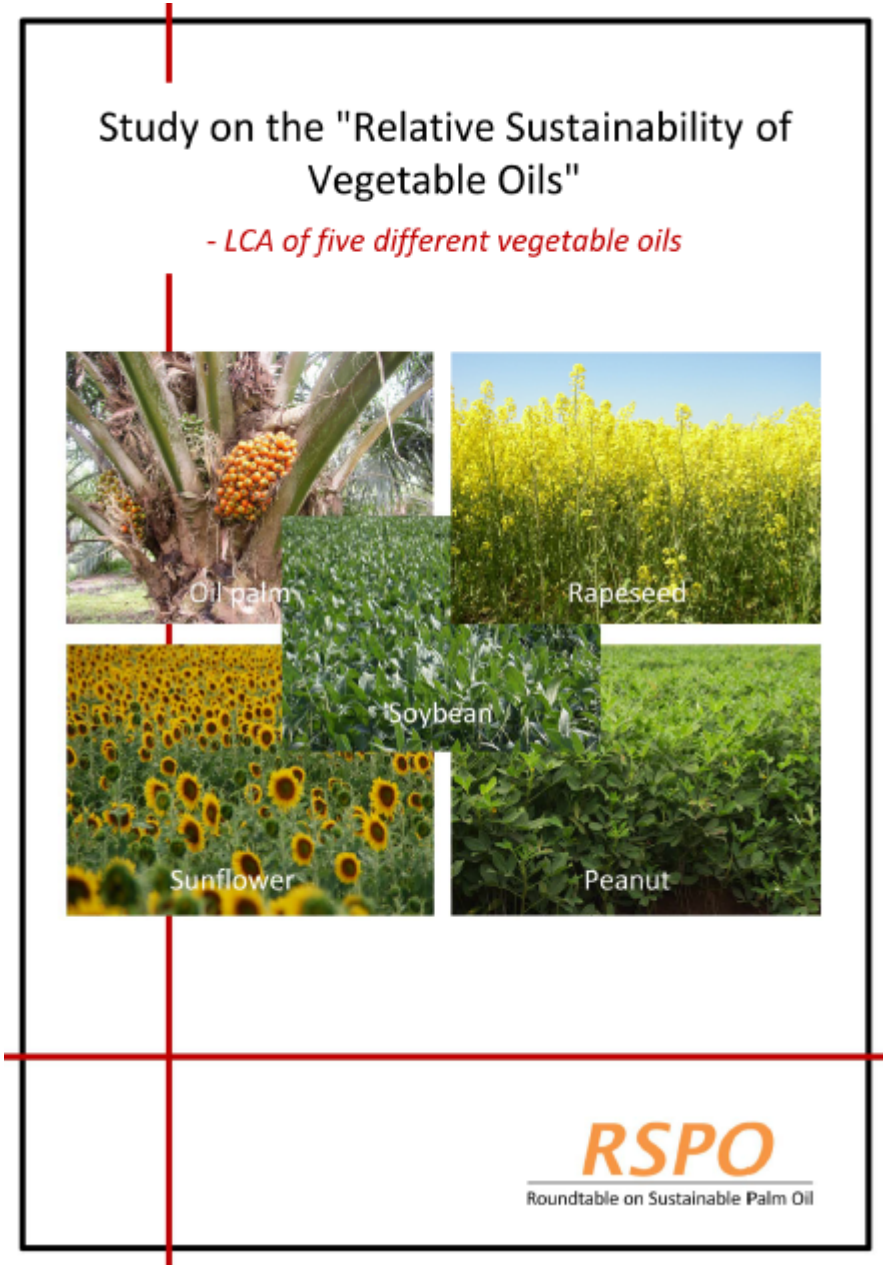

Five Edible Oils
- a comparison

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Medan 12th November 2013

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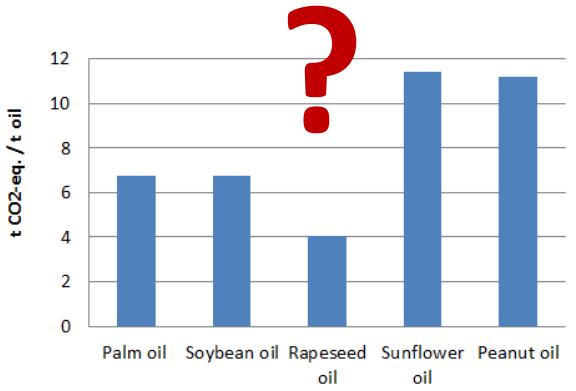
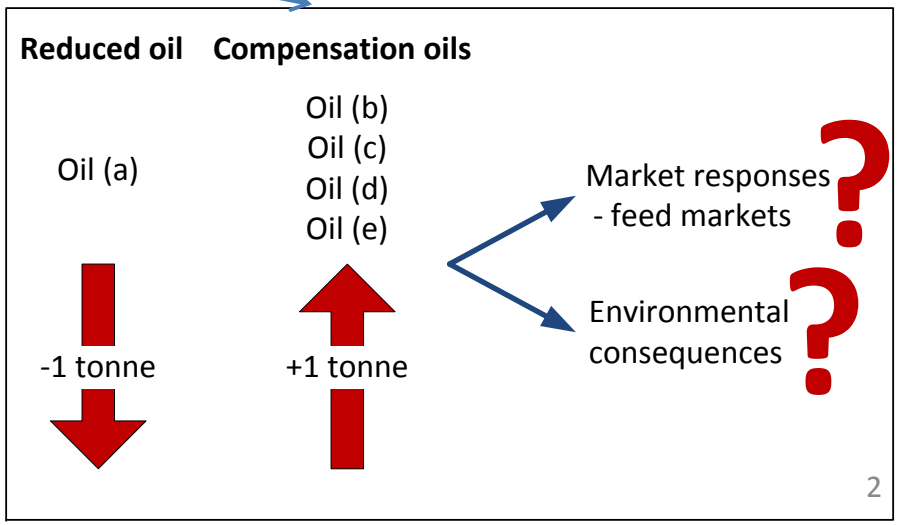
Background

- Life cycle assessment (LCA)
- Commissioned by RSPO
- ISO 14040 and 14044
- Purpose
  1. environmental information on five oils,
  2. taking out different vegetable oils: market responses and environmental consequences
- Oils:
  - Palm oil
  - Soybean oil
  - Rapeseed oil
  - Sunflower oil
  - Peanut oil





Methods and data

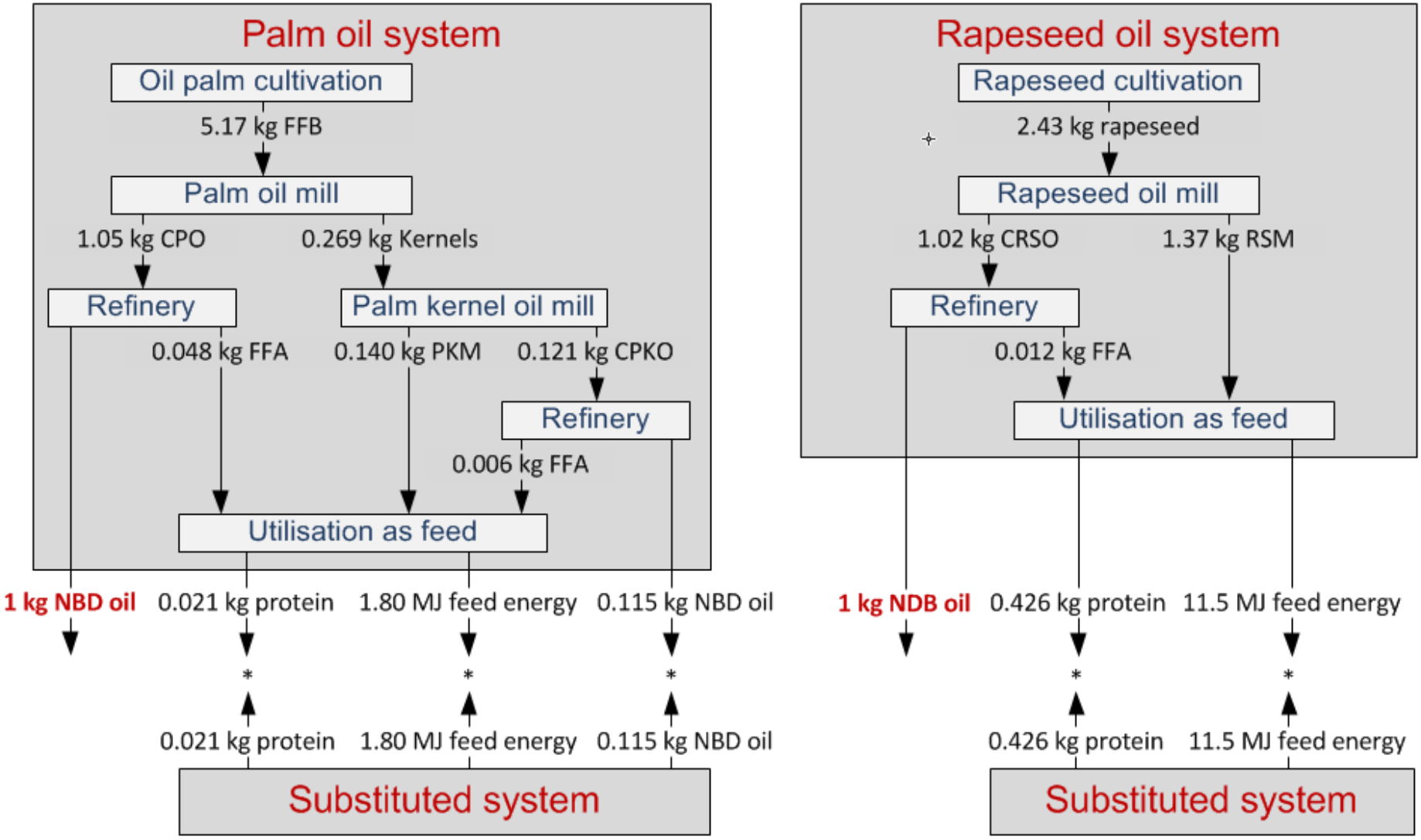
- **Functional units**
  1. Comparing oils: 1 t refined oil (NBD oil*)
  2. Reducing & compensating oil: 1 t reduced & 1 t increased refined oil (NBD oil*)
- **Impacts**
  - GHG-emissions (GWP_{100}, measured in t CO_2-eq.)
  - Biodiversity (land occupation, measured in ha yr)
  - Water (blue water weighted by Water Stress Index, measured in m^3 blue water eq.)
- **Market responses and compararability => next slides**
- **Indirect land use changes (iLUC) => next slides**

*NBD oil: Neutralized, bleached and deodorized

Market responses and comparability (1 of 3)

- **Market responses**
  - Oil system's by-products => animal feed (oil meals)
  - Changes in vegetable oils will have effects on feed markets (protein and energy feeds)
- **Comparability of oil systems**
  - Different oils come with different amounts of feed co-products
  - Therefore equivalence of compared systems must be ensured

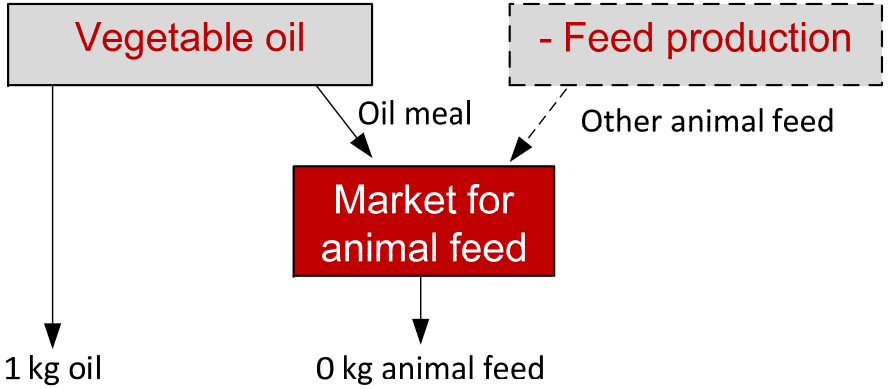
Market responses and comparability (2 of 3)



Market responses and comparability (3 of 3)
- By-products; two cases

Most common case case:

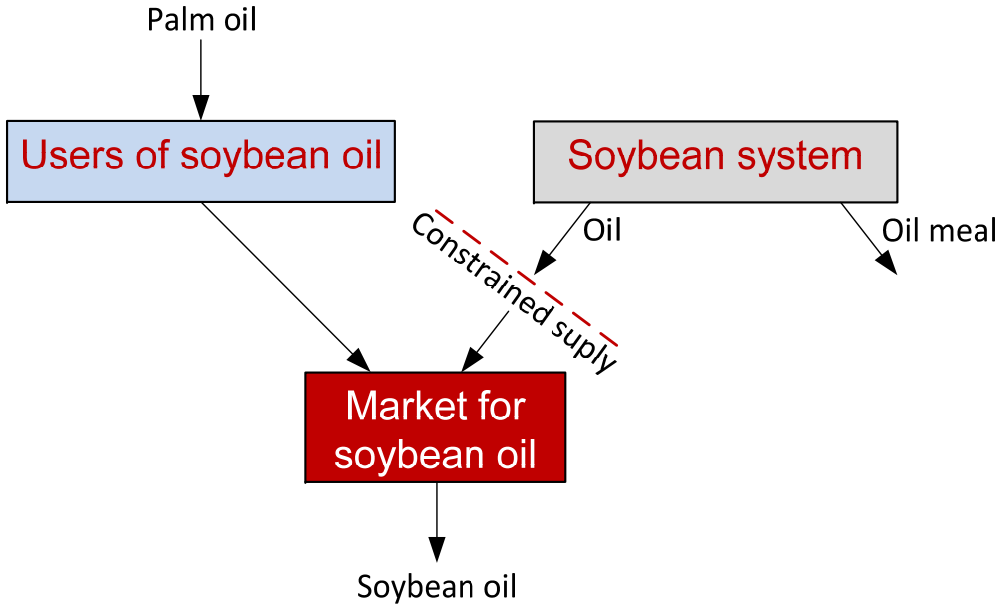
- Palm oil
- Rapeseed oil
- Sunflower oil
- Peanut oil



Demand for oils
=> effect = oil minus feed

Special case:

- Soybean oil

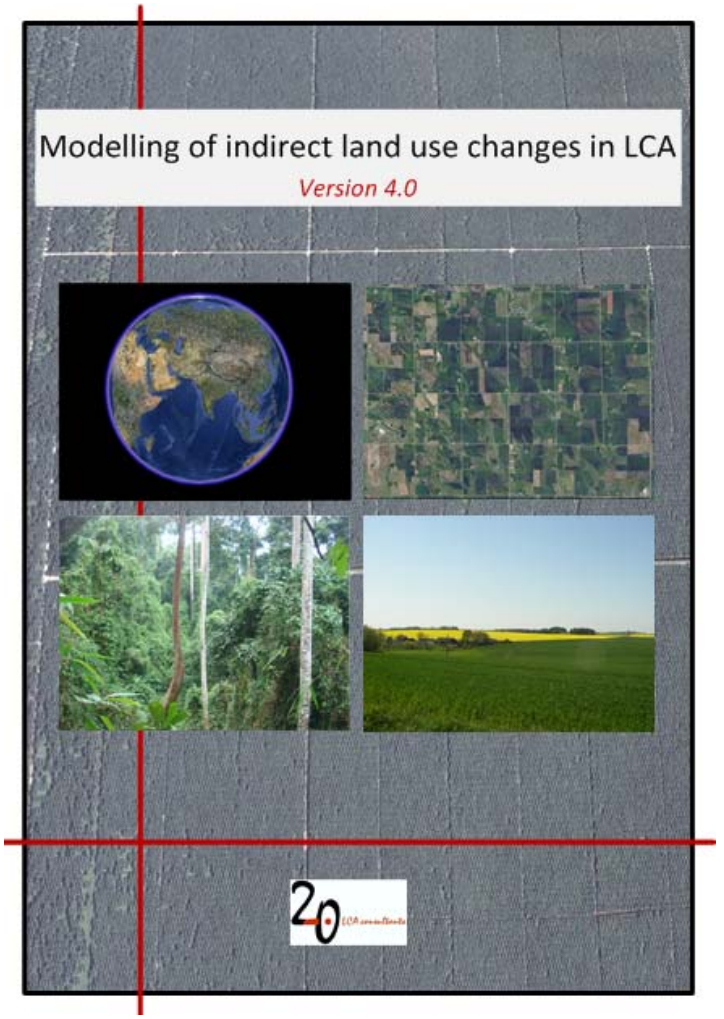


Demand for soybean oil
=> effect equal to palm ol

Indirect land use changes

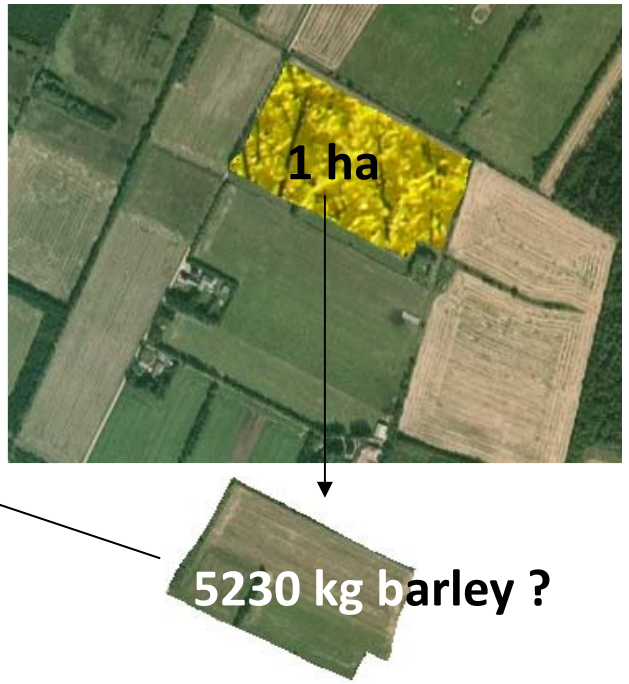
- Novel model used
- The **iLUC – initiative** (since 2010)

  - Aalborg University, Department of Planning and Development, AAU (plan.aau.dk)
  - Arla Foods (arla.com)
  - Concito (concito.dk)
  - CSIRO (csiro.au)
  - DuPont Nutrition and Health (dupont.com)
  - DONG Energy (dong.dk)
  - ecoinvent (ecoinvent.org)
  - National Agricultural Research Center, Japan (naro.affrc.go.jp)
  - Niras (niras.dk)
  - Round Table on Sustainable Palm Oil, RSPO (rspo.org)
  - Sustainability Consortium (sustainabilityconsortium.org)
  - Swedish University of Agriculture Sciences, SLU (slu.se)
  - TetraPak (tetrapak.com)
  - Unilever (unilever.com)
  - United Plantations Berhad (unitedplantations.com)
  - University of Copenhagen, The Faculty of Life Sciences, LIFE (life.ku.dk)

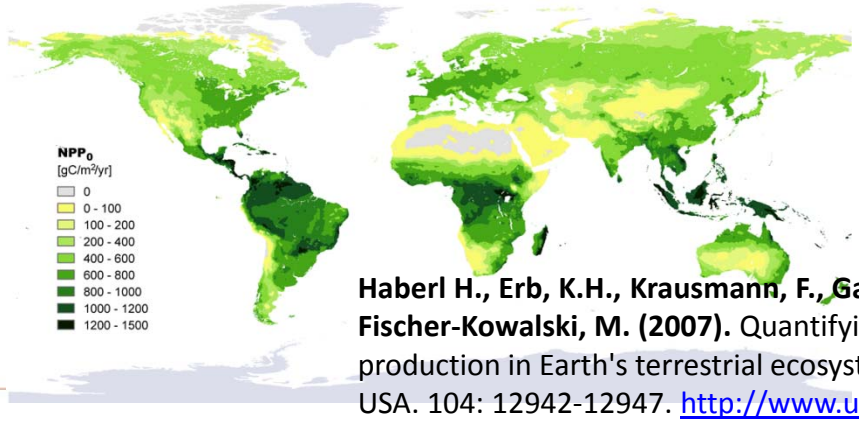


More info at:
www.lca-net.com/projects/iluc_model/

Indirect land use changes



- 10% of global CO_2 from LUC
- Driver => demand for land
- 'Land' is a global asset
- Cultivation requires capital inputs (assets)
  - Tractor, Machinery
  - ... and land
- How is 'land' produced? => Land transformation & intensification
- iLUC is caused by the use of productive land:
  - Productivity of land
  - 0.6 hectare year in Malaysia/indonesia = 1 hectare year in Europe

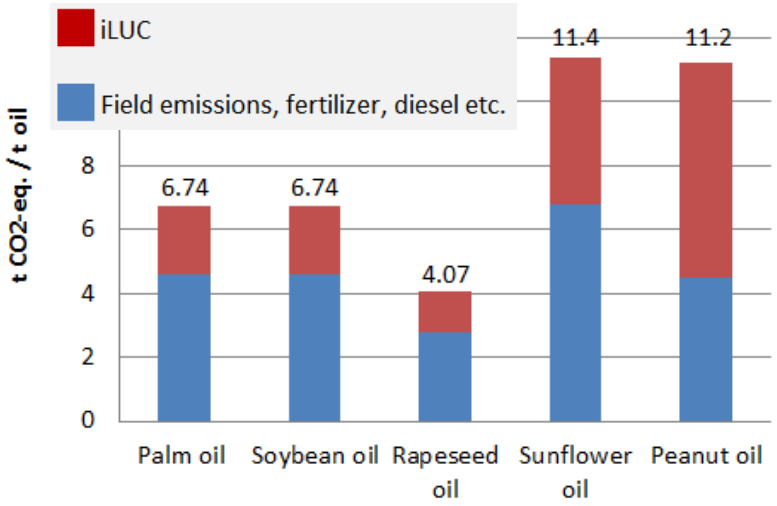


Haberl H., Erb, K.H., Krausmann, F., Gaube, V., Bondeau, A., Plutzar, C., Gingrich, S., Lucht, W., Fischer-Kowalski, M. (2007). Quantifying and mapping the global human appropriation of net primary production in Earth's terrestrial ecosystem. Proceedings of the National Academy of Sciences of the USA. 104: 12942-12947. http://www.uni-klu.ac.at/socec/inhalt/1191.htm

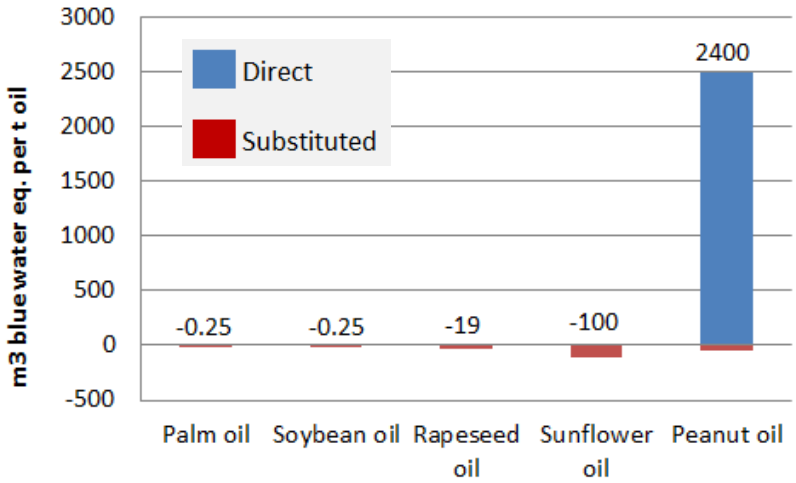
Results

- Impacts per tonne of oil

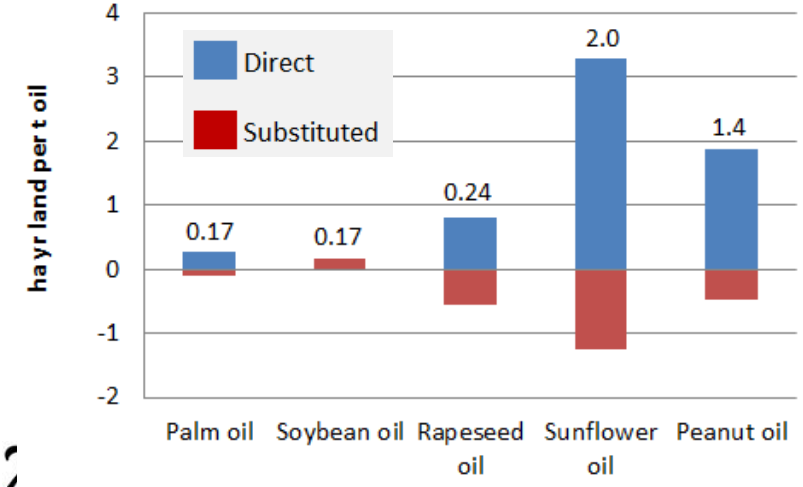
GHG-emissions (t CO_2-eq.)



Water stress index (m^3 blue water eq.)



Land use (ha yr)

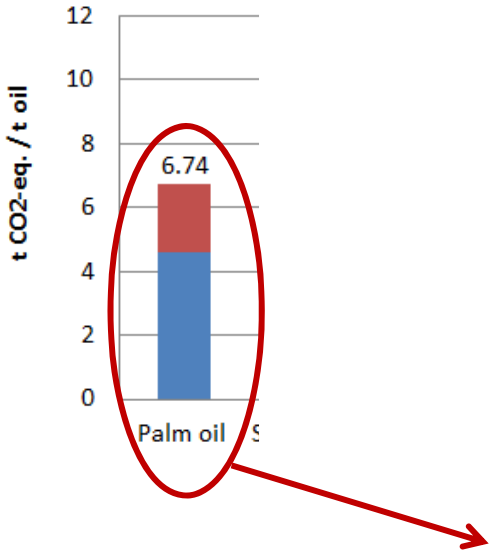


Ranking	GHG-emissions	Land-use	Water stress
best 1	Rapeseed oil	Palm oil Soybean oil	Sunflower oil
2	Palm oil Soybean oil	Rapeseed oil	Rapeseed oil Palm oil Soybean oil
worst 3	Sunflower oil Peanut oil	Sunflower oil Peanut oil	Peanut oil

Results

- What is behind the numbers?

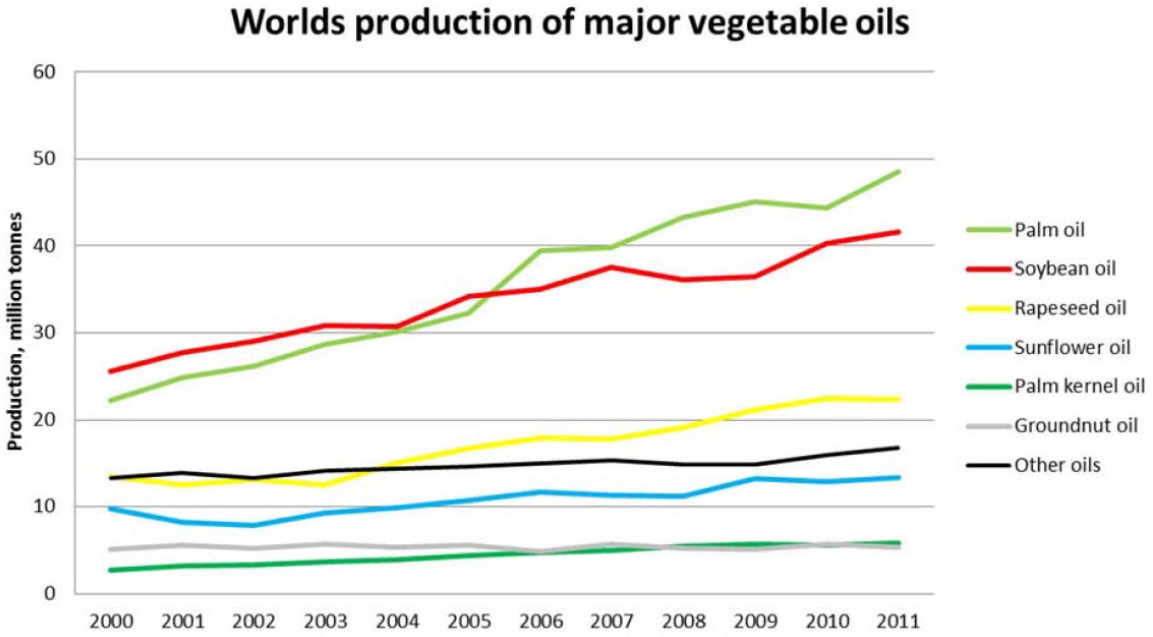
GHG-emissions (t CO_2-eq.)



Palm oil	kg CO_2-eq	Total
Palm cultivation		
Field emission (N_2O)	0.58	
Peat emissions (CO_2 and N_2O)	2.4	
iLUC oil palm	2.5	
Fertiliser	0.19	
Energy/other	0.052	**5.8**
Palm oil mill		
POME emissions (CH_4)	1.0	
By-product: utilisation of kernels for oil and meal		
Barley and soybean meal excl. iLUC	-0.015	
iLUC barley	-0.11	
iLUC soybean	-0.085	
By-product: utilisation of POME as fertiliser	-0.014	
By-product: utilisation of EFB as fertiliser	-0.0075	
Energy/transport/other	0.25	**1.0**
Palm oil refinery		
Energy/transport/other	0.12	
By-product: utilisation of free fatty acids as animal feed		
Barley and soybean meal excl. iLUC	-0.056	
iLUC barley	-0.24	
iLUC soybean	0.089	**-0.079**
Total		**6.74**

Results

- Reducing and compensating scenarios

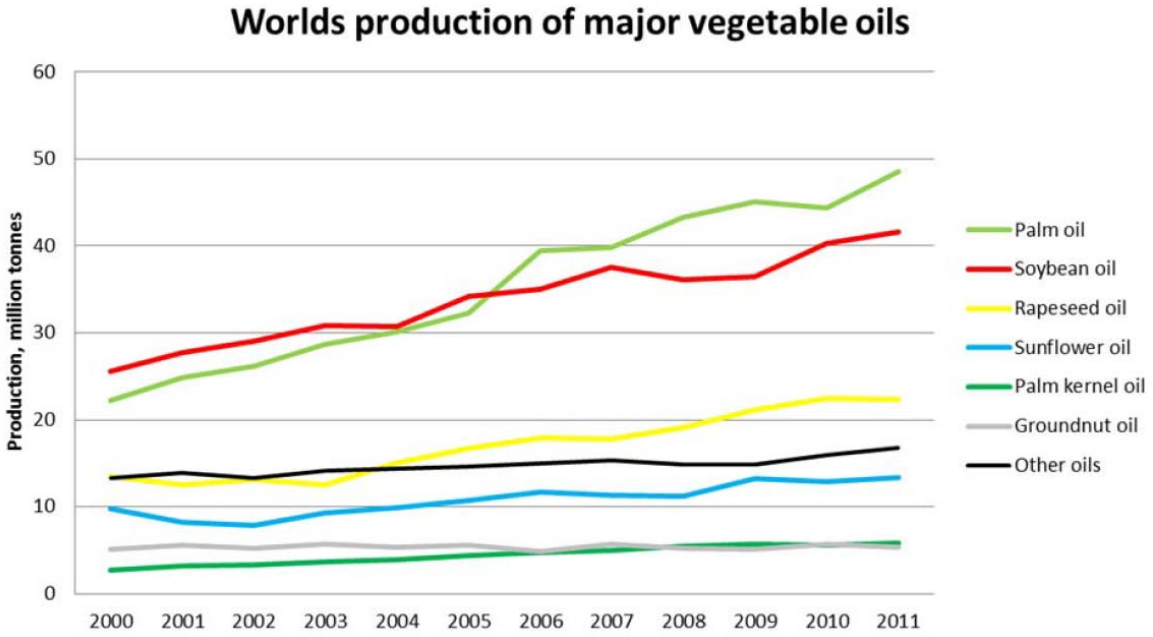


Unit = tonne oil

		Reduced oil				
		Palm oil	Soybean oil	Rapeseed oil	Sunflower oil	Penaut oil
Affected oil	Palm oil	-1.00	0.57	0.84	0.78	0.73
	Soybean oil	0.50	-1.00	0.00	0.00	0.00
	Rapeseed oil	0.27	0.23	-1.00	0.18	0.17
	Sunflower oil	0.16	0.14	0.12	-1.00	0.10
	Penaut oil	0.06	0.06	0.05	0.04	-1.00
Total		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Results

- Reducing and compensating scenarios



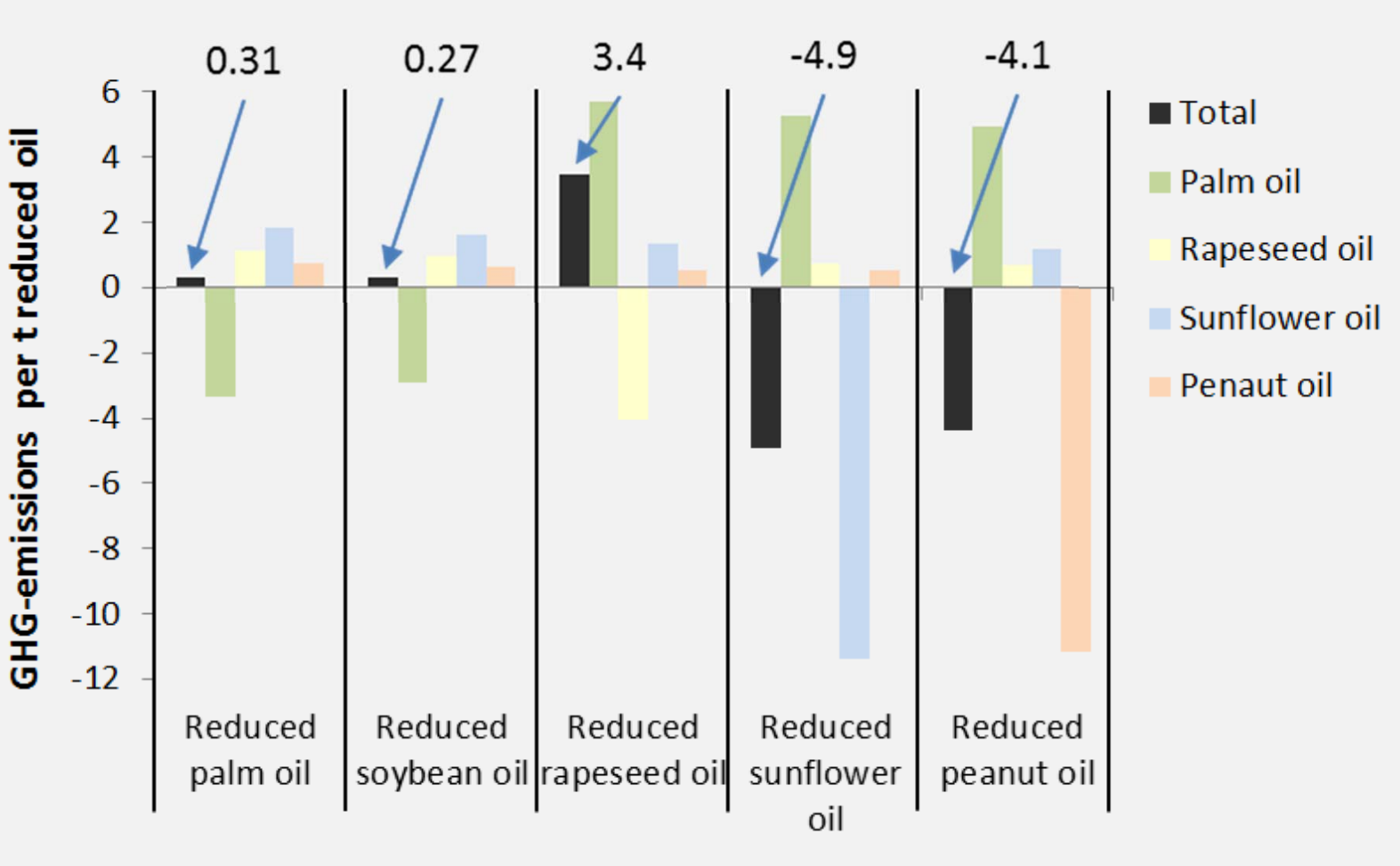
Unit = tonne oil

		Reduced oil				
		Palm oil	Soybean oil	Rapeseed oil	Sunflower oil	Penaut oil
Affected oil	Palm oil	-0.50	-0.43	0.84	0.78	0.73
	Soybean oil	0.00	0.00	0.00	0.00	0.00
	Rapeseed oil	0.27	0.23	-1.00	0.18	0.17
	Sunflower oil	0.16	0.14	0.12	-1.00	0.10
	Penaut oil	0.06	0.06	0.05	0.04	-1.00
Total		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Results

- Reducing and compensating scenarios

GHG-emissions

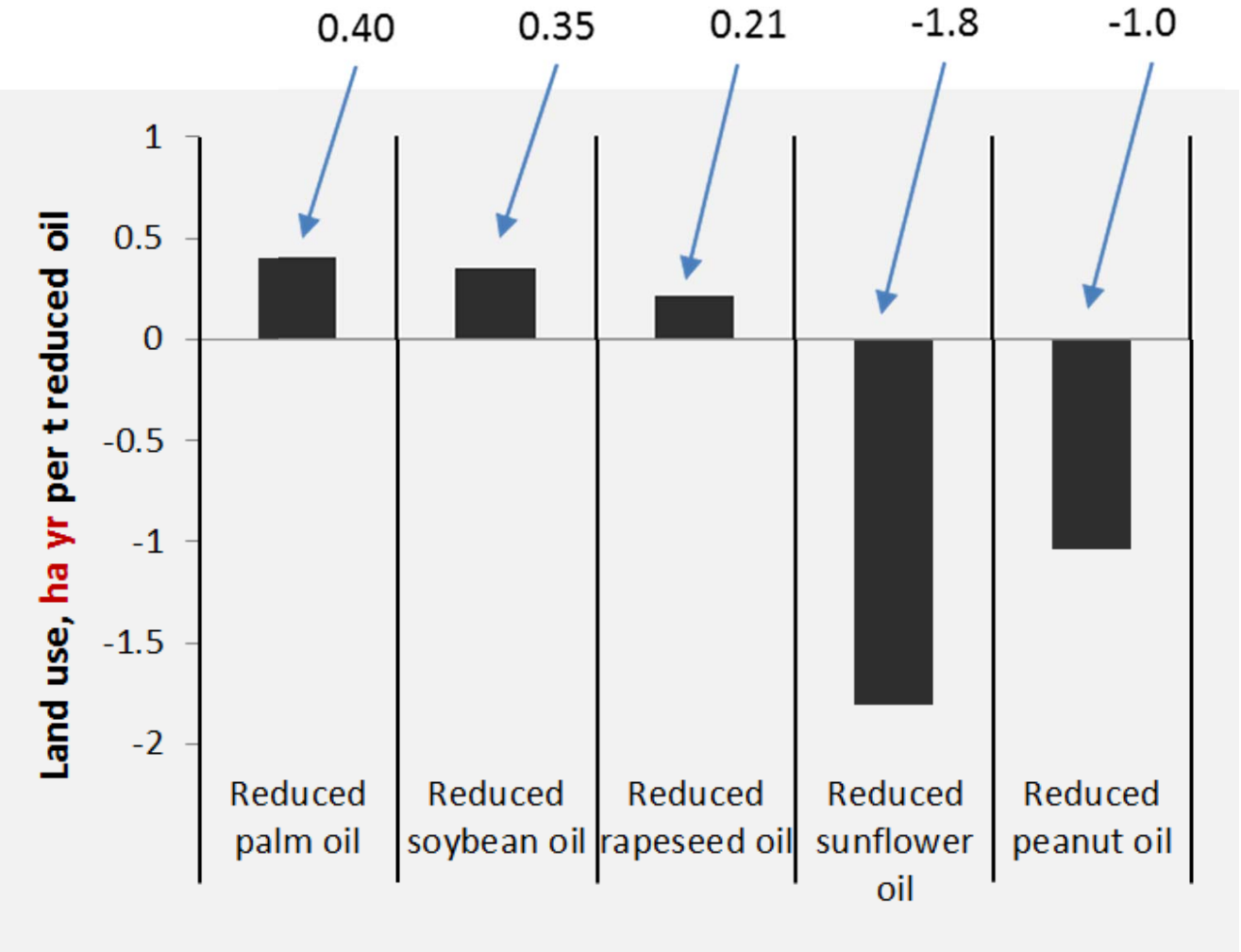


Scenario: small scale average

Results

- Reducing and compensating scenarios

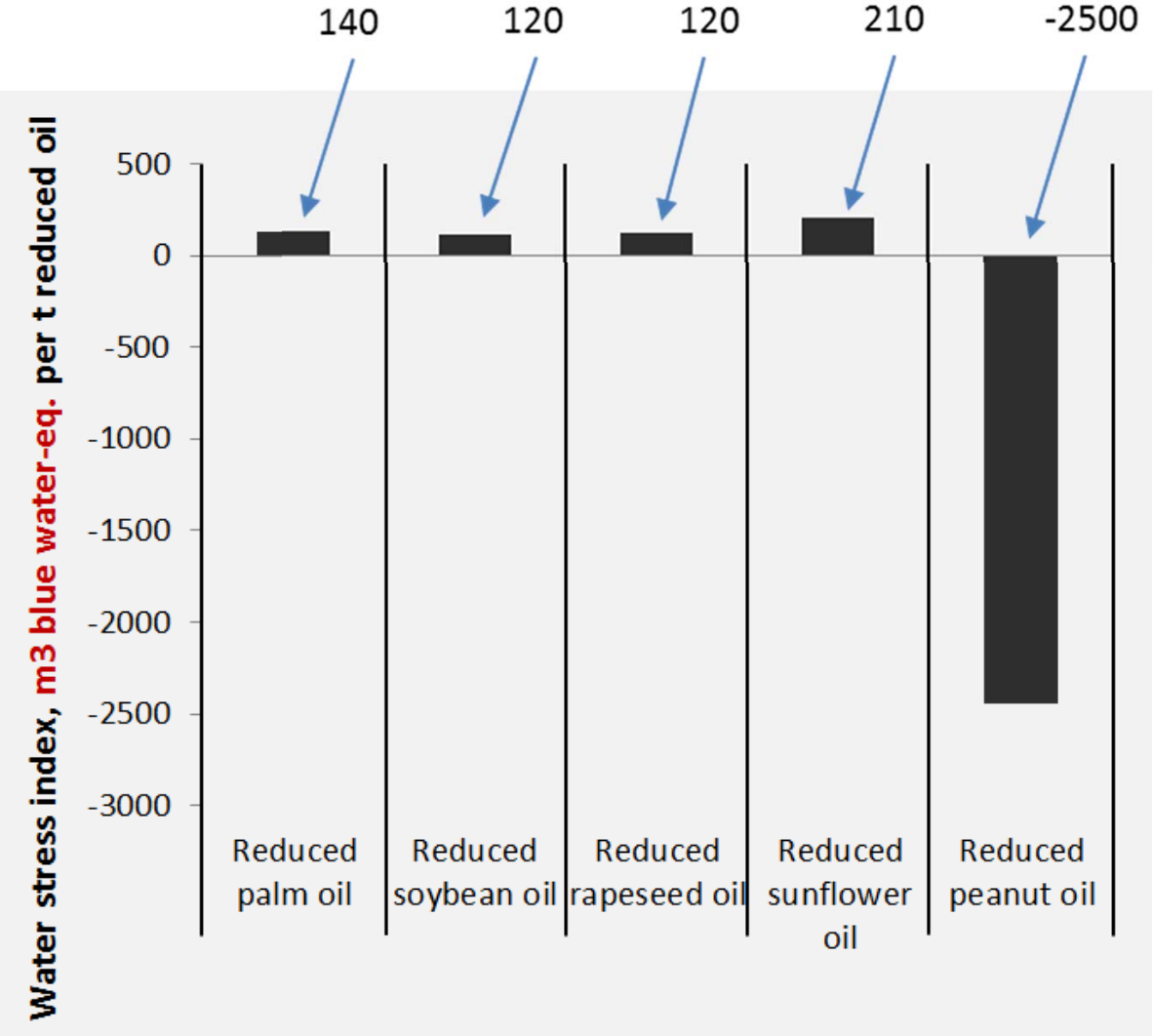
Land use



Results

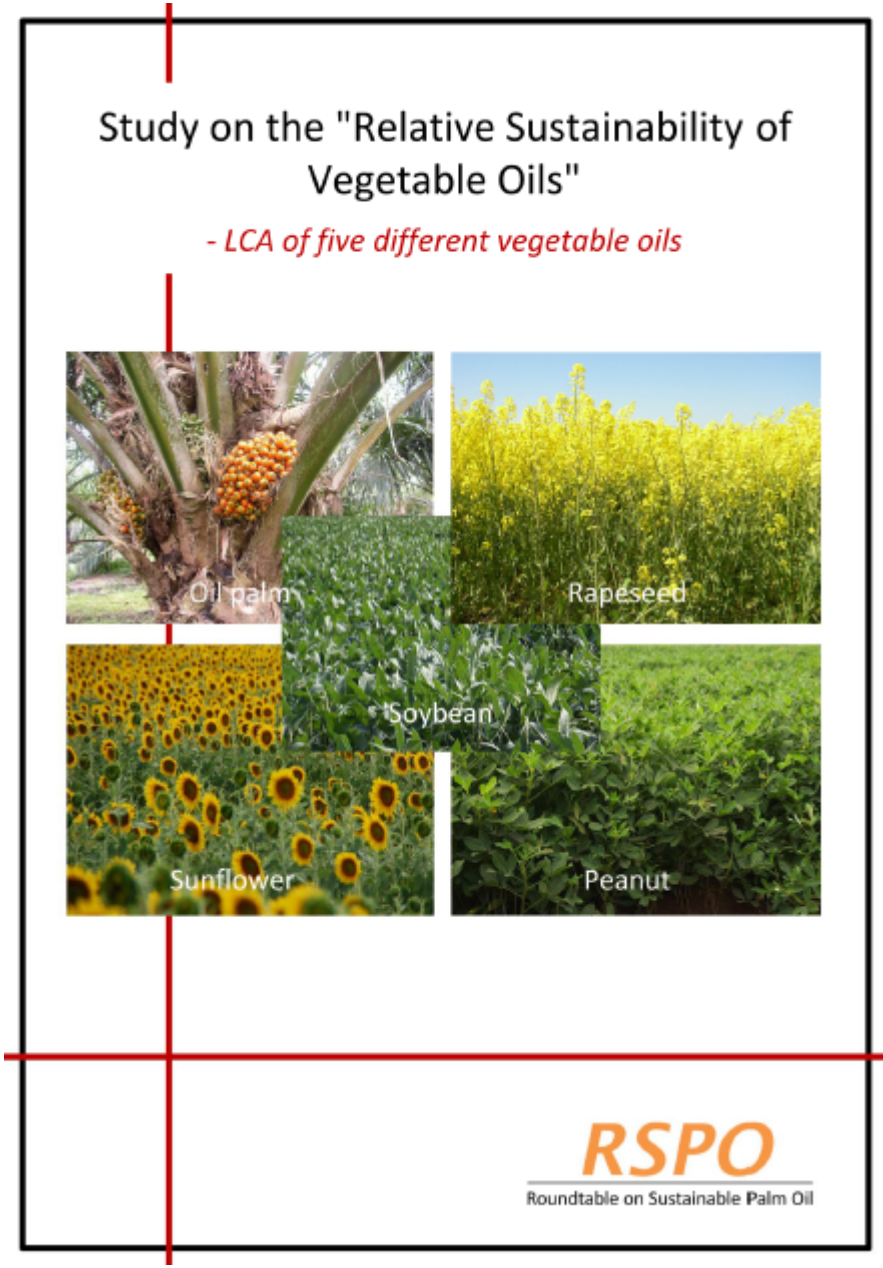
- Reducing and compensating scenarios

Water stress index



Conclusions

- **Results per tonne of oil**
  - **Low impact oils:** palm, soybean and rapeseed
  - **High impact oils:** sunflower and peanut
- **Reducing and compensating scenarios**
  - There are tradeoffs in substituting any particular vegetable oil
  - Generally beneficial to replace high impact oils with low impact oils
- **Improvement options for palm oil**
  - Reduce peat
  - Capture methane from POME
  - Increase yields (good management)



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