OIL PALM IN INDONESIA: RECONCILING CROP PRODUCTION AND ENVIRONMENTAL GOALS THROUGH SUSTAINABLE INTENSIFICATION

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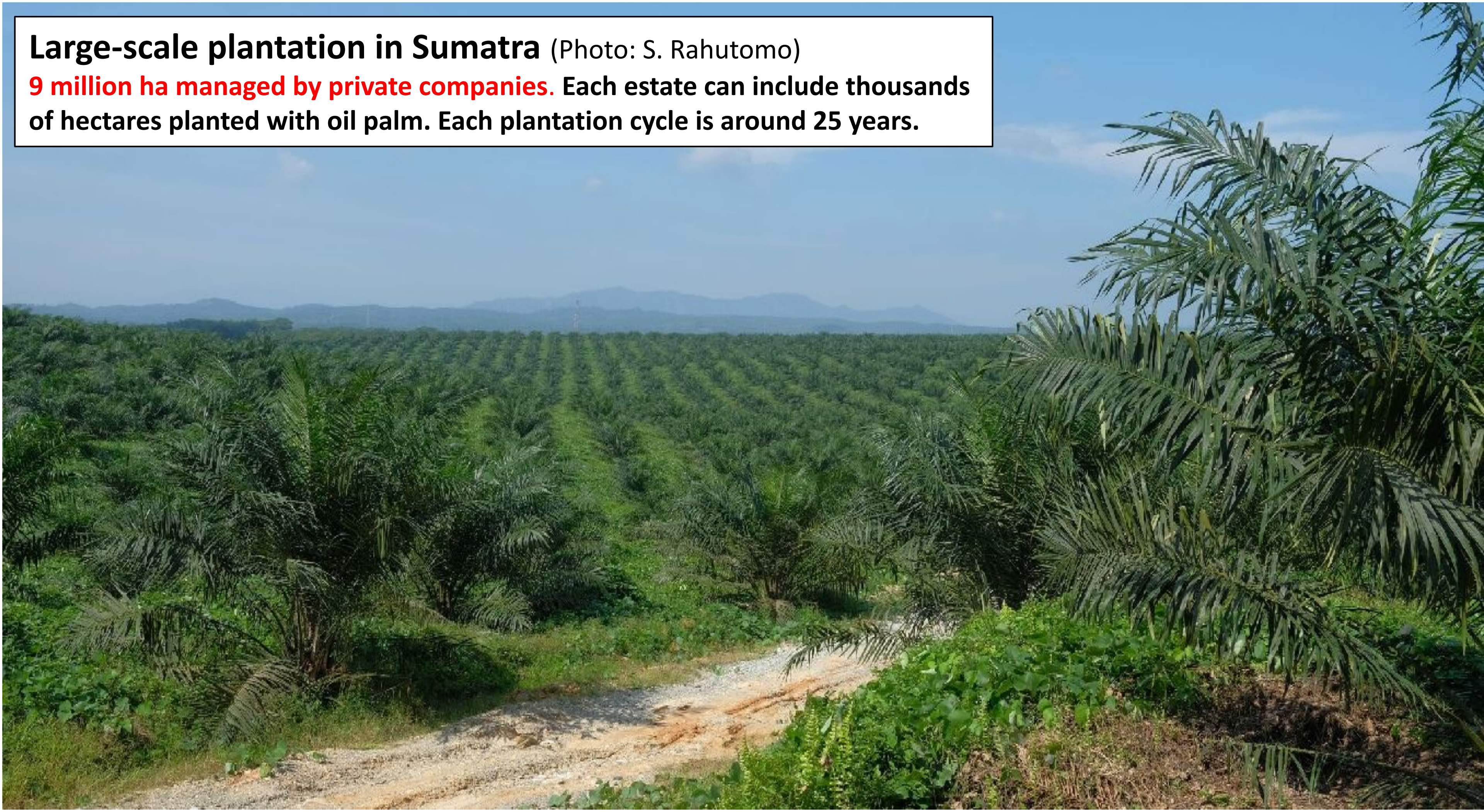
Oil palm & Indonesia

- **Oil palm: most important source of vegetable oil in the world (cooking oil, processed food, cosmetics, cleaning products, biodiesel, etc.)**

- **Crude palm oil (CPO) is a major source of income for Indonesia, which is the biggest producer of this commodity (45 MMT CPO)**
- **Nearly 15 million ha planted with oil palm in Indonesia**



Large-scale plantation in Sumatra (Photo: S. Rahutomo)

9 million ha managed by private companies. Each estate can include thousands of hectares planted with oil palm. Each plantation cycle is around 25 years.

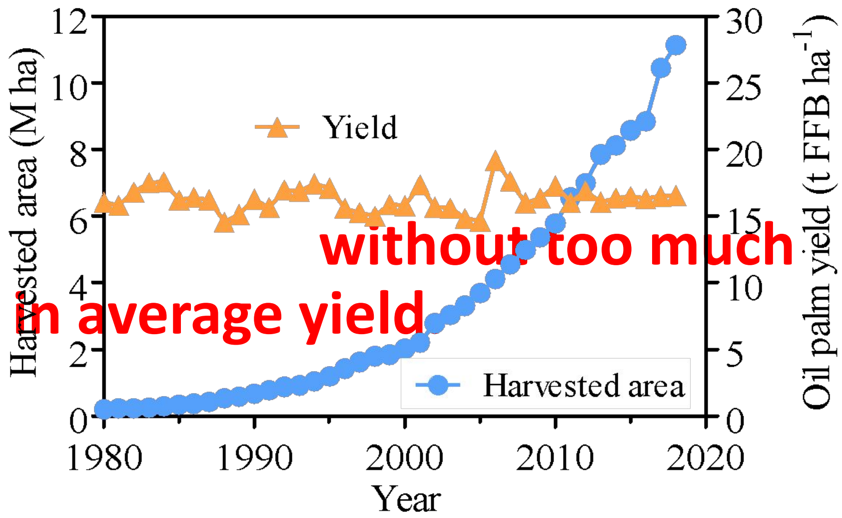
Smallholder plantation in Kalimantan/Borneo (Photos: P. Grassini).

6 million ha managed by smallholder farmers – each managing around 2 hectares of oil palm – low productivity

Efforts to increase yield focused on replanting programs – not much into agronomic management of current plantations

Oil palm in Indonesia: past and future

- During the past 20 years, crude palm oil (CPO) has increased **at expense of area expansion** (+0.5 million ha per year), **without too much increase in average yield**

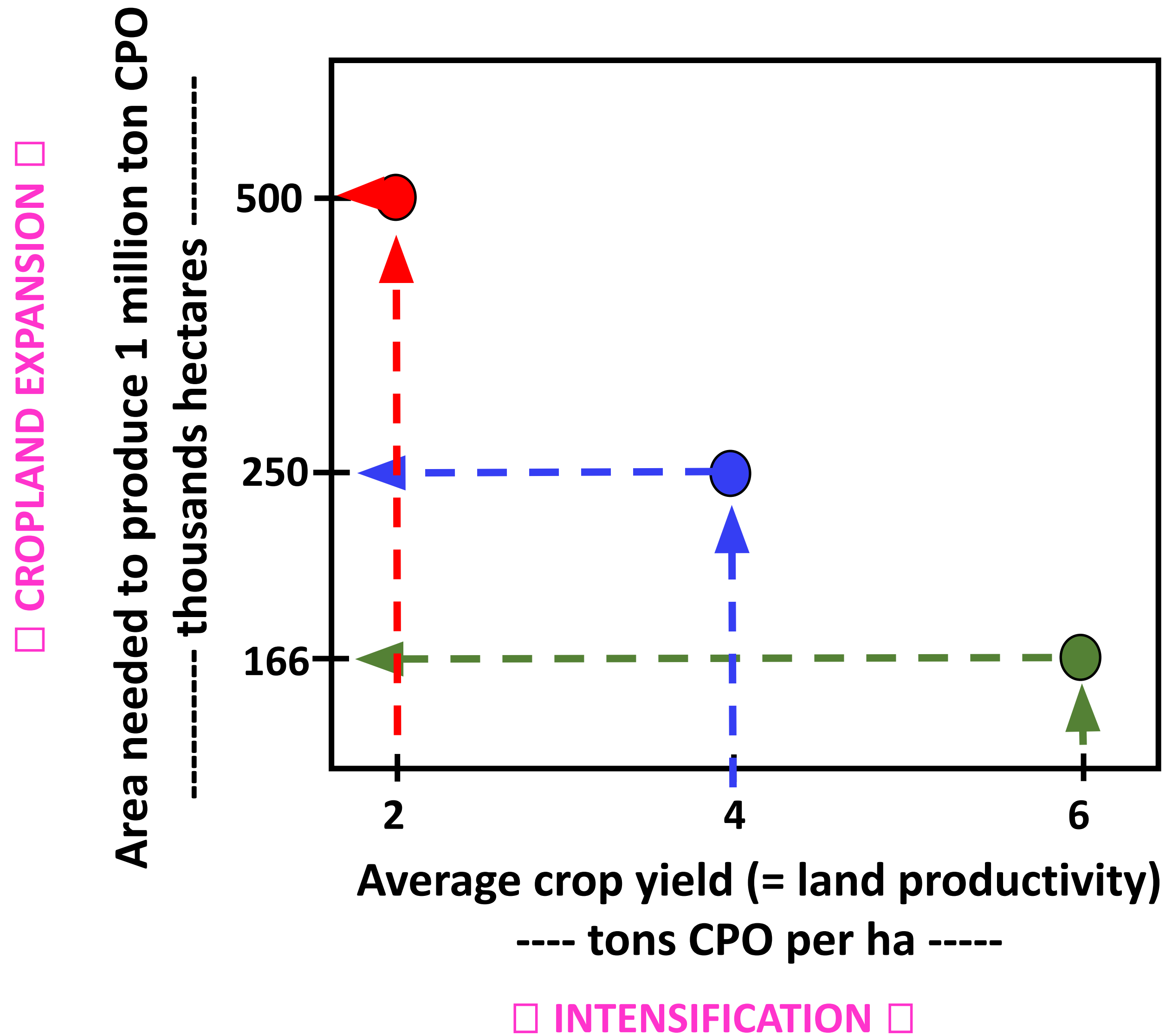


- One third of area expansion at expense of forests and peatlands, with associated biodiversity loss and greenhouse gas emissions

- Future demand estimated at 60 MMT CPO by year 2035 (+33% increase in relation to current production)

  Or even higher due to recent national mandates on CPO-based biodiesel.

Crop demand, land requirement, and yield

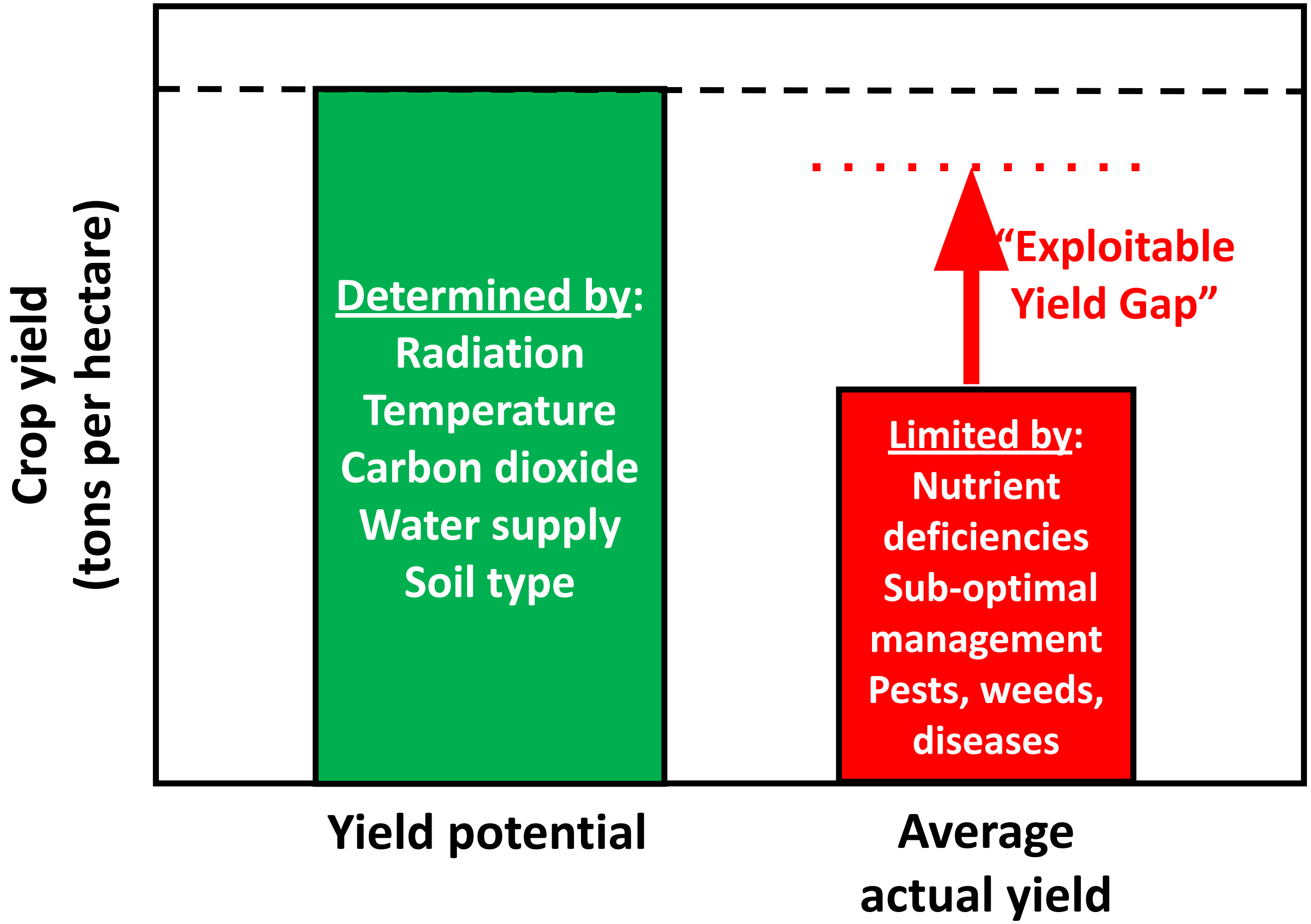


Can intensification on existing oil palm plantation area help Indonesia reconcile production and environmental goals?*

** Achieving the required degree of intensification is only one piece of the challenge; it must be complemented with appropriate policies and institutions to ensure land sparing for nature*

Norwegian Ministry of Foreign Affairs

Yield potential and yield gap

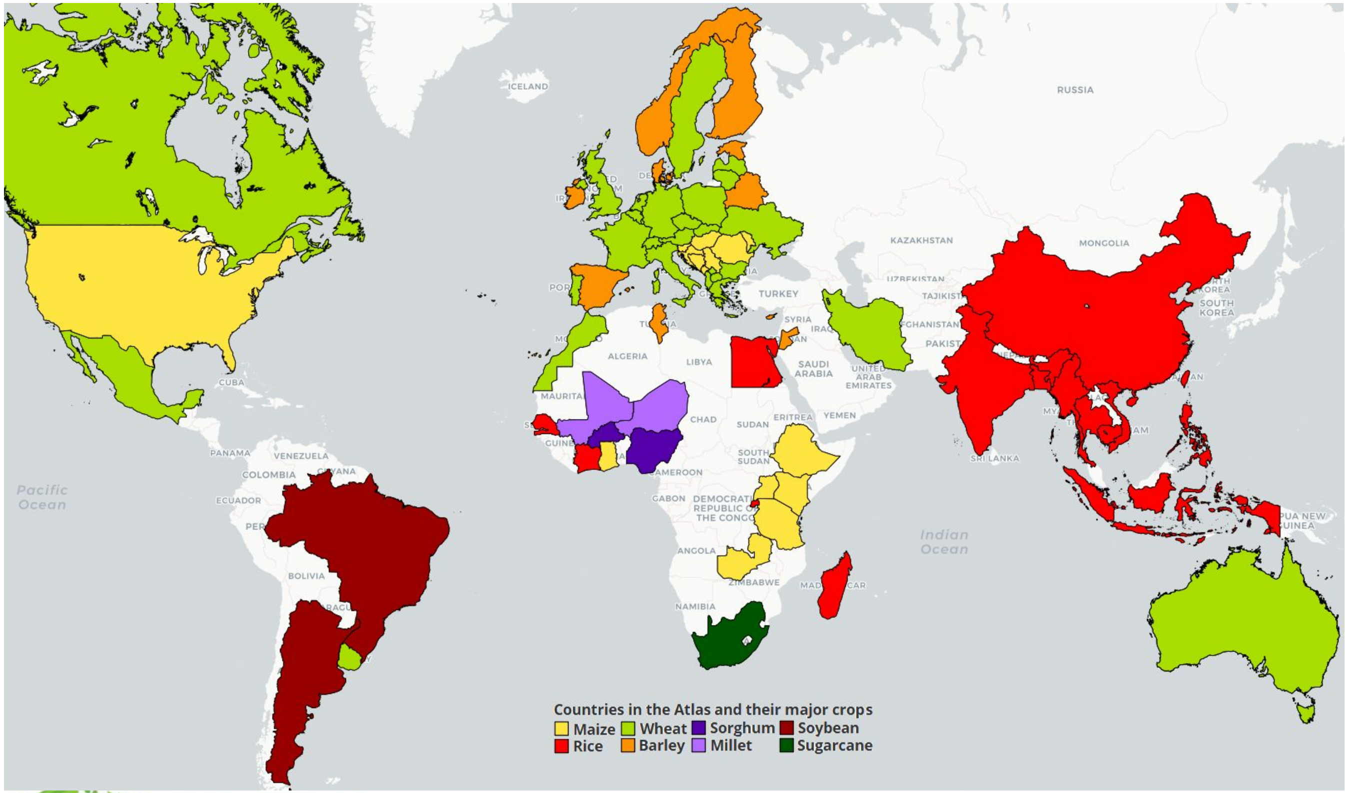


Attaining 70% of the yield potential is a reasonable target for farmers with access to inputs, markets, and extension services.

Global Yield Gap Atlas (GYGA)

Global initiative to estimate food production potential on existing cropland, currently available for 70 countries and 13 crops

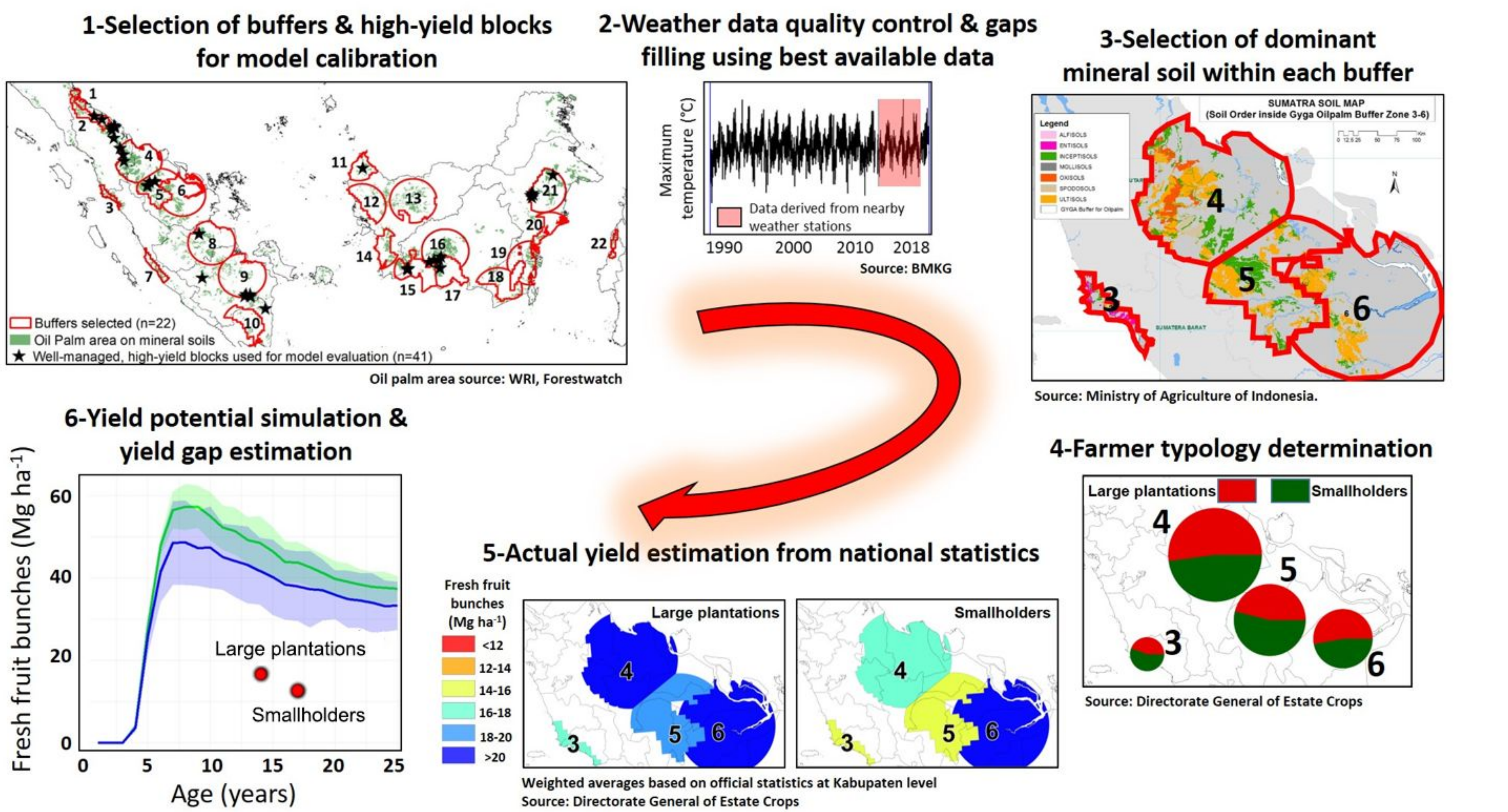
Online tool available at: www.yieldgap.org



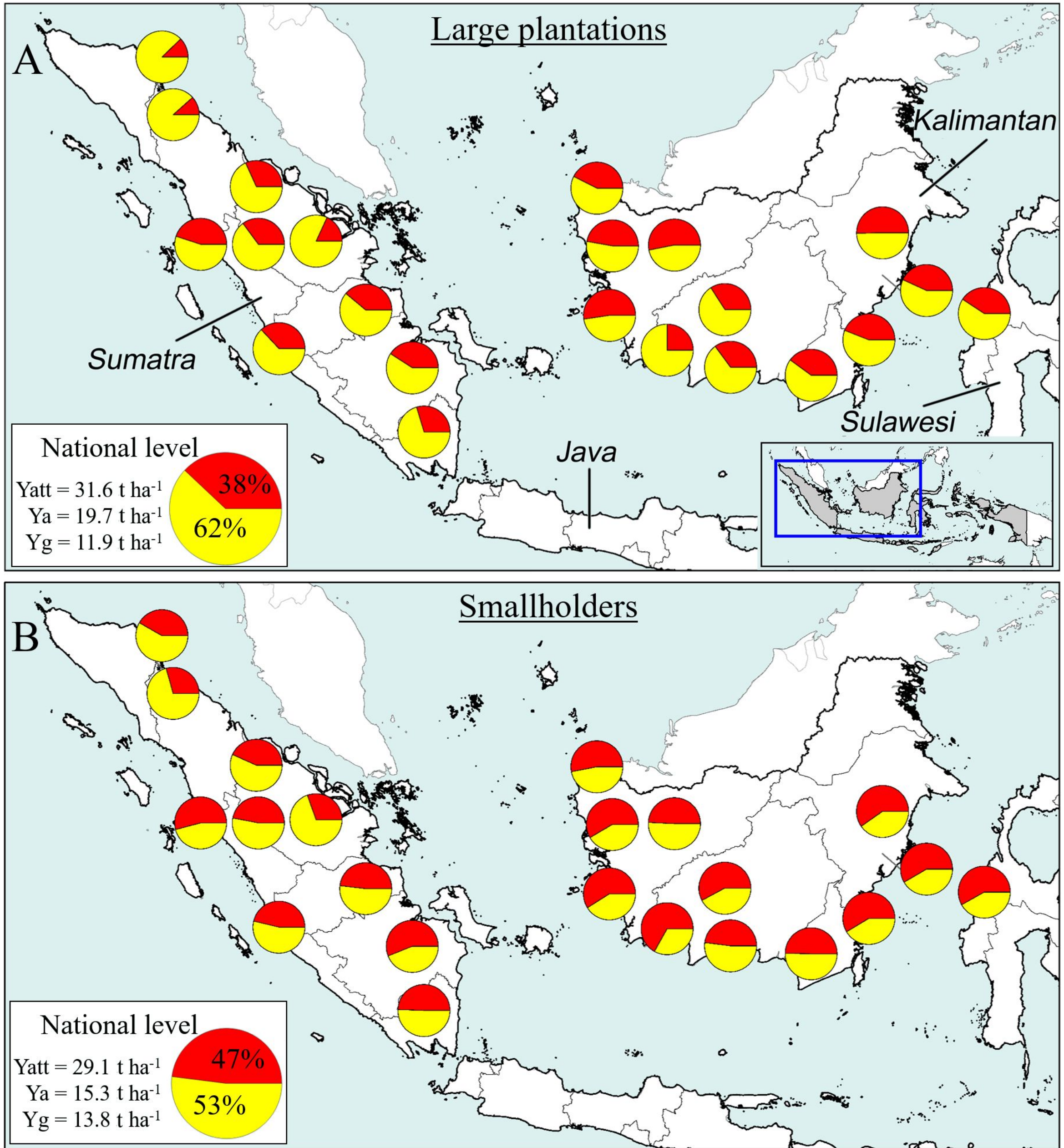
Yield Gap Atlas in Indonesia

- Atlas developed by University of Nebraska for rice and maize in Indonesia during 2016-2017 working with researchers from the Indonesian Agency for Agricultural Research & Development (IAARD)
- Atlas developed for oil palm in 2018-2019 with researchers from IAARD/BRIN and the Indonesian Oil Palm Research Institute (PPKS/IOPRI) to estimate production potential on existing plantation area
- Working since 2019 on closing yield gaps in oil palm to orient R+D programs and inform policy

First is first: current yield gap of oil palm



Yield gaps for oil palm in INDONESIA



Yellow and red colors indicate average yield and yield gap, respectively (as % of attainable yield).
At national level, exploitable yield gap represents 38% of attainable yield in large plantations and 47% in smallholders

Scenarios of production and GHG emissions

Business-as-usual (BAU):

Historical trends in oil palm yield and area over the 2000-2018 period remains unchanged between 2018 and 2035

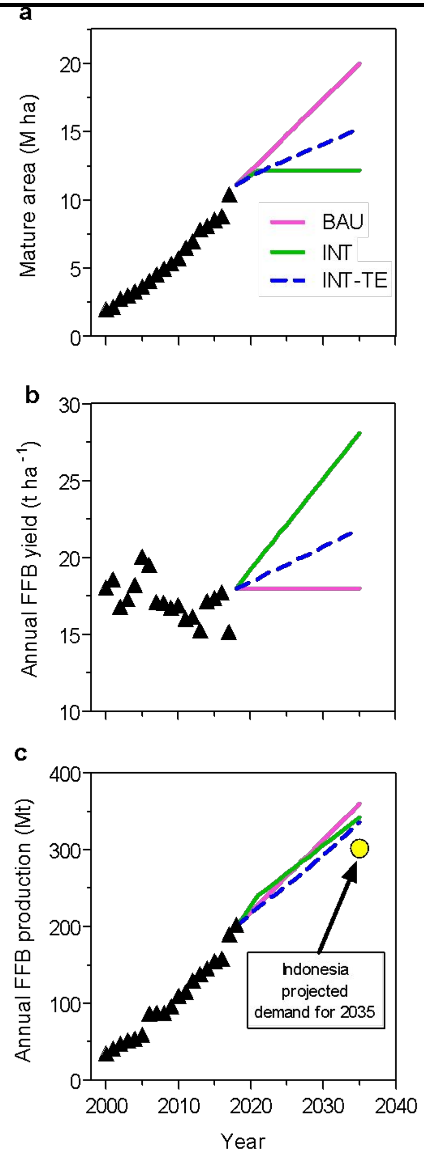
Intensification (INT):

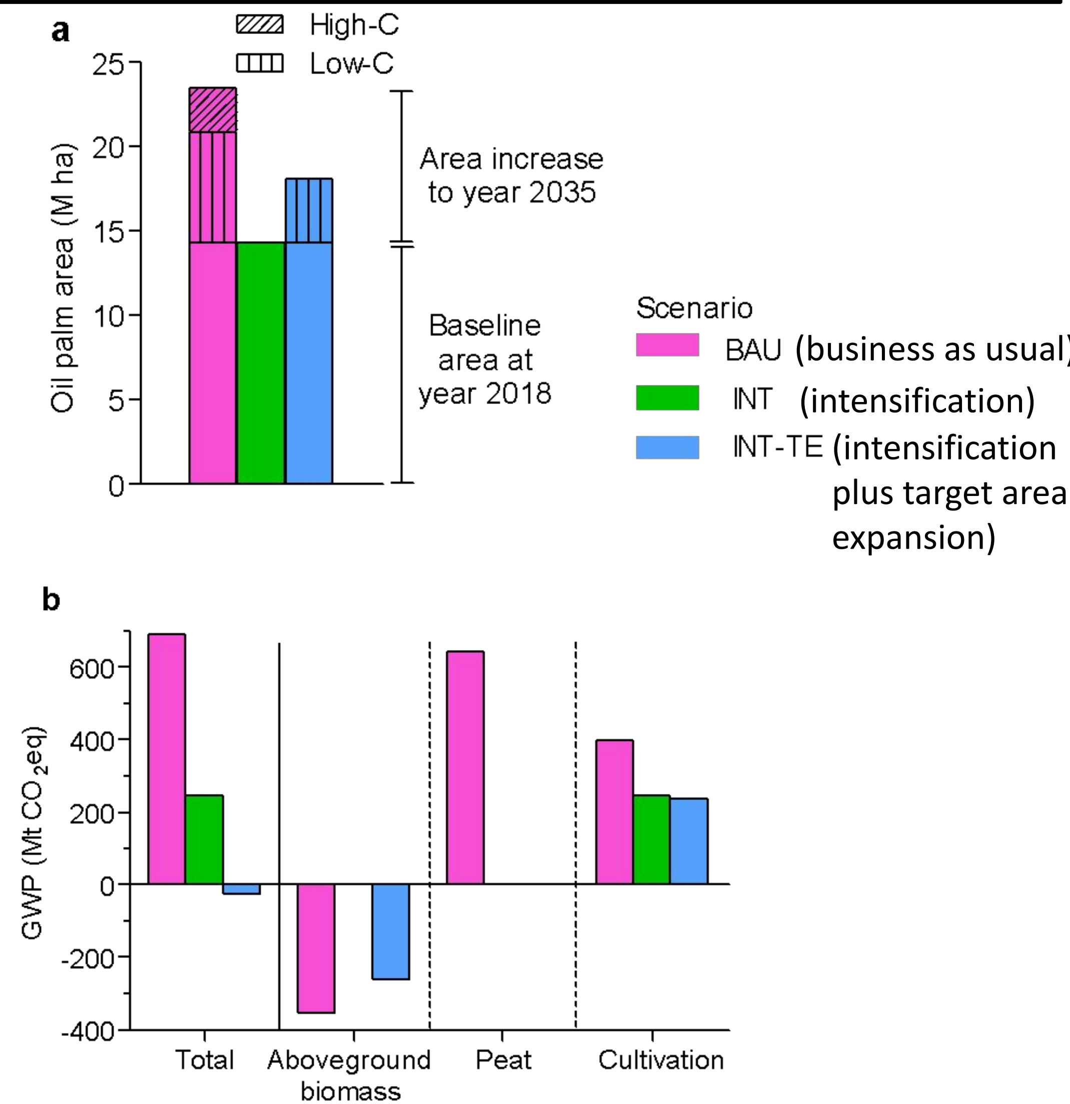
Full closure of the exploitable yield gap so that average farmer yield reaches 70% of yield potential and no area increase

Intensification plus target area expansion (INT-TE):

A more reasonable yield gap closure (nearly one third of current gap) and target expansion of oil palm area into low-carbon land

Narrowing the yield gap *via* improved agronomic management, together with a limited expansion that excludes fragile ecosystems, would save 2.6 million hectares of forests and peatlands and avoid 714 Mt CO_2eq release to the atmosphere and allow Indonesia to produce 60% more palm oil, which would meet the production target for 2035





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ARTICLES

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Fostering a climate-smart intensification for oil palm

Juan P. Monzon[1], Maja A. Slingerland[2], Suroso Rahutomo[3], Fahmuddin Agus[4], Thomas Oberthür[5], José F. Andrade[1], Antoine Couëdel[1], Juan I. Rattalino Edreira[1], Willem Hekman[2], Rob van den Beuken[2], Fandi Hidayat[3], Iput Pradiko[3], Dwi K. G. Purwantomo[4], Christopher R. Donough[1], Hendra Sugianto[1], Ya Li Lim[1], Thomas Farrell[1] and Patricio Grassini[1] ✉

Oil palm production in Indonesia illustrates the intense pressure that exists worldwide to convert natural ecosystems to agricultural production. Oil palm production has increased because of expansion of cultivated area rather than due to average-yield increases. We used a data-rich modelling approach to investigate how intensification on existing plantations could help Indonesia meet palm oil demand while preserving fragile ecosystems. We found that average current yield represents 62% and 53% of the attainable yield in large and smallholder plantations, respectively. Narrowing yield gaps via improved agronomic management, together with a limited expansion that excludes fragile ecosystems, would save 2.6 million hectares of forests and peatlands and avoid 732 MtCO_2e compared with following historical trends in yield and land use. Fine-tuning policy to promote intensification, along with investments in agricultural research and development, can help reconcile economic and environmental goals.

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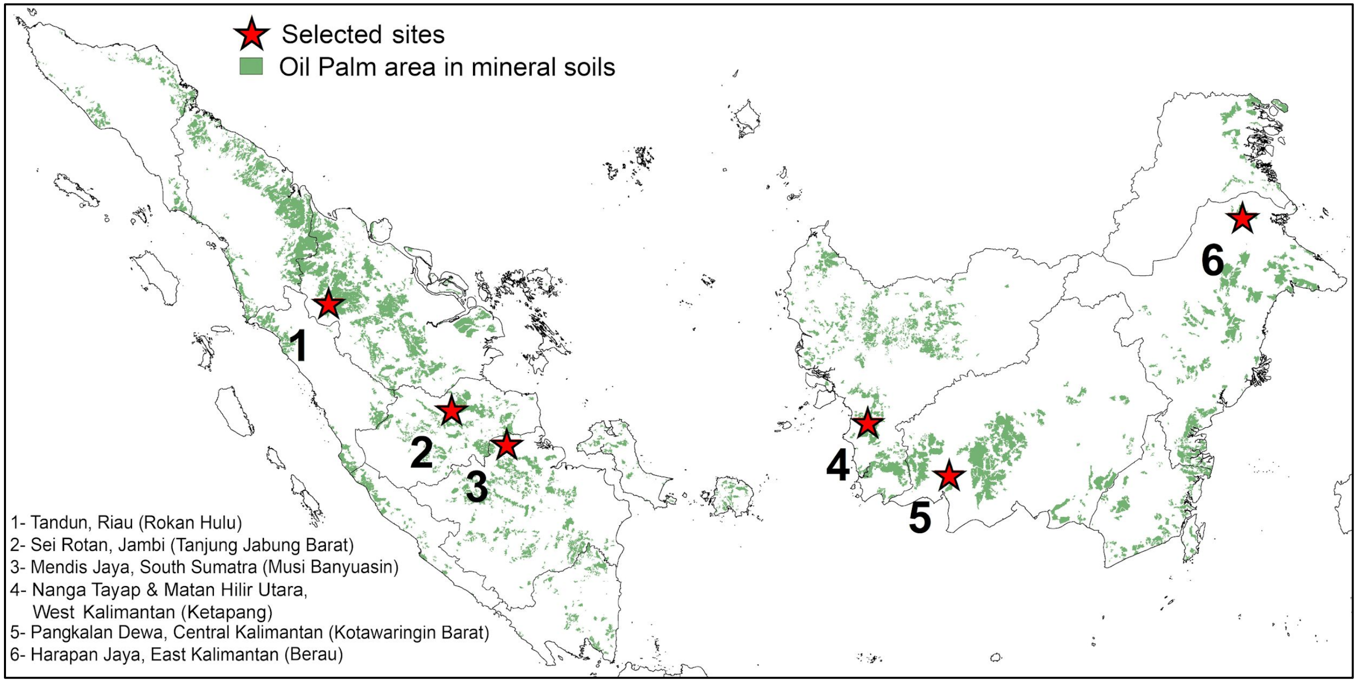
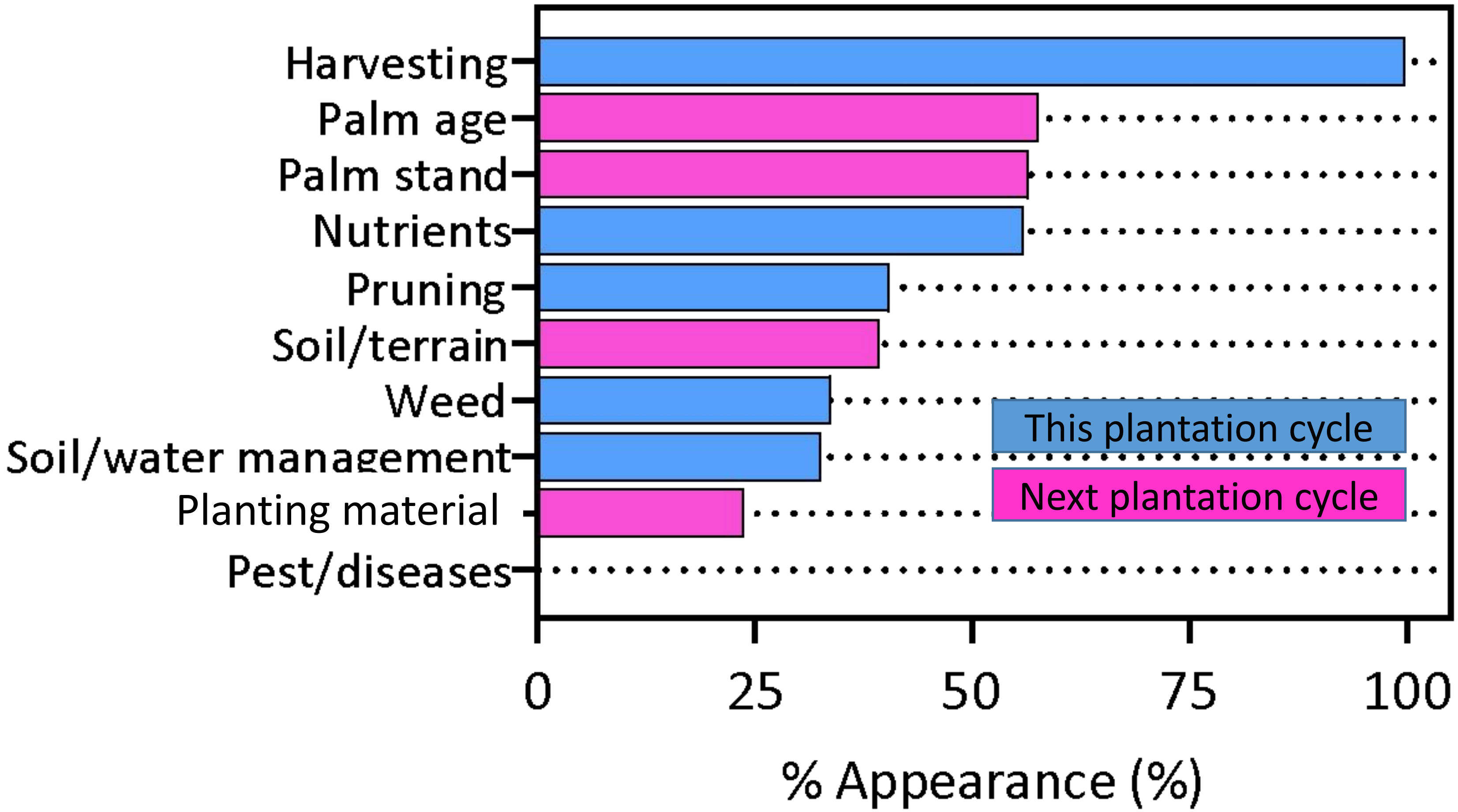
Moving into a solutions agenda

- On-going project with focus on independent smallholder plantations located in mineral soils in six provinces
- Goal: identify causes for yield gaps and evaluate cost-effective management options to increase yield



Causes for yield gaps

Besides agronomic practices, use of non-certified planting material further reduces oil yield.
But note that farmers need to wait for the next replanting cycle to replace the current planting material.

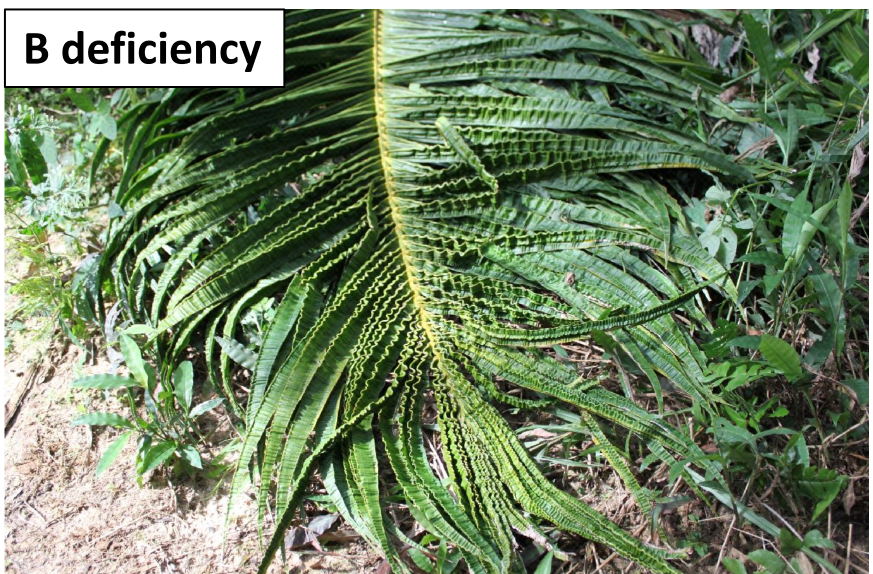


Monzon *et al.*, in preparation

Nutrient deficiencies and imbalances

K deficiency

B deficiency



Mg deficiency

Photos: P Grassini, H Sugianto, C. Donough

Moving from diagnosis to yield gap closure

- **Selection of farmers in each province to demonstrate management options to narrow the existing yield gap**

- **Two fields per farmer (with same planting material, palm age, and soil):**

  □ A reference (REF) field where we let farmers continue with their usual management practices

  □ Another field where we provide technical support to the farmer to implement best management practices (BMP) to increase both yield AND farmer profit

Best management practices (BMPs)

Harvest criteria and frequency

Pruning and frond arrangement

Nutrient rate, source, timing, and placement

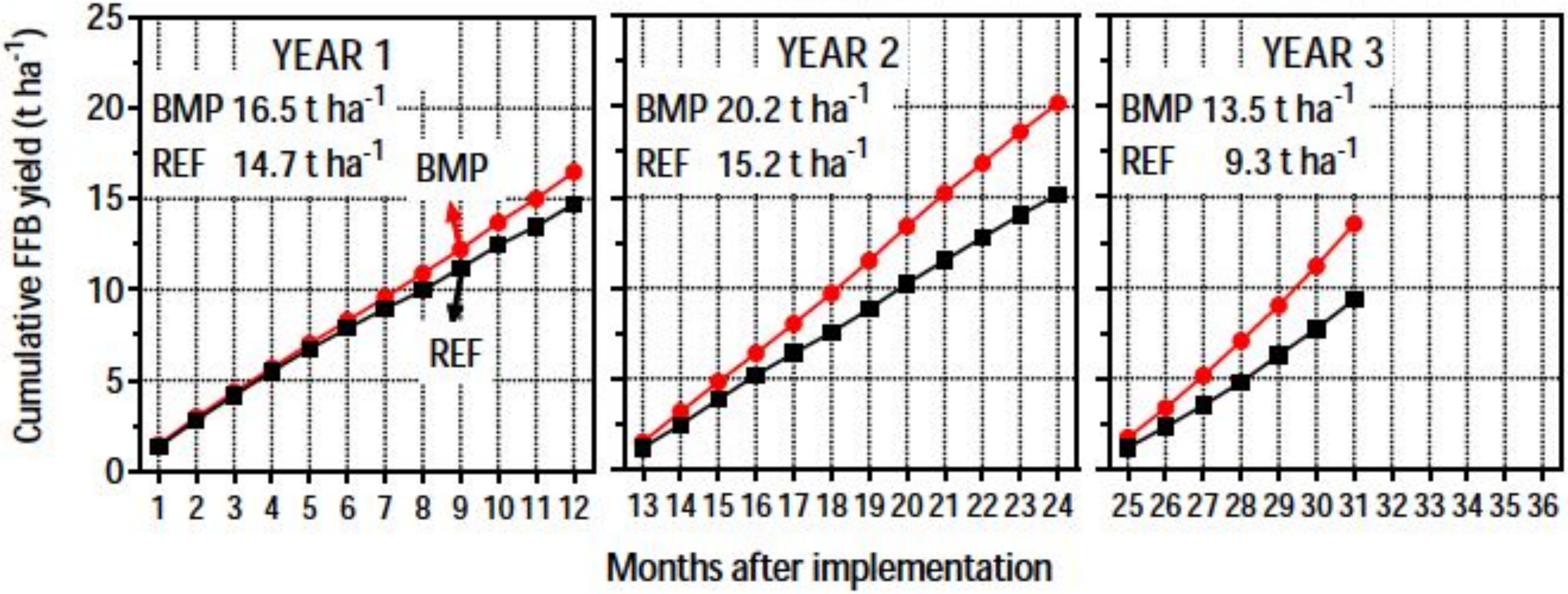
Management of weeds and beneficial vegetation


Economic analysis
Plant growth
Soil carbon and root density
Foliar nutrient analysis
Carbon stocks

Yield trends in BMP trials

Implementation of BMPs lead to higher yields in Year 1 (+12%), Year 2 (+32%), and Year 3 (+45%).
The yield benefit increases over time as palms keep benefiting from the improved plant nutrition status.

Each value corresponds to the average across provinces



Sugianto *et al.*, in preparation

Economic impact of intensification

Implementation of Best Management Practices (BMPs) resulted in an overall +20% increase in net profit across sites. The economic benefit will be larger in subsequent years as yield keeps increasing.

MANAGEMENT	Total production costs* (M IDR ha^{-1})	Gross income** (M IDR ha^{-1})	Net income*** (M IDR ha^{-1})
REFERENCE	10	68	42
BMPs	20	52	48
DIFFERENCE	+10	+16	+6 (+20%)

* Includes all total inputs and labor costs during the first two years of the project
** Based on FFB yield and actual FFB price received by farmers during the first two years of the project
*** Estimated as the difference between gross income and total costs during the first two years of the project

Sugianto *et al.*, in preparation

Scaling out the potential benefits of intensification

Implementation of BMPs across all independent smallholders would amplify the effect of current replanting programs, helping farmer to increase yield NOW, leading to a positive socio-economic impact.

Variable (per year)	Baseline	Replanting	Replanting & BMPs
Oil Yield (t/ha)	2.9	3.5	4.7
National CPO (million tons)	10.1	12.2	16.2
CPO Revenue (billion USD)	8.3	10.1	13.4
Potential Land Saving (million ha)	0	0.7	1.2

Assumptions: full adoption across all mature independent smallholders' oil palm area in mineral soils in Indonesia (3.5 M ha), and current CPO price (800 USD per t CPO). Note that our estimate of BMP impact on FFB yield, profit and production is conservative considering that the yield benefit from BMP adoption is expected to be larger after year 2. Oil extraction rates were based on measurements performed in our field trials.

Main messages

- There is a large exploitable yield gap in current plantations, with larger gaps in smallholder farms
- Both better agronomic management and planting material are needed to close the yield gap
  - Strong evidence of nutrient deficiencies
  - +45% yield increase after three years of BMP implementation and +20% increase in net income
- Opportunity for Indonesia and other countries to reconcile competing economic and environmental goals by producing more on existing cropland
- Need to complement technologies with policy and knowledge
  - Access to proper inputs and strong extension services
  - Institutions and enforcement to ensure intensification gains lead to land sparing for nature

Thank you!

Nebraska UNIVERSITY OF Lincoln

PUSAT PENELITIAN KELAPA SAWIT
Indonesian Oil Palm Research Institute

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