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2025

Integrating crops and livestock in oil palm: benefits & challenges

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WHY INTEGRATION?





WHY INTEGRATION?

- Population growth increases demand for food but land becomes scarce. Two options to save land
 1. Intensification: increasing yield of oil palm/ha
 2. Integration: increasing total yield/ha through land sharing with crops or livestock
- Contribution to national food security
- Additional food and/or income per ha for oil palm growers
- Integration is seen as a regenerative practice, reducing use of agrochemicals for weeding and fostering nutrient cycling



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INTERCROPPING



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COMMON PERCEPTION



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- Oil palm intercropping is only for **smallholder oil palm growers**, to close the income gap (or at least produce food) at replanting till 3 years after.
- Smallholders will not invest much and crops will then probably compete with the palm trees **reducing their yield**. Therefore, oil palm companies are against intercropping by smallholders
- **Oil palm companies** do generally not want intercropping activities next to their core business. It is seen as a distraction.
- It would require investment, skilled labor and management of new supply chains, may interfere with regular oil palm operations AND it may **decrease palm yields**.

CROP CHOICE



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Horticulture



Watermelon 1-12 ha



Banana 15 ha



Banana 1 ha

Food/Feed



Corn 1-10 – 200 ha



Jack bean 1-10ha

Food



Rice 1-10-200 ha



INTERCROP REVENUES

Catagory (per ha)	Watermelon* (20 t/ha)				Corn# (5.7 t/ha)		
	3 months	3 months	3 months	one year	4 months	4 months	one year
Investment	3684	2368	2368	8420	581	581	1162
Revenue	4736	4736	4736	14208	895	895	1790
Profit	1052	2368	2368	5788	314	314	628
Monthly income (€)	350	789	789	482	79	79	52

Monthly minimum wage (2025) in *Bengkulu :136 euro & in #South Kalimantan: 184 euro

Oil palm benefit: reduction in weeding costs: 96 euro per cycle or 192 euro/year for corn

Using corn residues as animal feed may add to the income



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INTERCROPPING CHALLENGES



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CHALLENGE 1

EFFECT OF INTERCROP ON PALM PERFORMANCE

Vegetative performance measured in Bengkulu

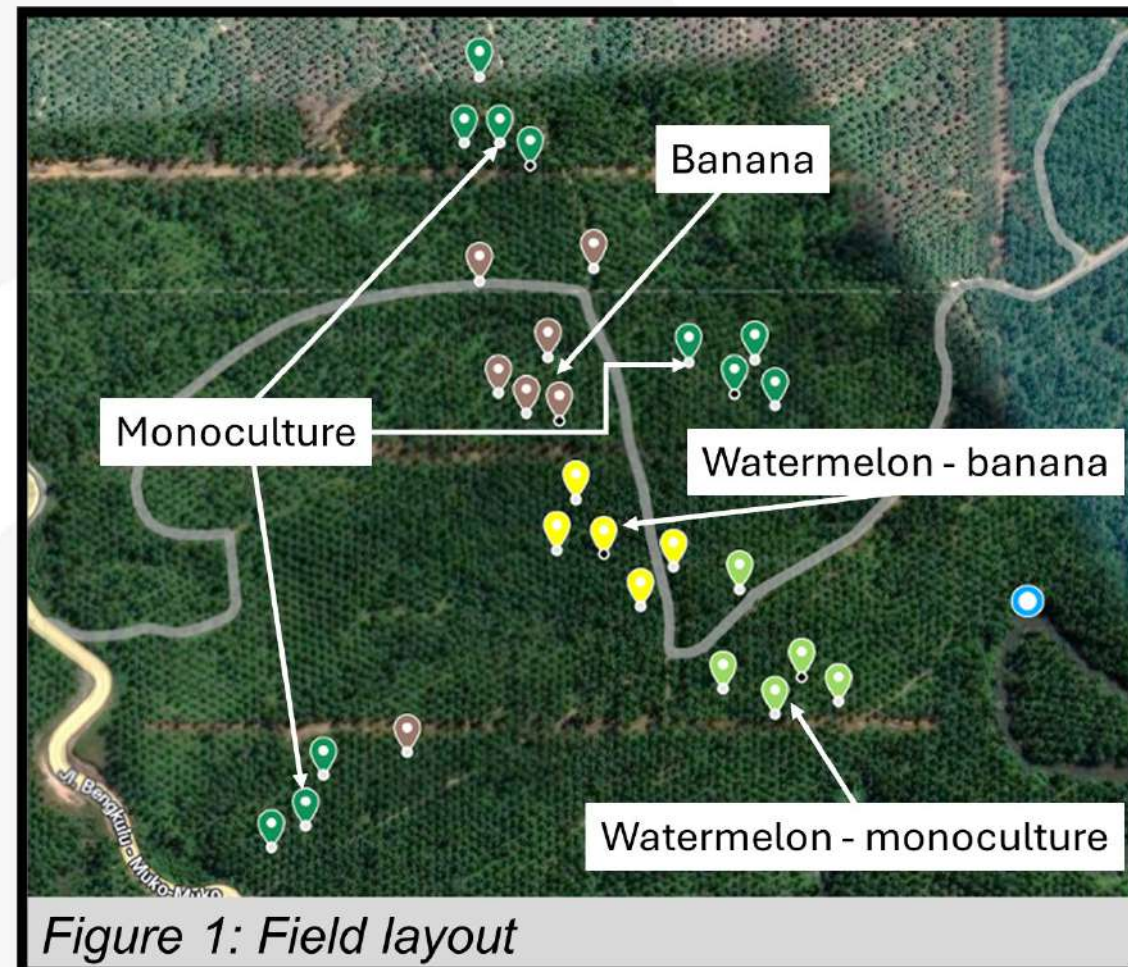
Large plantation: 4 treatments: crops cultivated following GAP

code	3 MAP	6-20 MAP	Fert	Non Fert
MM	Monoculture OP	Monoculture OP	9	2
MB	Monoculture OP	Banana intercrop	6	1
WM	Watermelon intercrop	Monoculture OP	4	1
WB	Watermelon intercrop	Banana intercrop	4	1

Observation plots in the plantation



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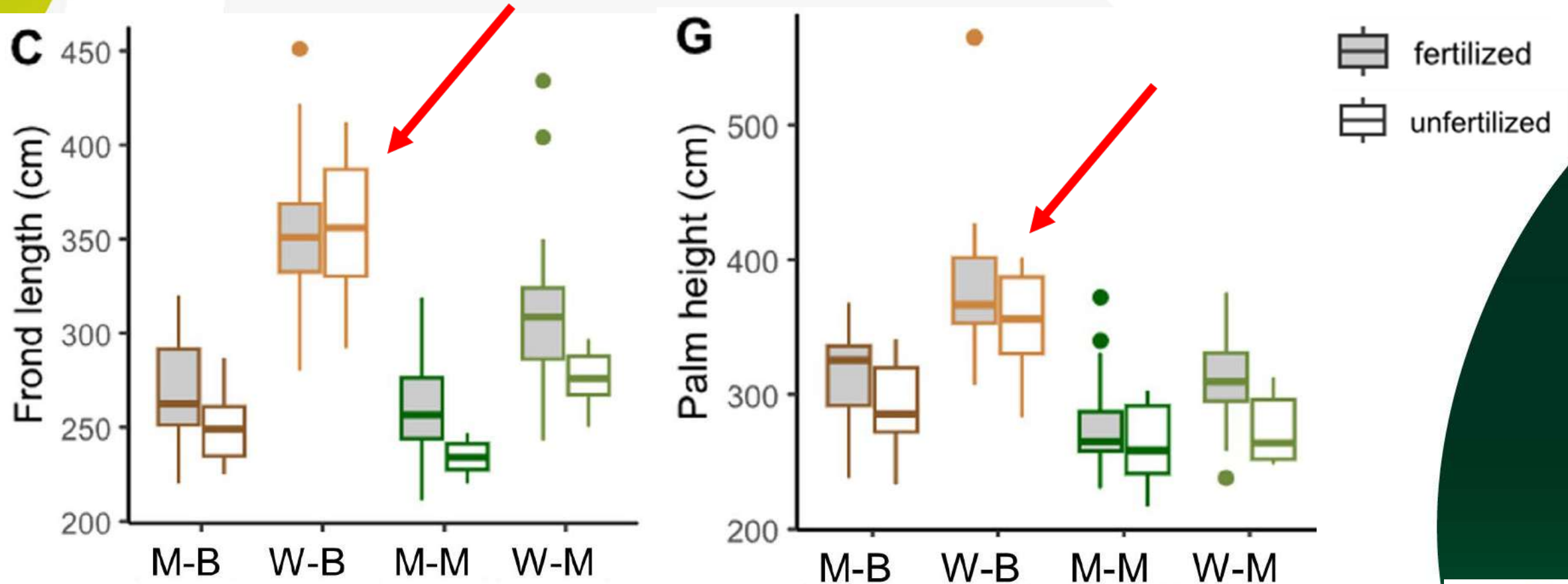


RESULTS



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Intercropped palms have larger frond length and height than palms in monoculture. Sequential WB intercrop has highest values



RESULTS



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FROND LENGTH MEASURED IN 29 SMALLHOLDER FIELDS, PAIRED BY YAP

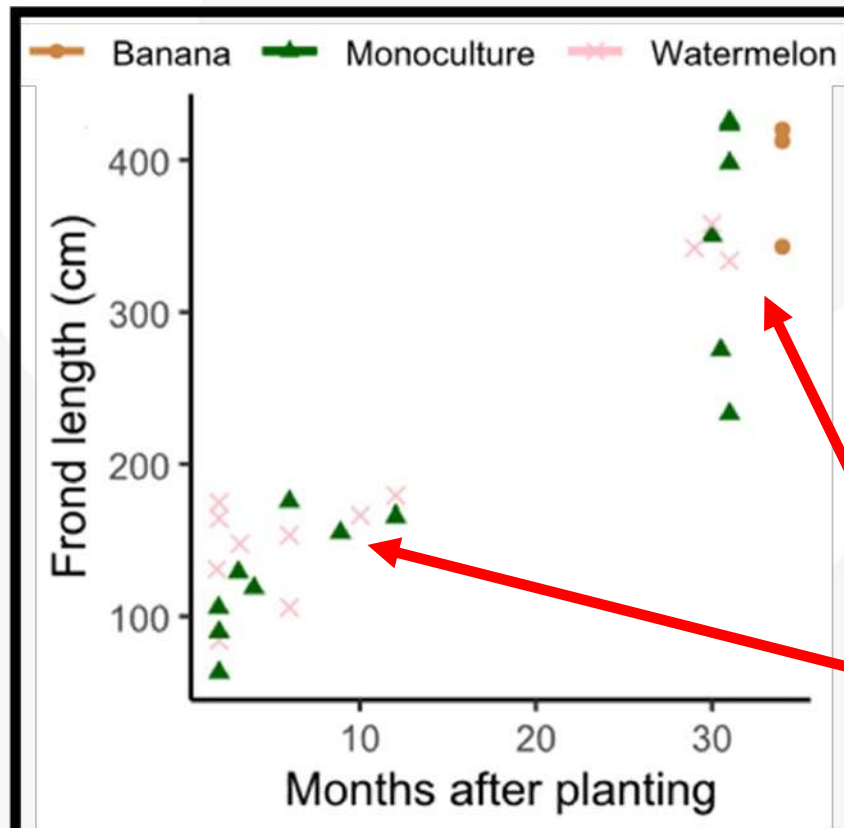


Figure 4: Intercropping effects on frond length in smallholder fields



Oil palm frond length in intercrop at least similar to monoculture till 30 MAP

DISCUSSION



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- Confounding effect of landscape position?
 - Watermelon intercropping is close to water bodies (needed for irrigation)
- Palms probably benefit from organic and inorganic fertilizers and water applied to banana and watermelon, and decomposition of crop residues
- Competition for light with bananas is likely
- Regenerative practice outcomes are assessed: effects of intercrop on soil chemical and physical quality, and on insects in soil, litter and air, AND on oil palm YIELD
- More long-term, fully randomized trials with complete measurements including water, nutrients and light, soil quality and biodiversity are urgently required to
 - (1) assess effect of intercropping on oil palm performance
 - (2) the factors responsible for these effects and
 - (3) the contribution of the practice to regeneration of the environment

CHALLENGE 2



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INTERCROPPING AS A BUSINESS ?



Lack of working capital: Replanting is costly, and crops require additional capital. To compensate for oil palm income loss, high value crops are needed. For sharecroppers which have no land as collateral, and will face high-interest loans, high-value crops like (water)melon/banana are also the most worthwhile option.



Limited knowledge on intercropping practices: Such high-value intercrops require intensive care and technical know-how



Restricted market access post-harvest: Horticultural crops are highly perishable and need to be sold quickly, with volume & quality aligning with buyers demands.

SHARECROPPING MODELS



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A Closed-Loop Ecosystem (CLE) for Intercropper



**Oil palm
landowner**

Oil palm owner
with other job

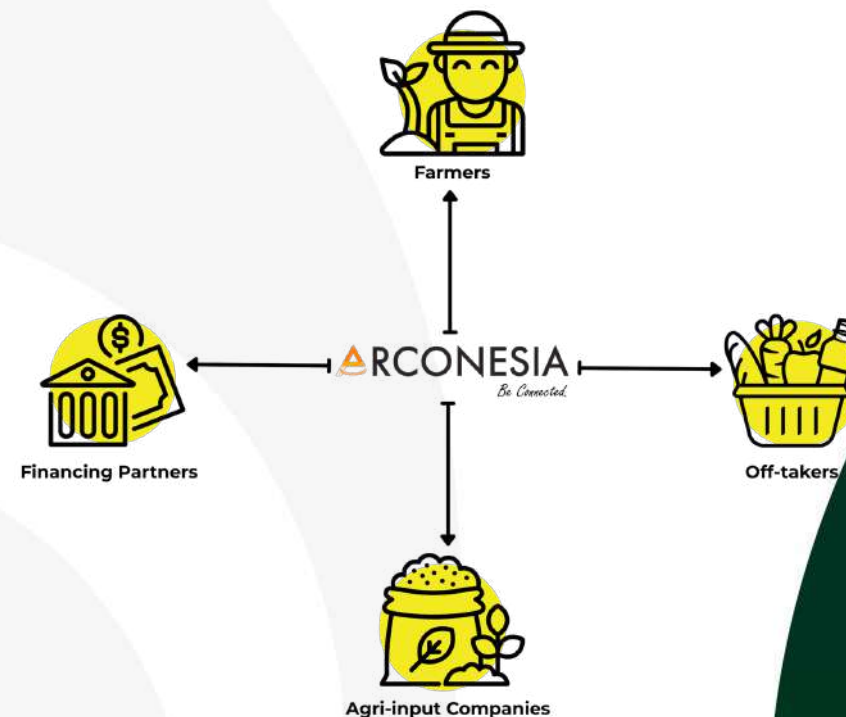
Large
plantation



**Land-less Farmers
(Intercroppers)**

Young
intercropper

Experienced
intercropper



SERVICES FOR INTERCROPPERS



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FULL SUPPORT PACKAGE: Access to land, financing, inputs, knowledge/agronomic support and market opportunities provided in one integrated collaboration scheme.

For **Young** intercropper

1. **Risk-free financing agreement** – Young farmers receive a fixed salary, while harvest revenue goes to Arconesia.
2. **Training & capacity building** – Regular training sessions and field schools are provided.
3. **Career pathway opportunities** – Young farmers can progress to the experienced farmer scheme

For **Experienced** Intercropper

1. **Input Loan Financing Agreement** – Collateral-free loans with repayment after harvest; 100% of harvest income goes to the farmer
2. **Training & Capacity Building** – Regular training sessions and field schools to strengthen farmers' skills and knowledge.

SHARECROPPING MOTIVATIONS FOR OIL PALM SMALLHOLDERS



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1. **Labour shortage solved** – intercrop farmers provide extra labour support to landowners
2. **Daily attendance to field** – intercrop farmers are present every day to monitor the young oil palm plantation (e.g. avoid cattle entry)
3. **Weeds under control** – 100% of landowners reported reduced weeding costs thanks to intercrops
4. **Nutrient & water sharing** – 89% of landowners experienced reduced fertilizer needs because intercrops share nutrients and leave residues that benefit palms
5. **Good land stewardship** – 98% of intercrop farmers use land for free: landowners socially support landless & keep land productive

Sustainpalm: indepth interviews + survey on 50 farmers



WHY IS INTERCROPPING OF INTEREST TO **LARGE PLANTATIONS?**

1. **Example of regenerative agriculture:** future “license to sell”?
2. **Barriers resolved:** With ARCONESIA services, large growers do not need to worry about skilled labor, inputs, or markets; they can stay focused on their core oil palm business.
3. **Benefit sharing:** Large plantations can choose to negotiate land rent/benefit sharing & or start their own intercrop unit for large areas
4. **Saving on operational costs:** reduced weeding costs (192 €/ha/year)!!
5. **Benefit from soil improvement:** land preparation for intercrop includes application of organic material, intercrop is properly fertilized, crop residues remain → reduced fertilizer cost for oil palm?
6. **No negative impact on palm performance** was found when GAP was applied to intercrop cultivation



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LIVESTOCK INTEGRATION



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PROVEN BENEFITS

- Additional revenues to oil palm area.
- Reduction of costs for weeding: labor and herbicides
- Oil palm yields are similar or increased
- Nutrients from weeds, oil palm fronds (fresh or in silage) and palm kernel meal as supplementary feed are recycled to the plantation via manure and urine and support oil palm production
- Increased bird diversity

Gabdo and Abdiatif, 2019; Latif and Mamat, 2002; Tohiran et al, 2017; Azhar et al, 2021; Gil et al, 2015; in Ruiz Alvarez et al, 2024. DOI: 10.1080/21683565.2023.2299012 and in Ha et al, 2025. DOI: [10.1079/cabireviews.2025.0016](https://doi.org/10.1079/cabireviews.2025.0016)



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LIVESTOCK INTEGRATION CHALLENGES



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OILPALM-LIVESTOCK CONFLICT

- Free roaming cattle can damage young palms and cause compaction when always in the same area and on bare soil
- Smallholders, with few cattle, have no labour for herding
- SSKA KUINTIP: Smallholder organisation, rotational grazing of the combined herd with mobile electric fences & oversight
 - only two people for surveillance
 - control of stocking densities → no damage
 - reduced weeding costs for oil palm owner
- SSKA ranch BKB provides knowledge, and access to supplementary feed, market, veterinary care, etc. (nucleus-plasma).





REPLANTING DECREASES GRAZING AREA

- Sale of livestock to maintain optimal grazing density
- Negotiate grazing area with oil palm grower with mature palms
- Cut and carry weeds from young plantations → labour demand is high
→ reduced weeding costs for OP owner

Cultivate fodder crops as inter crop instead of cover crops



Make silage from oil palm byproducts (fronds) or intercrop byproducts (corn stover)





DOES INTEGRATION SAVE FERTILIZER?

Cattle converts nutrients in weeds to nutrients in manure
→ lower C:N ratio in manure improves nutrient availability
→ no additional nutrients but only recycling → no fertilizer saving

Feeding supplements such as Palm Kernel Meal to grazing cattle → additional nutrients in manure → saves fertilizer

Use manure to increase value of oil palm by-products such as EFB by co-composting → improves EFB C:N ratio and nutrient availability
→ saves fertilizer



Composting EFB + Manure





EFFECT ON SOIL COMPACTION & DISEASE?

- Many narratives used against integration, but no proof.
- Should only worry about compaction when it decreases oil palm yields → yield reductions not reported
- Risk of compaction could be countered by effect of weed growth and manure on soil quality, and by rotational grazing
- Ganoderma spores could be spread by cattle movement, but does it lead to more basal stem rot infections? Many “carriers”.
- Ganoderma can be “suppressed”? Manure could improve soil health promoting Ganoderma antagonists, spores can die in cattle stomach or manure?!
- Bud rot could be spread by insects that “stay” in the weeds but these weeds could also host their natural enemies?!

GAP IN LIVESTOCK INTEGRATION?



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Example: SISKARANCH-PT Simbiosis Karya Agroindustri, PT Buana Karya Bhakti in South Kalimantan, Indonesia

KPIs of the RANCH address several aspects of economy & regenerative agriculture

KPI Category	Metric	Conventional Monoculture (Baseline)	SISKA Integrated System (PT BKB)	Impact / % Change
Economic	FFB Yield	Industry Average	28.29% FFB Yield	Enhanced Productivity
	Weeding Cost	Standard Herbicide Expenditure	IDR 250,000/ha/year Savings	Significant Cost Reduction
	Fertilizer Cost	Standard NPK Application	IDR 250,000/ha/year Savings	Significant Cost Reduction
	Income Streams	Single (Palm Oil)	Dual (Palm Oil + Beef)	Increased Resilience & Diversification
Ecological	Herbicide Use	Routine Application	Drastically Reduced/Eliminated	Reduced Chemical Footprint
	Nitrogen Leaching	74 kg N/ha/year	32 kg N/ha/year	-57% Reduction
	Soil Health	Declining Organic Matter	Increased Organic Matter & Nutrient Cycling	Improved Fertility & Structure
	Biodiversity	Low	Increased Bird & Insect Richness	Enhanced Ecosystem Services



SISKA®
COLLABORATIVE

Kolaborasi Riset dan Diseminasi
Sistem InterCrop (Tumpang Sari)
dan IntegCow (Budidaya Ternak
di Perkebunan Sawit)



GAPENSISKA

Gabungan Pelaku dan Pemerhati
Sistem Integrasi Sapi Kelapa Sawit

Source: Data compiled from Raisa et al. (2024)¹, Sidiq (2024)¹, Bremer et al. (2022)¹, and Formaglio et al. (2020).¹⁷

- Company supports thorough PhD research on soil compaction, soil quality, cattle productivity, optimal feeding regimes and income.
- SISKA & GAPENSISKA form a network to support livestock integration with advise and trainings for companies and smallholders on SISKA GAP, intercropping for feed is included



CONCLUSION



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Integration can be an economically and socially viable option to increase income and food and decrease oil palm operational (esp. weeding) costs. Negative effect on palm oil production were not found. Good agricultural practices need to be used for crops and livestock. Further research needs to assess effects of integration on oil palm yield & factors responsible!!

Integration is defined as example of regenerative practices. Environmental effects include lower use of agrochemicals for oil palm cultivation, effects on soil quality and biodiversity, many of which need further investigation. Research is needed on effects of integrating crops & livestock on oil palm diseases.

MUCHAS GRACIAS

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