Life cycle assessment (LCA) of palm oil

– methods and updates on results for RSPO certified vs non-certified palm oil

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Brussels 22nd May 2024

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Agenda

- **Intro to LCA**
  - The basics
  - Standards and methods
  - Land use changes and nature conservation
- **LCA of palm oil: RSPO certified vs non-certified**
  - Goal and scope
  - Results
  - Improvement potentials
- **Q&A**

Draft results from crowdfunded project:
https://lca-net.com/clubs/palm-oil/

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What is an LCA?

- "Compilation of emissions, resources and environmental impacts of a product… throughout its life cycle

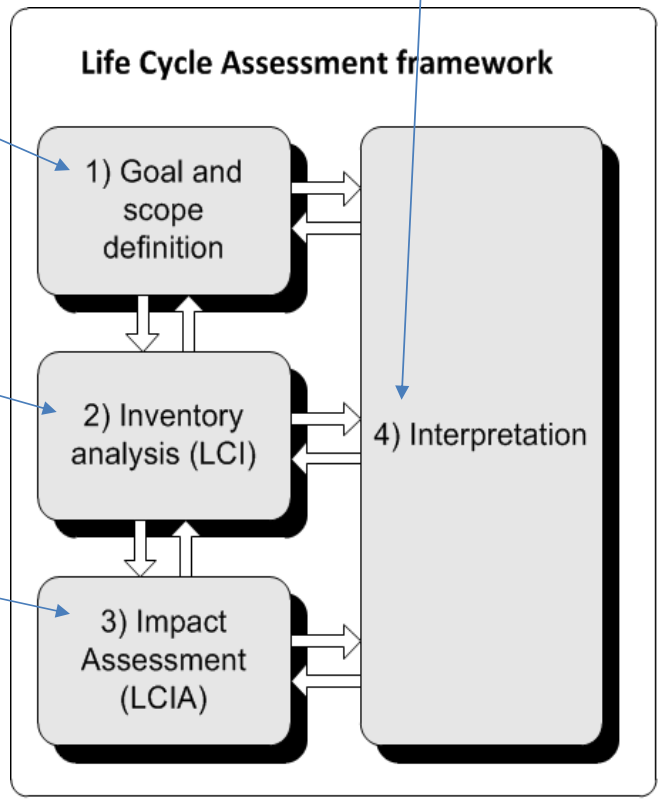
LCA

- Functional unit
- System boundaries
- Choice of background DB
- Choice of LCIA method

- Data collection
- Linking unit processes

- Calculating results
- Hotspot and contribution

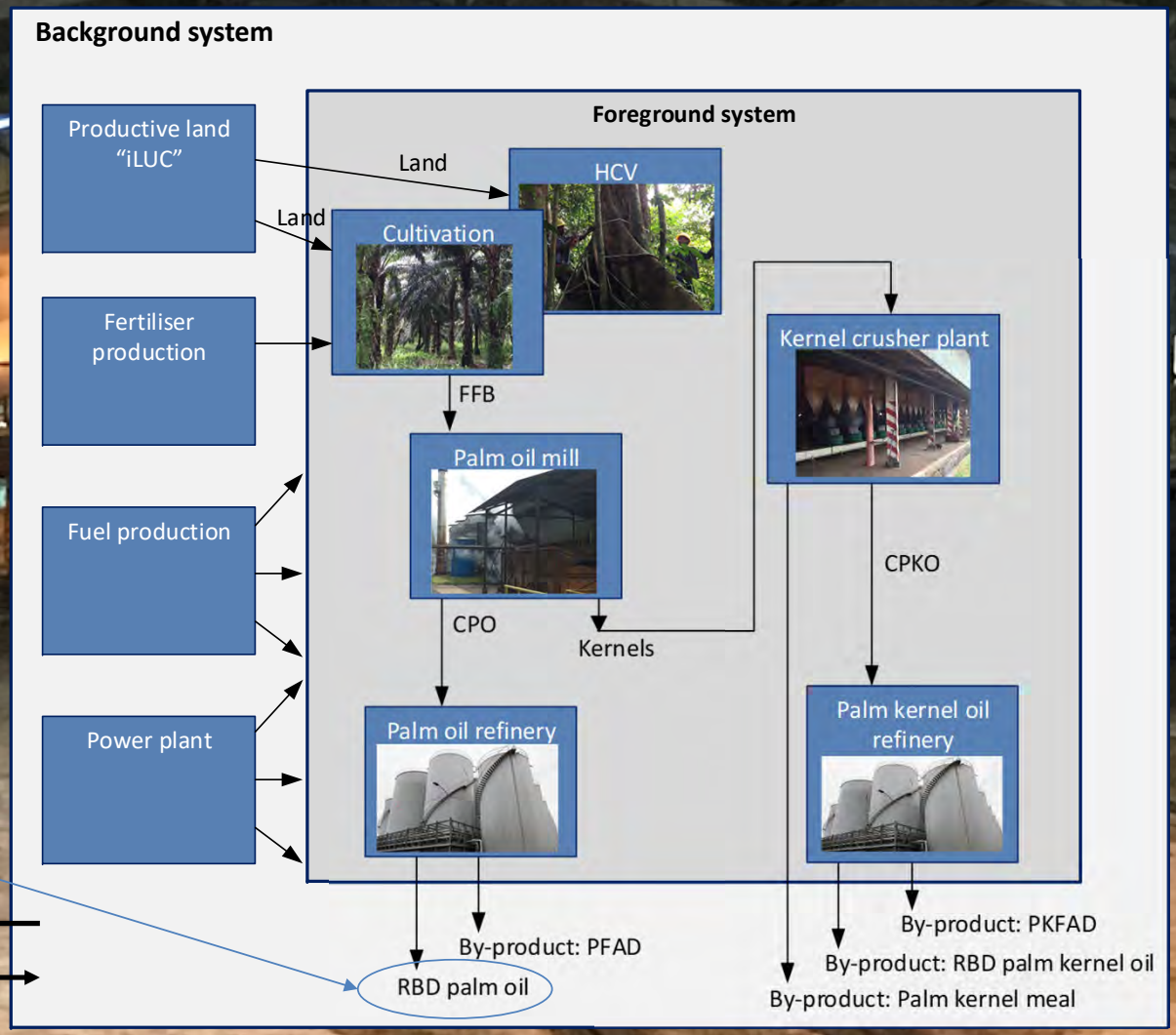
- Conclusions
- Evaluation of consistency, completeness and sensitivity



Many standards and guidelines

- **ISO 14040 and 14044 (2006)**
- ISO 14067 Carbon Footprint
- EU product environmental footprint (PEF)
- EU Renewable Directive (RED)
- GHG Protocol
- PAS2050
- FAO Leap Guideline
- Science-based Targets (SBTi)
- International Dairy Federation (IDF) Guide for LCA
- Pathfinder Framework Version 2.0
- EN 15804
- …

Life cycle assessment (LCA)



Product system

Functional unit

System boundary

Foreground & background

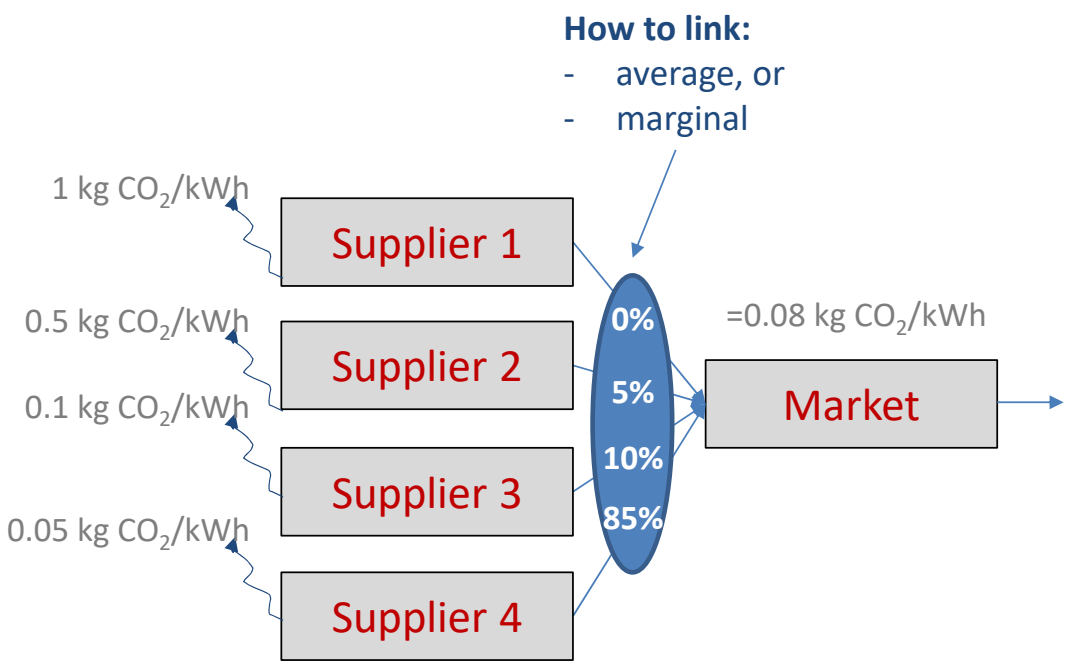
Emisisons

Resources

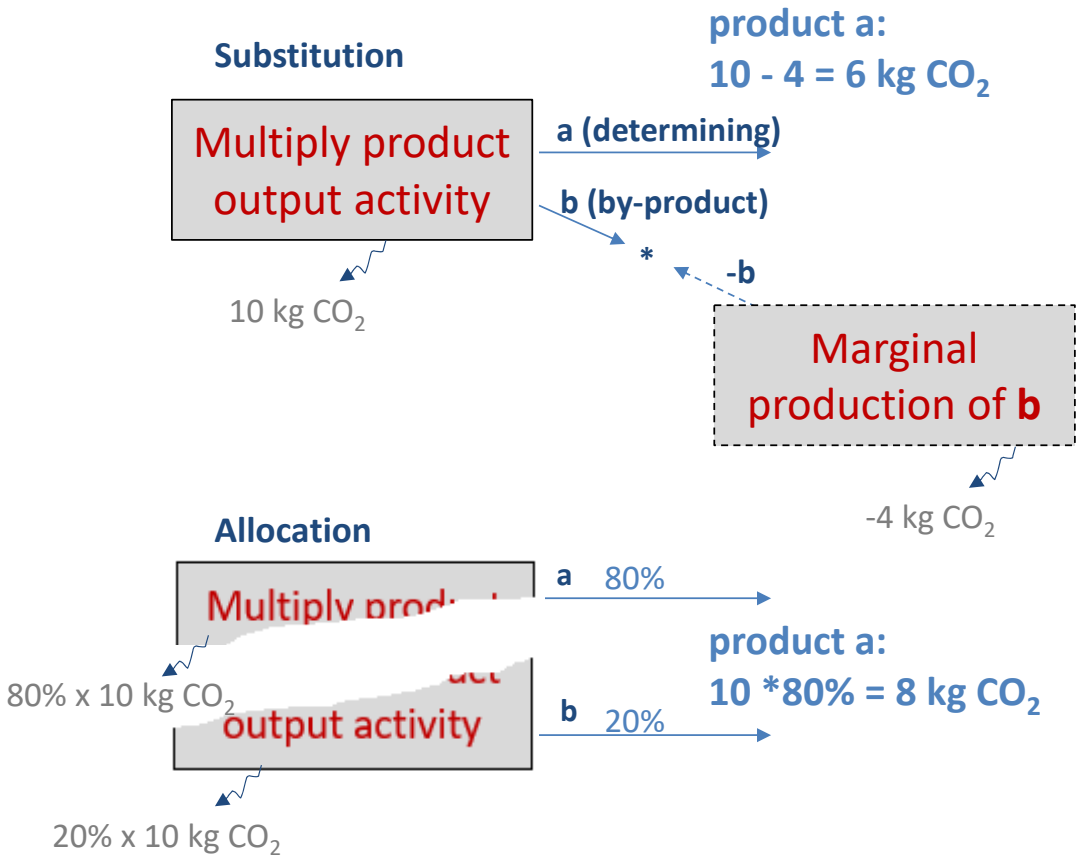
Picture: Jannick Schmidt. Hanau palm oil mill, Sinarmas, Central Kalimantan 2018

LCA methods

Supply mix: marginal vs average



By-products: substitution vs allocation



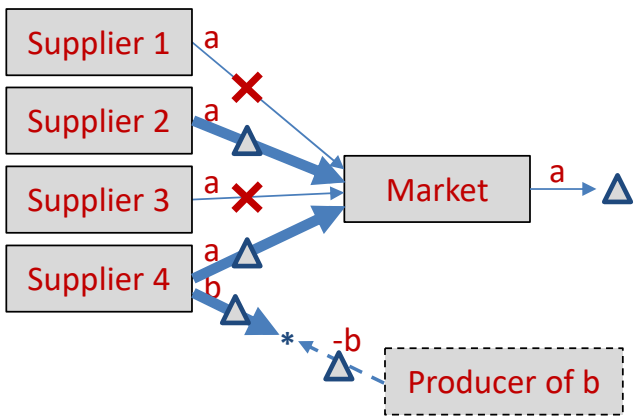
Consequential and attributional models

Consequential

Δ demand a

⇨ Δ production

⇨ Δ emissions

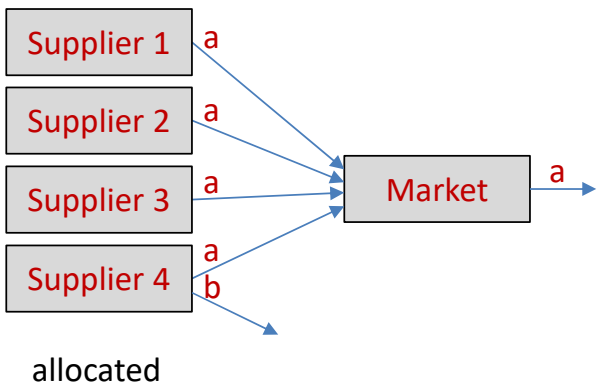


Purpose: Calculate emissions related to a change in demand for product ***a***

⇨ Decision support

Attributional

Product a ⇨ historical tracking and allocating emissions (often via mass/energy/economic criteria)

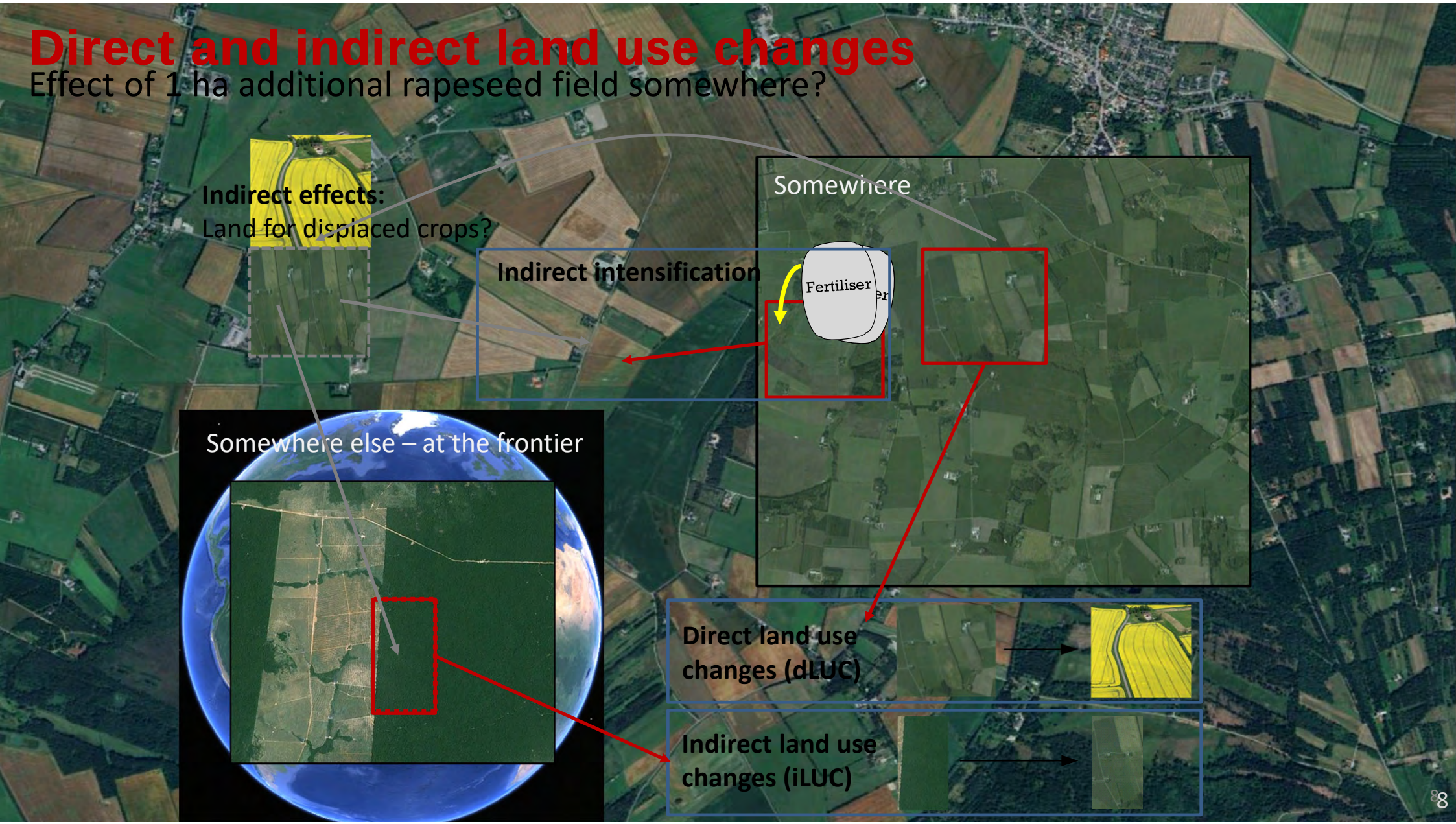


Purpose: Calculate emissions allocated to product ***a*** following a normative rule

⇨ Compliance to regulations and specific standards etc.

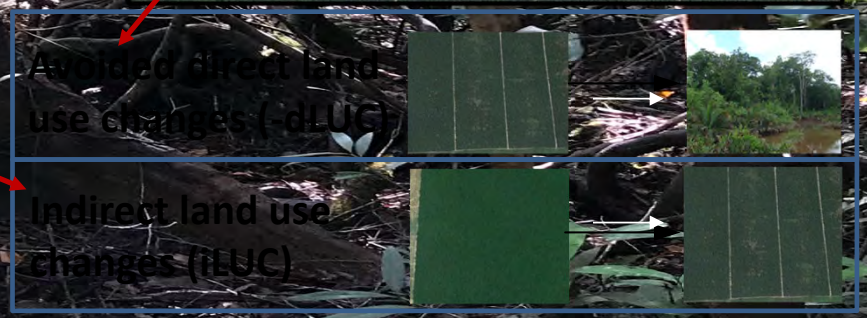
Direct and indirect land use changes

Effect of 1 ha additional rapeseed field somewhere?



Nature conservation

- **Effect of 1 ha Nature conservation**
- **The choice:**
  - Cultivate oil palm, or
  - Nature conservation



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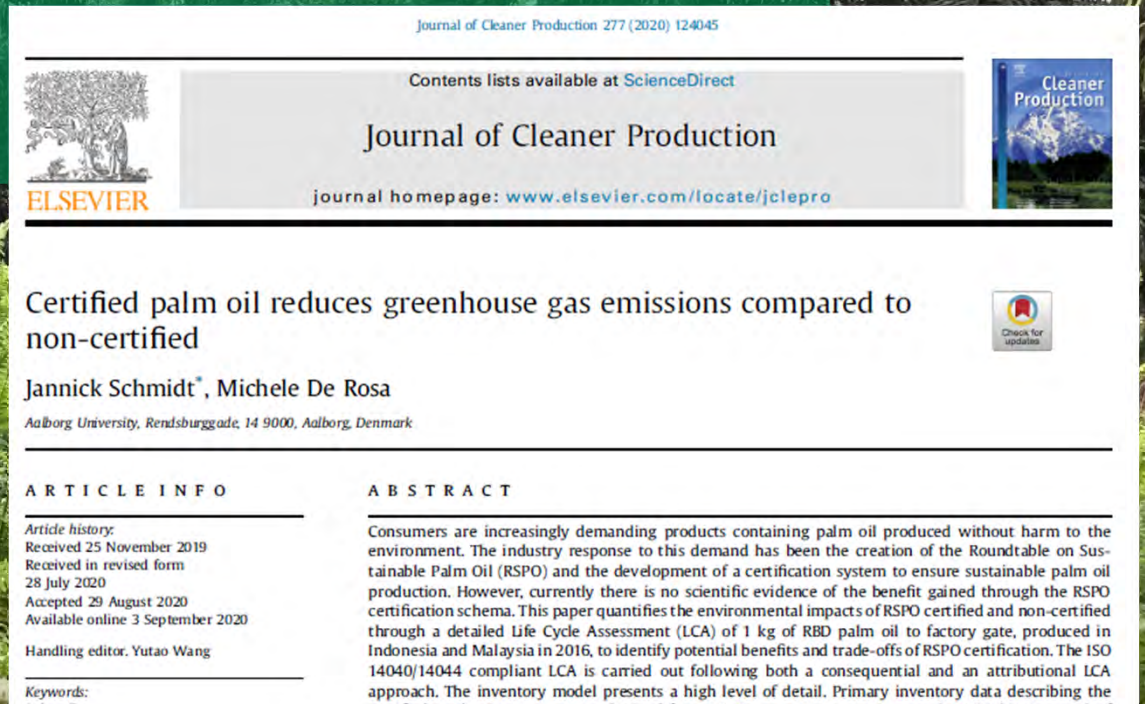
Background

- Sustainable palm oil? RSPO certification is the most acknowledged choice
- Little knowledge - what are the environmental benefits?
- Crowdfunded project: https://lca-net.com/clubs/palm-oil/
- First project 2016-2000 (16 members)
- Current project 2020- (21 members)



Journal of Cleaner Production 277 (2020) 124045

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Certified palm oil reduces greenhouse gas emissions compared to non-certified

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ARTICLE INFO

Article history:
Received 25 November 2019
Received in revised form
28 July 2020
Accepted 29 August 2020
Available online 3 September 2020

Handling editor. Yutao Wang

Keywords:

ABSTRACT

Consumers are increasingly demanding products containing palm oil produced without harm to the environment. The industry response to this demand has been the creation of the Roundtable on Sustainable Palm Oil (RSPO) and the development of a certification system to ensure sustainable palm oil production. However, currently there is no scientific evidence of the benefit gained through the RSPO certification schema. This paper quantifies the environmental impacts of RSPO certified and non-certified through a detailed Life Cycle Assessment (LCA) of 1 kg of RBD palm oil to factory gate, produced in Indonesia and Malaysia in 2016, to identify potential benefits and trade-offs of RSPO certification. The ISO 14040/14044 compliant LCA is carried out following both a consequential and an attributional LCA approach. The inventory model presents a high level of detail. Primary inventory data describing the

Project promoted and supported by RSPO
Carried out independently of RSPO

Picture: Jannick Schmidt. Sinarmas, Central Kalimantan 2018

Scope	2016-2020 study	Current study
Results granularity		
Geographical	Indonesia & Malaysia aggregated	Indonesia (regions: Sumatra, Kalimantan) Malaysia (regions: Peninsular, Sarawak, Sabah) Thailand Colombia Nigeria **92% of global palm oil**
Temporal	2016	2016, 2021
Grower type	Average	Estates, smallholders
Certification	RSPO certified, non-certified	RSPO certified, non-certified
Model	Consequential & attributional	Consequential & attributional
Features		
Functional unit	1 tonne RBD palm oil, 1 tonne CPO	
Land use changes	Consequential: dLUC + iLUC Attributional: PAS2050 approach	
Nature conservation	Consequential: yes Attributional: no	
Cut-off	Consequential: no cut-off Attributional: services not included	

Data collection

Input data		Input data		Input data
Industry total		**RSPO certified**		**Non-certified**
Estates		**Estates**		**Estates**
Yield		Yield		Yield
Fertiliser		Fertiliser		Fertiliser
Peat		Peat		Peat
Fuels		Fuels		Fuels
Conservation		Conservation		Conservation
Oil mills		**Oil mills**		**Oil mills**
OER		OER		OER
KER		KER		KER
Fuels		Fuels		Fuels
POME		POME		POME

minus =

- **Total industry**
  - Statistics and GIS
  - LCA coefficients to close gaps
- **RSPO certified: PalmGHG extracts**
  - 656 estates (25% of all certified grower entries)
  - 186 oil mills (55% of all certified CPO)

Picture: Jannick Schmidt. Hanau palm oil mill, Sinarmas, Central Kalimantan 2018

What do the data show?

N.B. preliminary data!

Estates

Key performance indicators (KPIs)for oil palm cultivation. ID & MY 2021

Flows	Unit	Malaysia			Indonesia		
		industry	RSPO	non-certified	industry	RSPO	non-certified
Total planted area	million ha	5.73	1.03	4.71	15.14	1.97	13.17
Share of area RSPO certified	%	18%	100%	0%	13%	100%	0%
Total FFB production	million tonne	94.97	17.82	77.15	233.50	35.78	197.72
Share of FFB RSPO certified	%	19%	100%	0%	15%	100%	0%
Share of oil palm on peat	%	20%	4%	23%	11%	12%	11%
Drainage depth (DD) of peat	cm	73	57	74	73	57	76
FFB yield, mature	t/ha	18.4	19.3	18.2	17.1	20.2	16.7
Fuel use	MJ/ha	1710	2708	1493	1710	1828	1692
Applied mineral N	kg N/ha	66	90	61	86	91	86
Applied organic N	kg N/ha	21	19	21	19	22	19
Applied mineral P2O5	kg P2O5/ha	49	58	47	37	79	31
Applied organic P2O5	kg P2O5/ha	8	8	8	7	9	7
Applied mineral K2O	kg K2O	204	198	205	63	165	48
Applied organic K2O	kg K2O	66	57	68	61	69	60

Oil mills

Key performance indicators for palm oil mills. ID & MY 2021

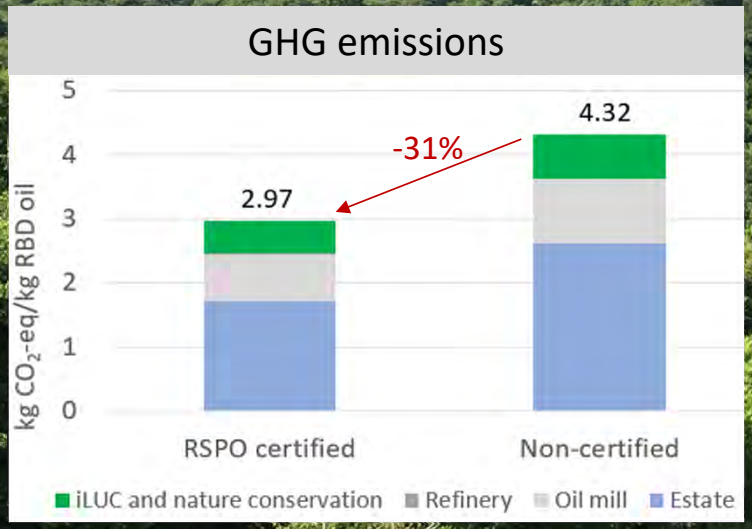
Flows	Unit	Malaysia			Indonesia		
		industry	RSPO	non-certified	industry	RSPO	non-certified
Total CPO production	million tonne	19.0	5.0	14.1	46.8	11.4	35.4
Share of CPO that is RSPO certified	%	26%	100%	0%	24%	100%	0%
OER	%	20.0%	20.3%	19.9%	20.0%	21.0%	19.8%
KER	%	5.0%	4.6%	5.1%	4.5%	4.7%	4.4%
Share of POME treated with biogas capture	%	28%	39%	24%	7%	25%	2%

Picture: Jannick Schmidt. UIE palm oil mill, United Plantations, Peninsular Malaysia 2017

N.B. preliminary data!

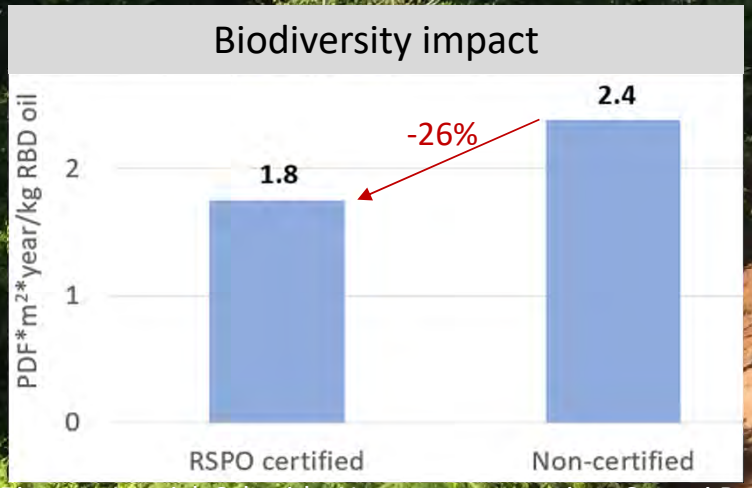
Buyer's perspective

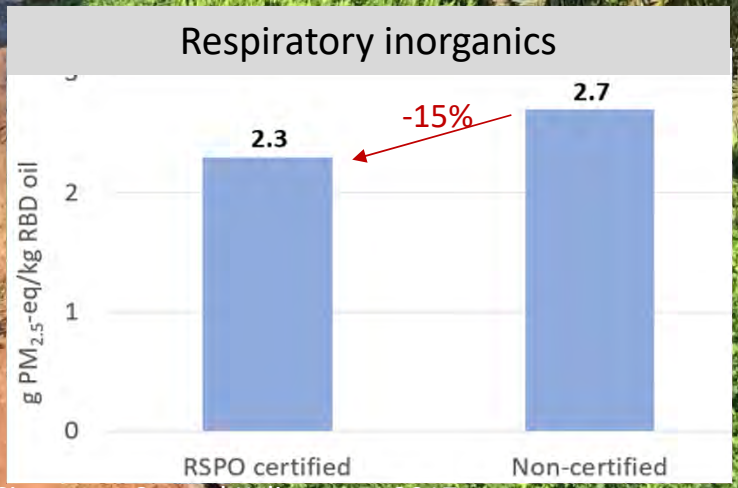
- What is the effect of buying certified palm oil in the market?



Buyer's perspective:

- Global marginal market
- ID 86%, MY 4%, TH 5%, CO 3%, NG 2%



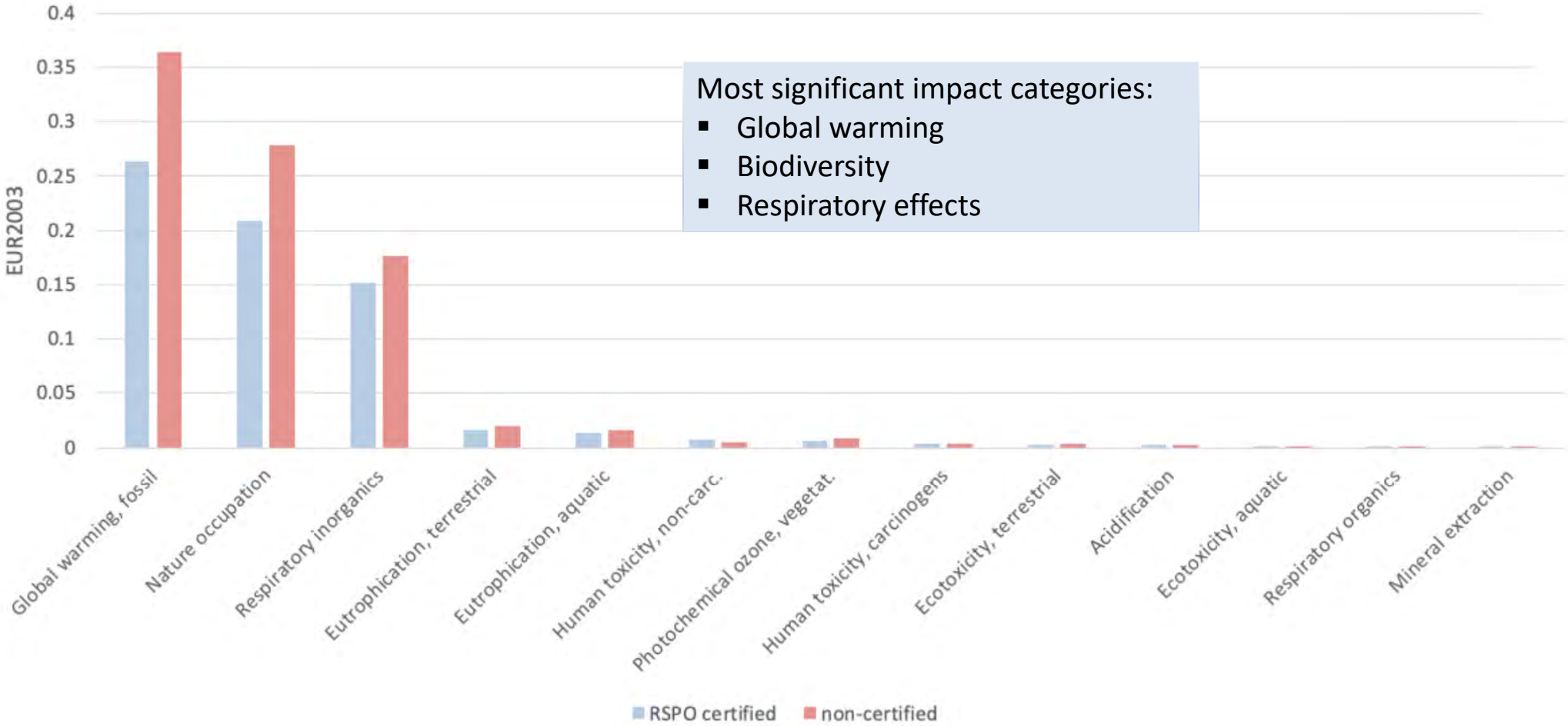


Picture: Jannick Schmidt. Nature conservation, Sungai Rungau estate, Sinarmas, Central Kalimantan 2017

Which impacts are most important?

N.B. preliminary data!

- Global palm oil supply



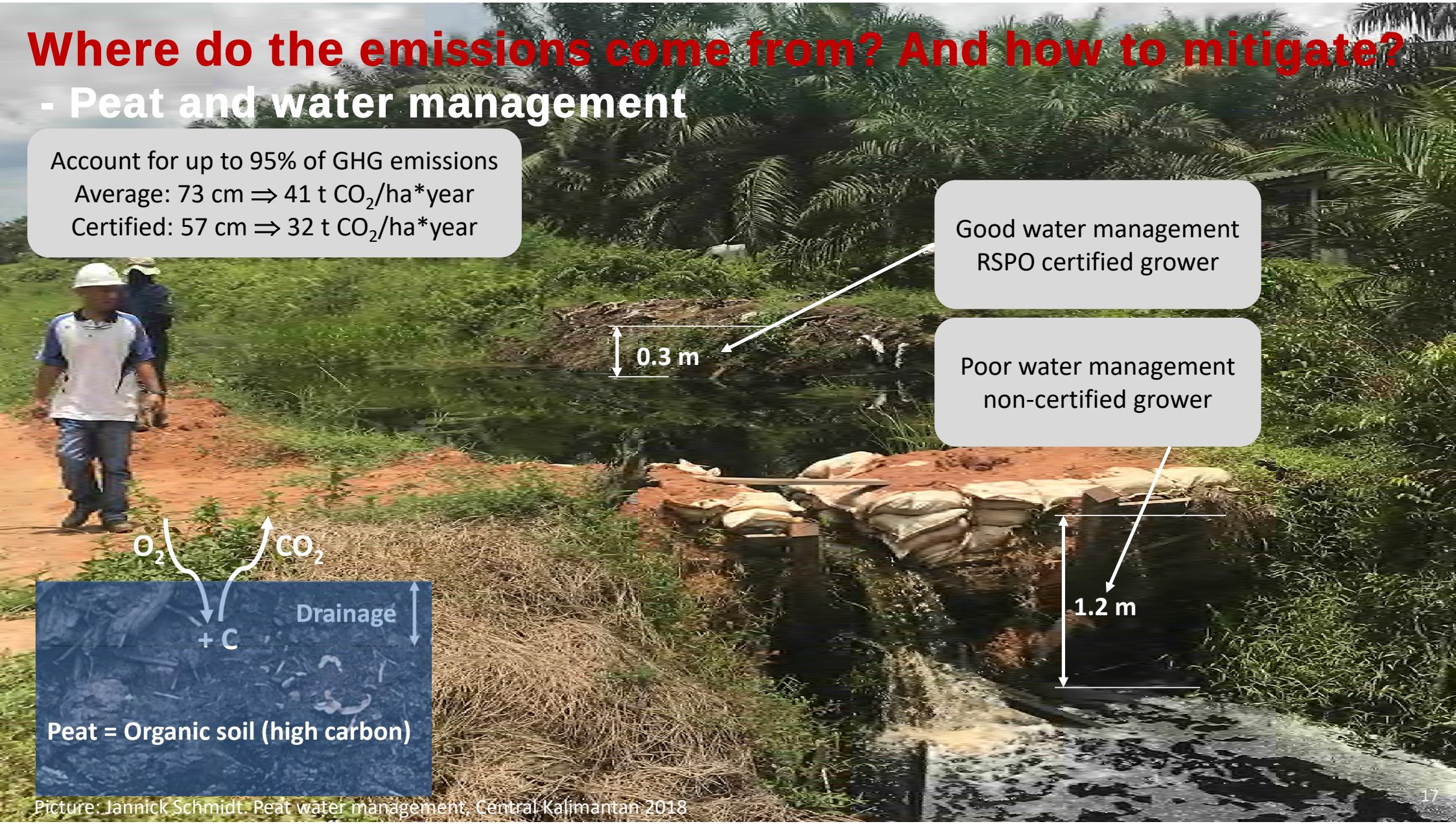
Most significant impact categories:

- Global warming
- Biodiversity
- Respiratory effects

Where do the emissions come from? And how to mitigate?

- Peat and water management

Account for up to 95% of GHG emissions
Average: 73 cm ⇒ 41 t CO_2/ha*year
Certified: 57 cm ⇒ 32 t CO_2/ha*year

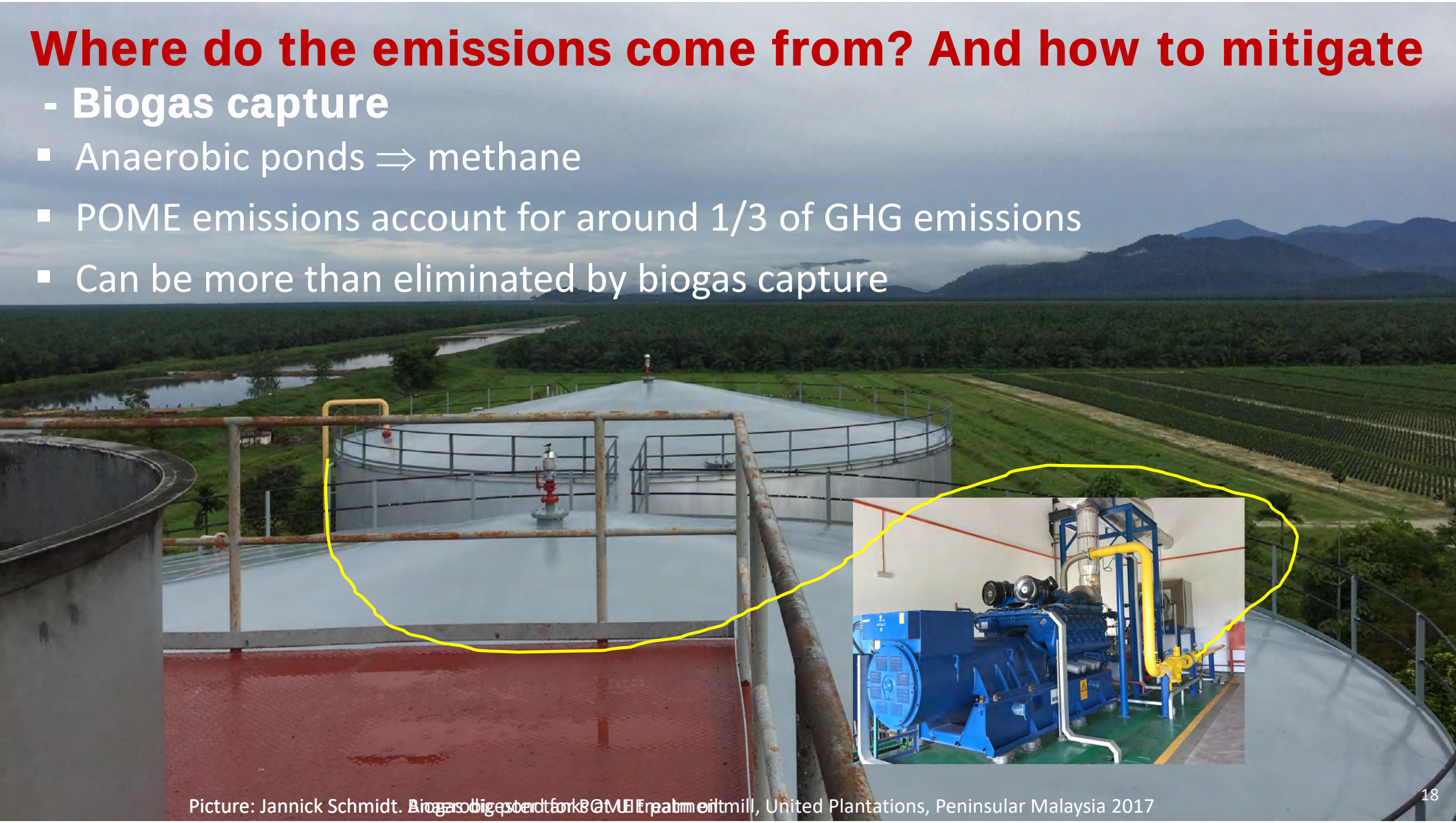


Picture: Jannick Schmidt. Peat water management, Central Kalimantan 2018

Where do the emissions come from? And how to mitigate

- Biogas capture

- Anaerobic ponds ⇒ methane
- POME emissions account for around 1/3 of GHG emissions
- Can be more than eliminated by biogas capture



Picture: Jannick Schmidt. Biogas digester for POME treatment at palm oil mill, United Plantations, Peninsular Malaysia 2017

Nature conservation as a means to mitigate

- 1 ha*year nature conservation (mineral soil) = **saves 1 tonne CO_2**
- 1 ha*year nature conservation (peat soil) = **saves 33-42 tonne CO_2**

Picture: Jannick Schmidt. Nature conservation, Sungai Rungau estate, Sinarmas, Central Kalimantan 2017

Breakdown of palm oil at global market

N.B. preliminary data!

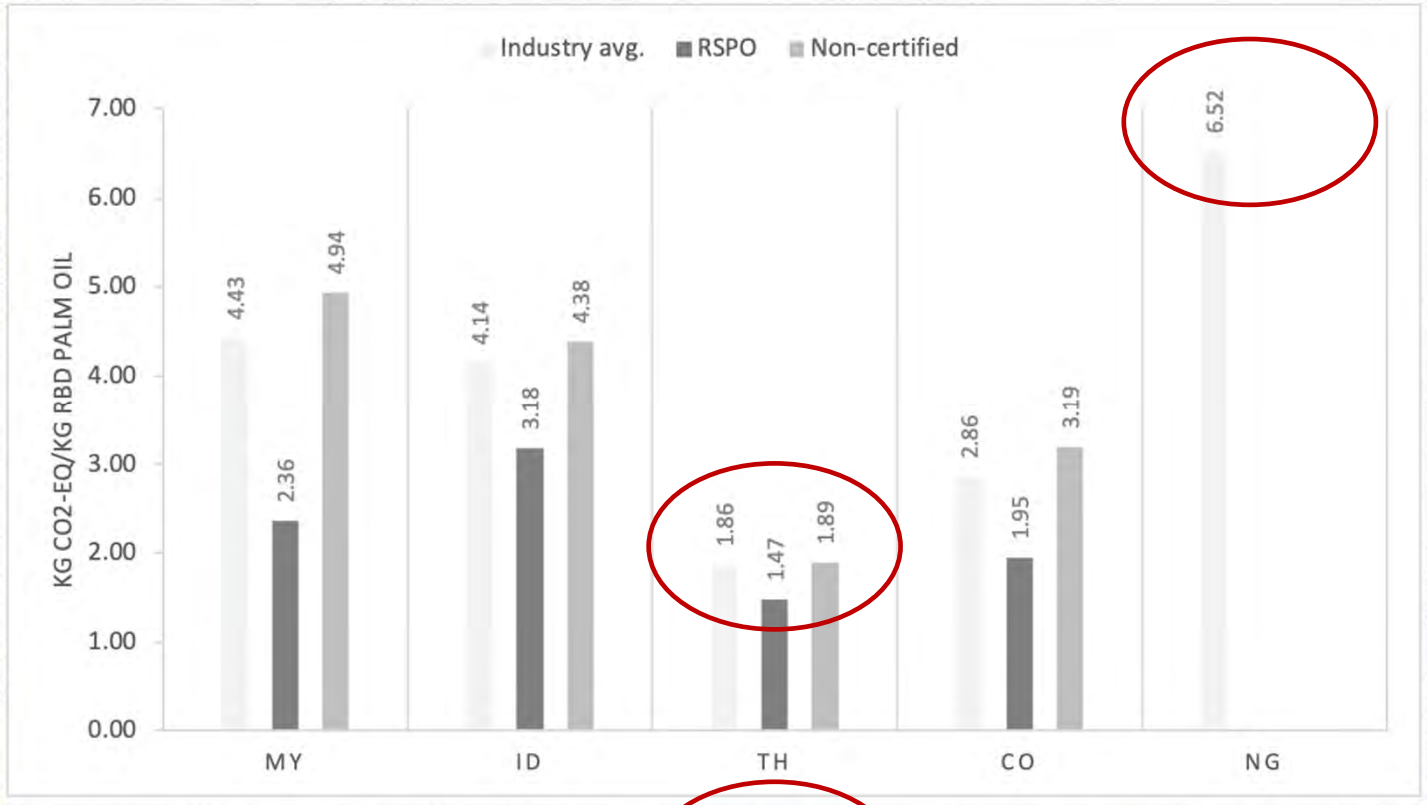
GHG emissions (kg CO_2e/kg RBD palm oil)

	RSPO certified	Non-certified
Cultivation: Land use	0.54	0.70
Cultivation: Peat	0.85	1.59
Cultivation: Fertiliser and pesticides	0.56	0.66
Cultivation: Other	0.29	0.36
Oil mill: POME	1.0	1.4
Oil mill: Kernels	-0.34	-0.48
Oil mill: Other	0.08	0.09
Refinery	0.00	0.00
Total	**2.97**	**4.32**

Producers perspective: geographical differences

GHG emissions

N.B. preliminary data!

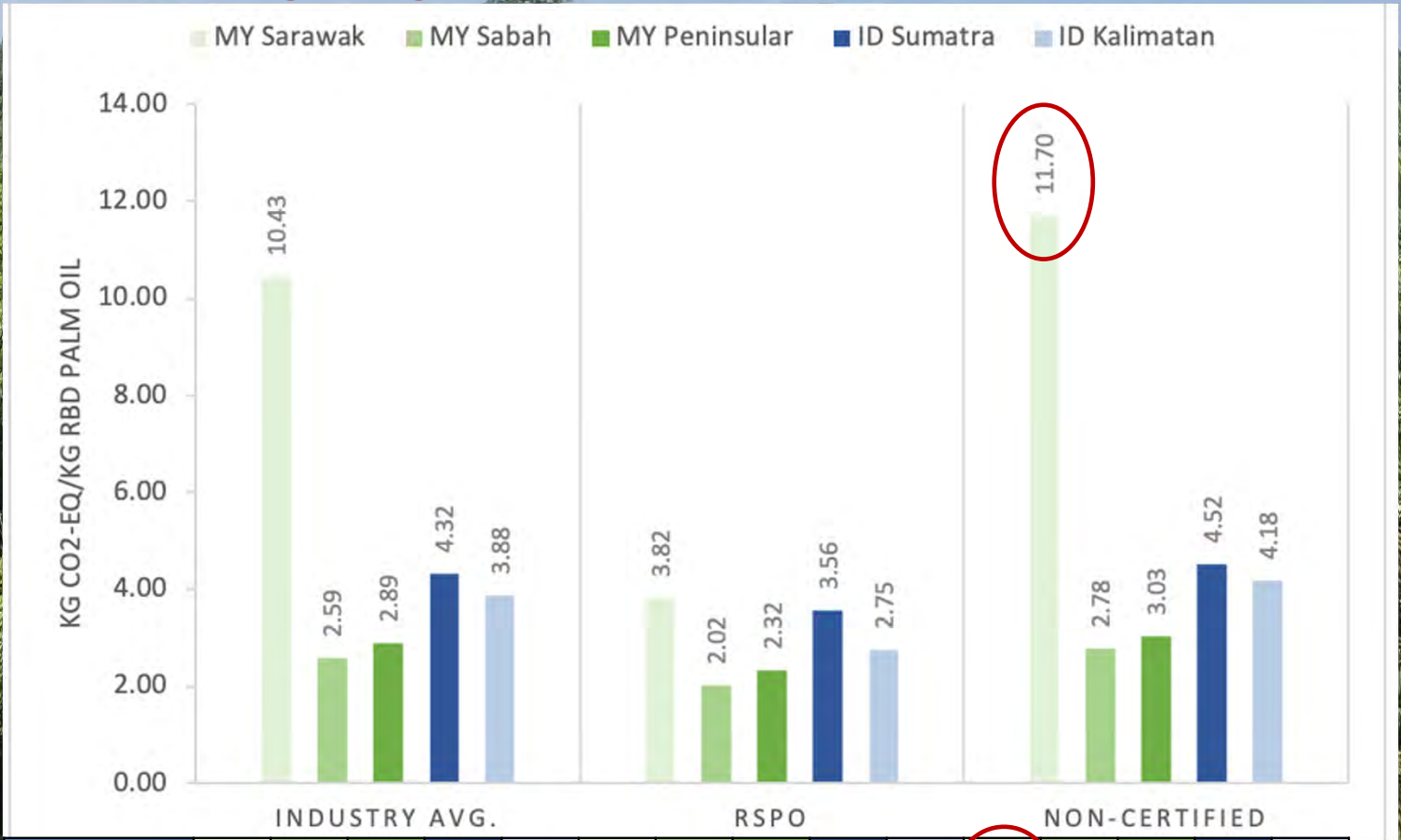


Peat	20%	4%	23%	11%	12%	11%	2%	2%	2%	2%	2%	2%
Biogas	28%	39%	24%	7%	25%	2%	68%	100%	65%	7%	28%	0%
Yield (t/ha)	18.4	19.3	18.2	17.1	20.2	16.7	17.6	19.1	17.6	15.8	22.2	14.3

Producers perspective: geographical differences - Sub-national

N.B. preliminary data!

GHG emissions

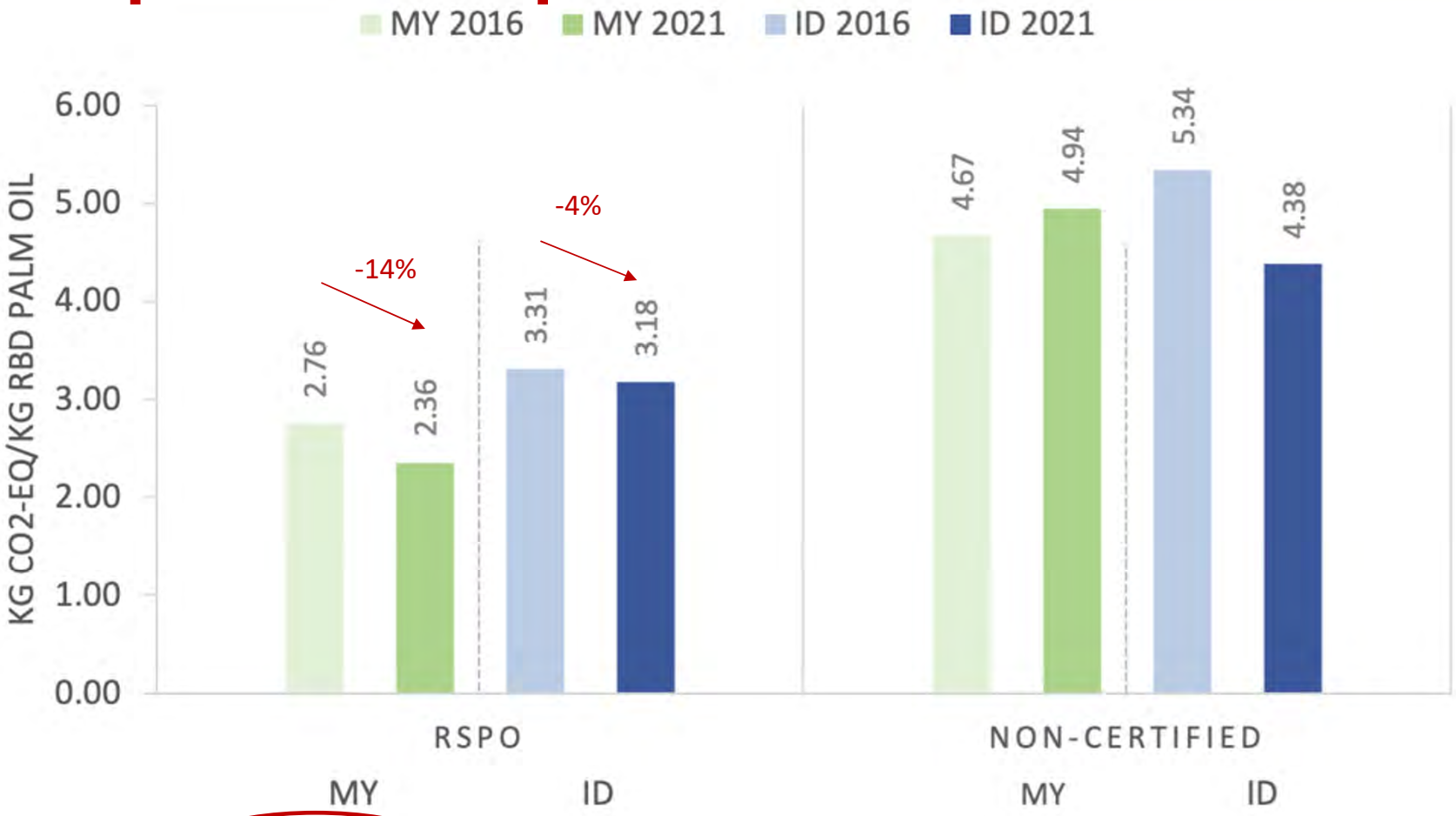


Peat	55%	3%	9%	13%	8%	9%	1%	3%	16%	7%	66%	3%	11%	13%	8%
Biogas	28%	28%	28%	9%	11%	59%	52%	25%	30%	23%	17%	20%	29%	3%	7%
Yield (t/ha)	14.4	16.9	21.6	17.8	16.5	11.2	17.9	21.4	19.6	21.2	15.2	16.7	21.7	17.5	15.7

Producers perspective: temporal differences

N.B. preliminary data!

GHG emissions

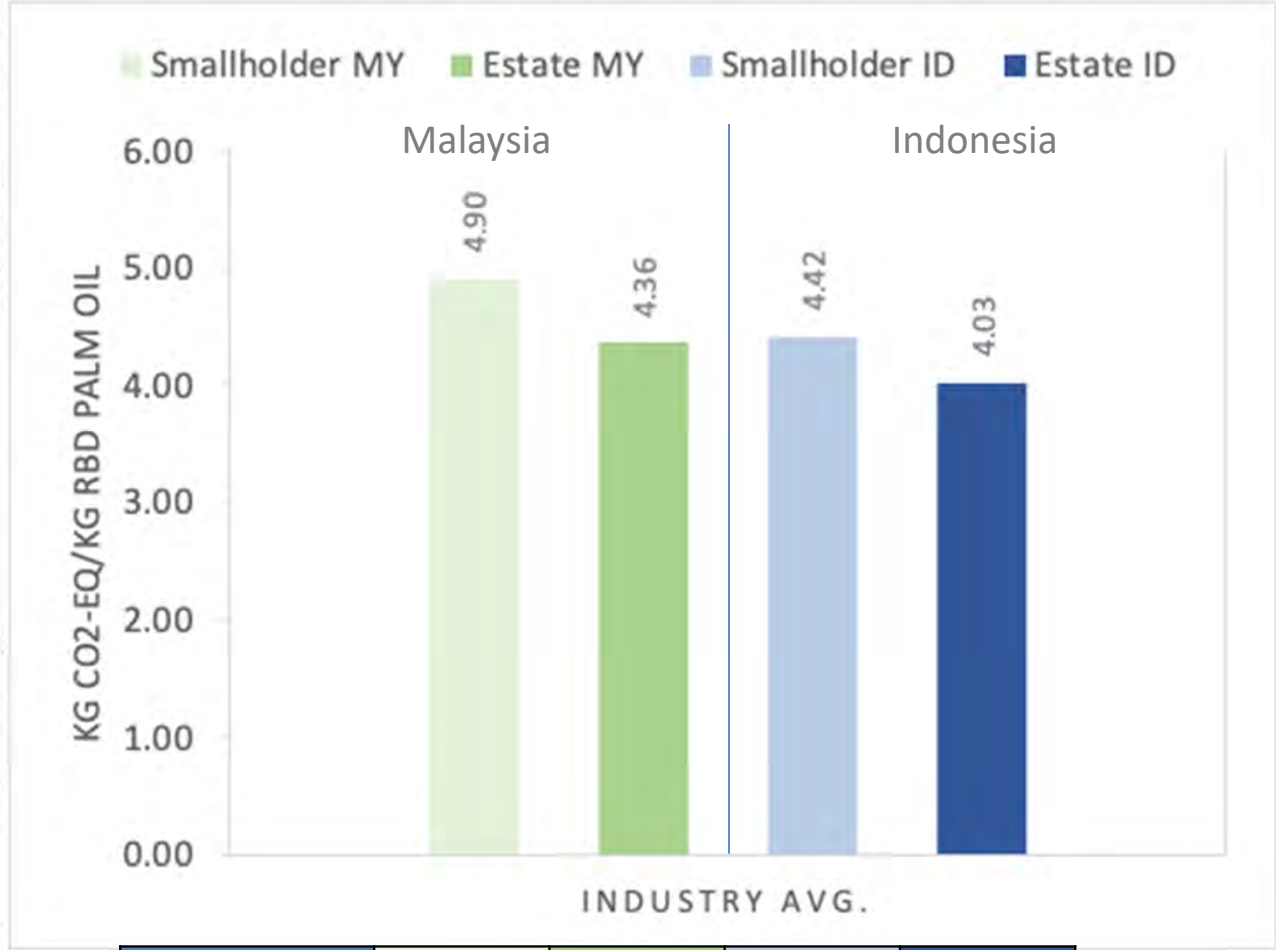


Peat	11%	4%	11%	12%	21%	23%	20%	11%
Biogas	16%	39%	12%	25%	15%	24%	6%	2%
Yield (t/ha)	20.2	19.3	19.9	20.2	19.0	18.2	16.4	16.7

Producers perspective: smallhoders vs estates

N.B. preliminary data!

GHG emissions



Yield (t/ha)	15.6	18.9	15.1	18.4

Conclusions

- RSPO certified outperforms non-certified
- Large differences
  - Cultivation on peat soil ⇨ significantly increases GHG
  - POME with biogas capture ⇨ significantly reduces GHG
- Smaller differences
  - Smallholders have smaller yields ⇨ high GHG
- Mitigation options
  - Avoid peat
  - Use biogas capture
  - Set-aside high value conservation and high carbon stock

Pictures: Jannick Schmidt. Tanjung Puting, Central Kalimantan 2018

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Thank you

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