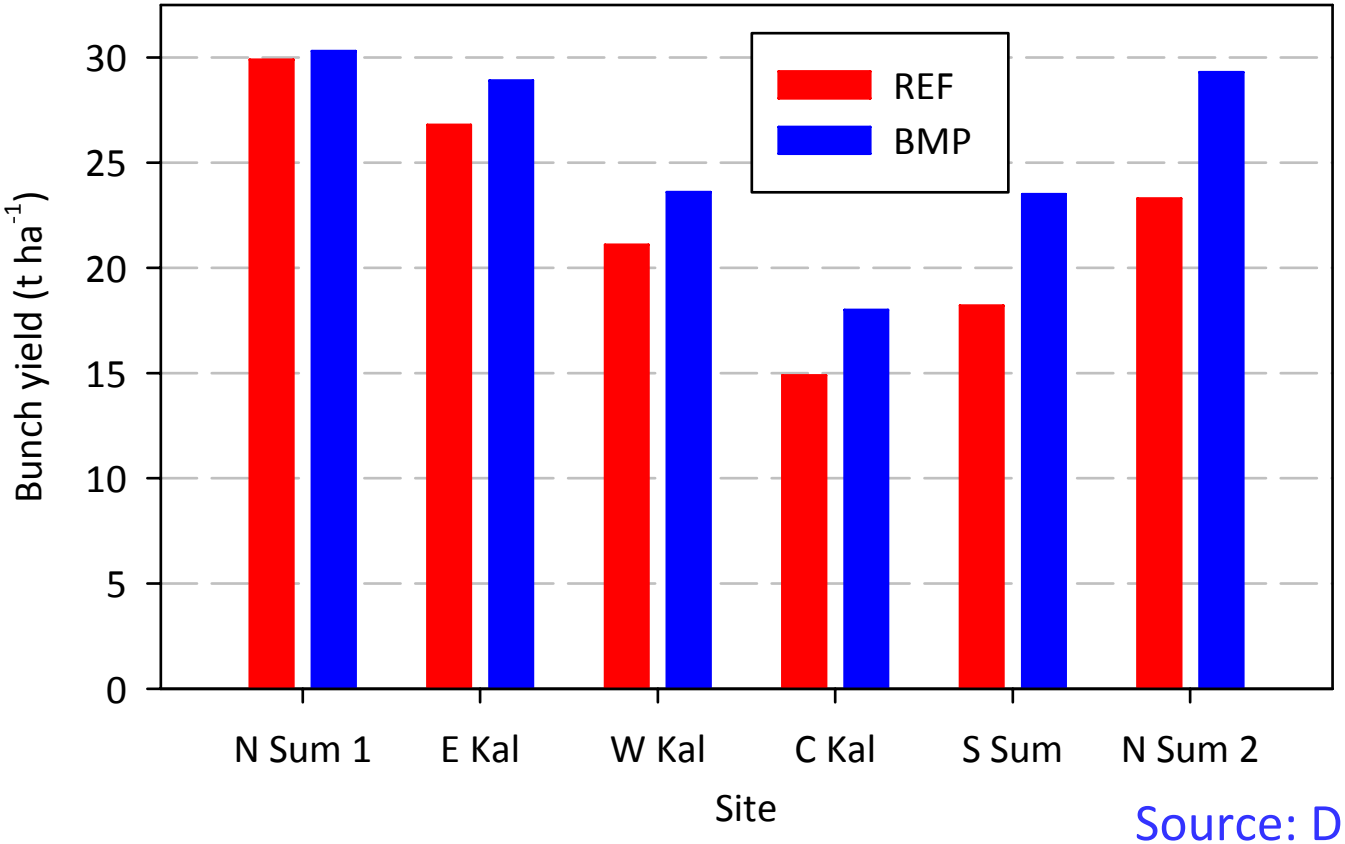


Source: Donough, 2009

# **BMP works on degraded lands**
(anthropic savanna of *Imperatacylindrica*)

# 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!

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