Life cycle assessment of rapeseed oil and palm oil
- PhD thesis

Jannick H Schmidt
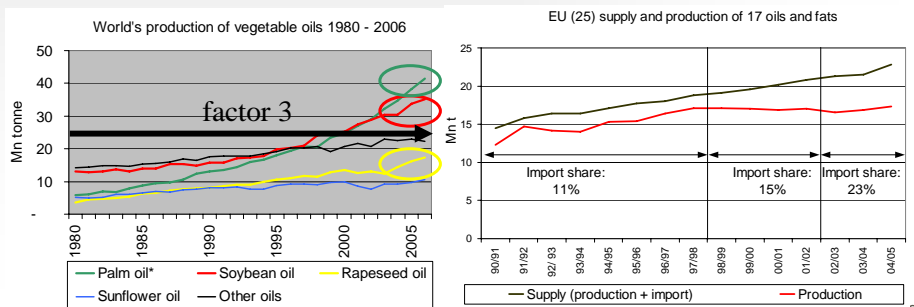

Background

3 observations:

- **Problem: globalisation leads to**
  - Increased outsourcing
  - Environment: Less information, control and regulation
- **Lack of studies**
  - Few comparative studies (local/global) are indentified
- **Global/local campagnes are typically based on non-holistic assessments**
  - Need for life cycle perspective: All life cycle stages, globalt product system
  - Need for inclusion of several impact categories

> **The focus of the thesis:**
> Case: Comarative study
> Metod: Life cycle assessment + development of methods
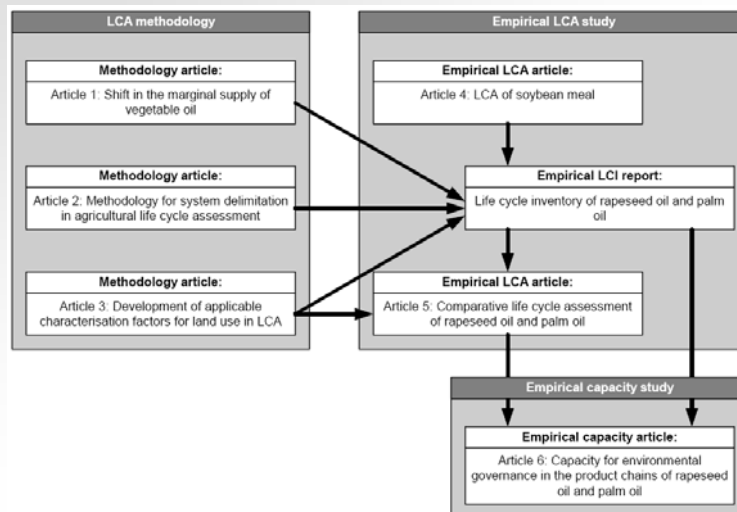> Implementation: Analysis of capacity for improvements

Casestudy – comparative study
- Rapeseed oil and palm oil

- Most significant impacts: Food, transport and housing
- Important food components: carbon hydrate, fat and protein
- Important fat sources: Palm oil, soybean oil, rapeseed oil
- 2 alternatives: Global and local supply of vegetable oil to the EU

World's production of vegetable oils 1980 - 2006

Mn tonne

factor 3

| Palm oil* | Soybean oil | Rapeseed oil |
| Sunflower oil | Other oils |

EU (25) supply and production of 17 oils and fats

Mn t

Import share: 11%

Import share: 15%

Import share: 23%

Supply (production + import) — Production

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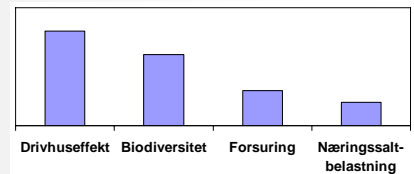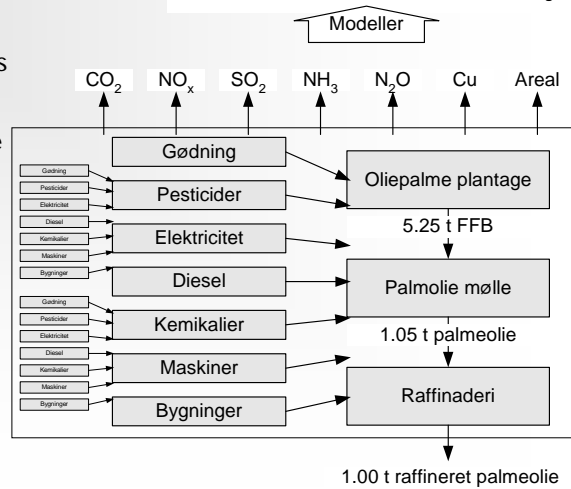# Purpose of the thesis

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Palm oil production

Life cycle assessment

What is an LCA?

- Env. assessment of products
- Life cycle perspective
- Includes all emissions in the product's life cycle
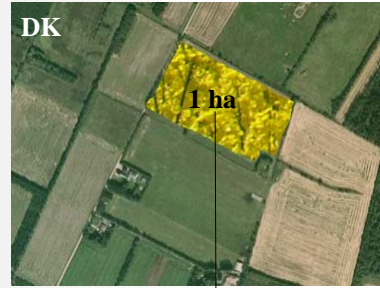- Evaluation of emissions: Potential impacts

Drivhuseffekt Biodiversitet Forsuring Næringssalt-belastning

Modeller

CO_2 NO_x SO_2 NH_3 N_2O Cu   Areal

Gødning
Pesticider
Elektricitet
Diesel
Kemikalier
Maskiner
Bygninger

Oliepalme plantage

5.25 t FFB

Palmolie mølle

1.05 t palmeolie

Raffinaderi

1.00 t raffineret palmeolie
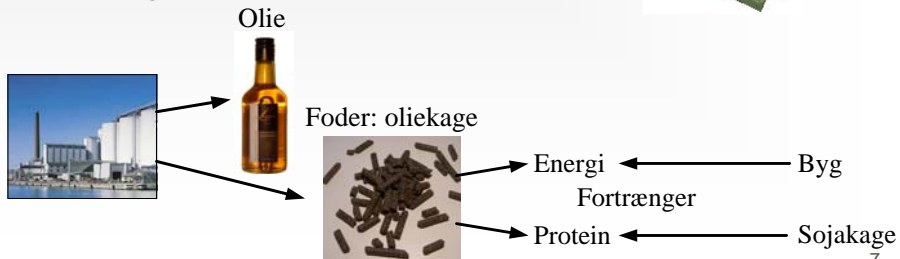
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System delimitation

- **Agricultural stage: Land use – how?**

1 ha rapeseed in DK
÷ 1 ha barley in DK
+ 1.8 ha barley in Canada

DK

1 ha
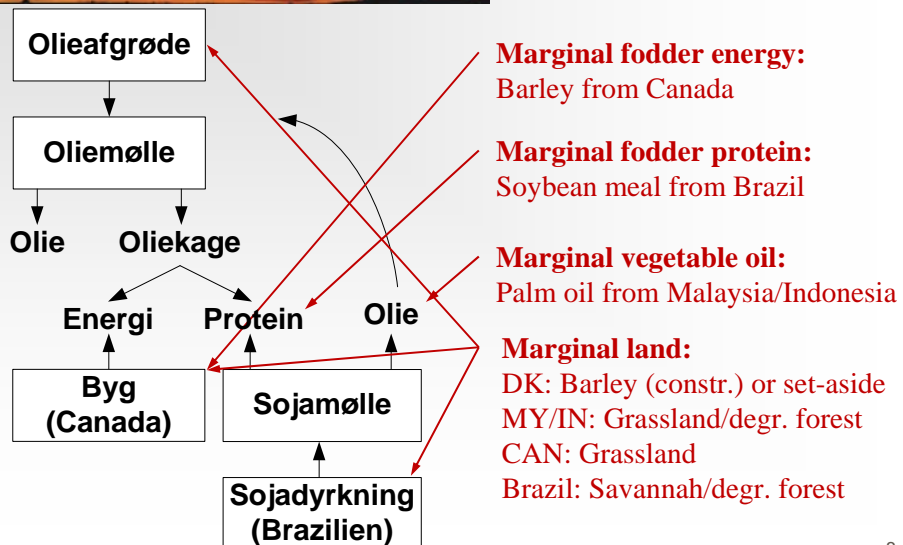
5230 kg barley ?

- **Oil mill stage: Co-products – how?**

Olie

Foder: oliekage

Energi ← Byg
Fortrænger
Protein ← Sojakage

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System delimitation
- loop and marginal processes

Olieafgrøde

Oliemølle

Olie   Oliekage

Energi   Protein   Olie

Byg
(Canada)   Sojamølle

Sojadyrkning
(Brazilien)

Marginal fodder energy:
Barley from Canada

Marginal fodder protein:
Soybean meal from Brazil

Marginal vegetable oil:
Palm oil from Malaysia/Indonesia

Marginal land:
DK: Barley (constr.) or set-aside
MY/IN: Grassland/degr. forest
CAN: Grassland
Brazil: Savannah/degr. forest

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System expansion – loop

1 tons rapsolie

$$1\,t\,RSO \cdot \begin{bmatrix} 1\,t\,oil/t\,RSO \\ 465\,kg\,prot./t\,RSO \\ 1{,}362\,SFU/t\,RSO \end{bmatrix} + t\,PO \cdot \begin{bmatrix} 1\,t\,oil/t\,PO \\ 19.2\,kg\,prot./t\,PO \\ 191\,SFU/t\,PO \end{bmatrix} + t\,SM \cdot \begin{bmatrix} 0.244\,t\,oil/t\,SM \\ 436\,kg\,prot./t\,SM \\ 1{,}207\,SFU/t\,SM \end{bmatrix} + t\,BL \cdot \begin{bmatrix} 0\,t\,oil/t\,BL \\ 91.8\,kg\,prot./t\,BL \\ 952\,SFU/t\,BL \end{bmatrix} = \begin{bmatrix} 1\,t\,oil \\ 0\,kg\,prot. \\ 0\,SFU \end{bmatrix}$$
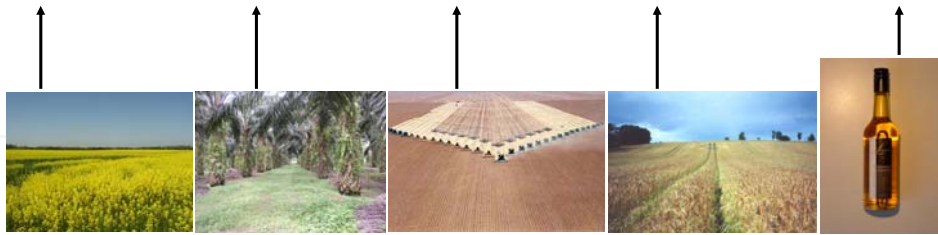
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Biodiversity in LCA – how?

- Transformation of land: Non-supported species during renaturalisation
  - 1 ha can produce XX? annual yields
- Occupation of land: Non-supported species during occupation
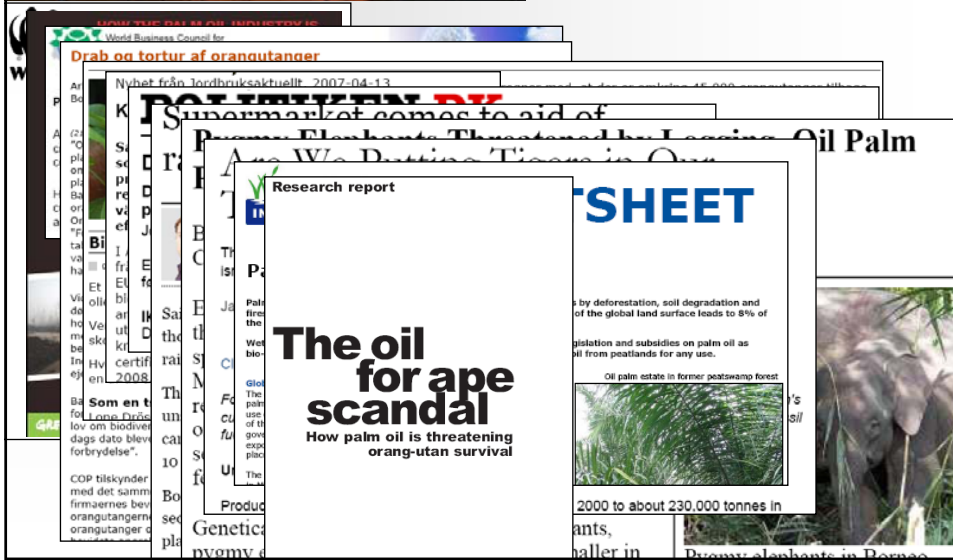 - 1 ha y occupation is proportional with crop output (annual yield, t per ha)
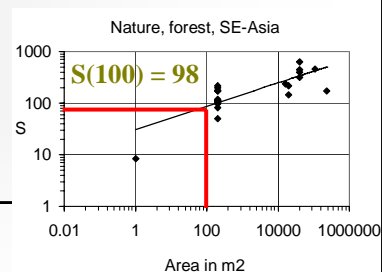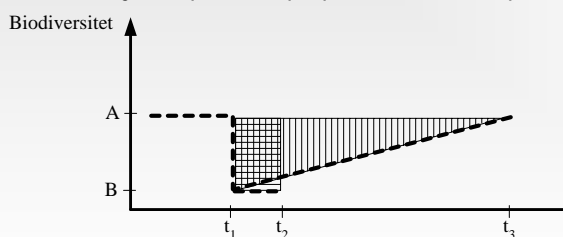
- Determination of A og B (S100)
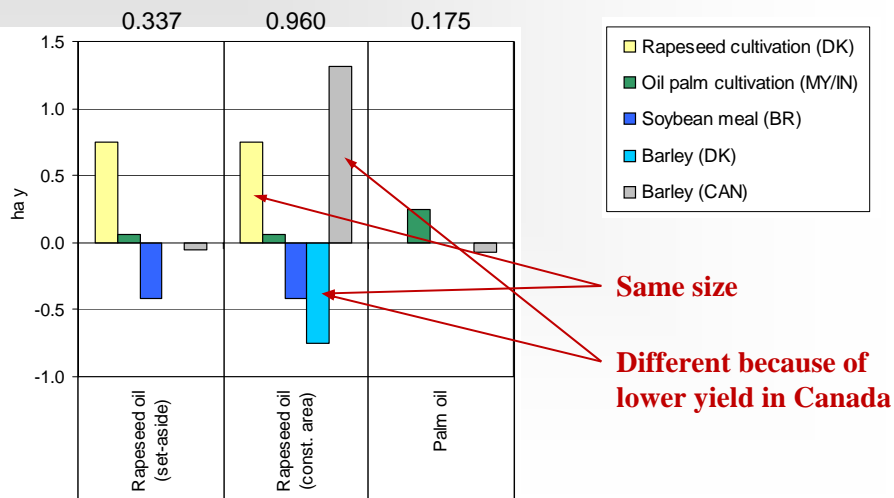- Ecosystem vulnerability (wS100)
  - depends of how much nature is left…

$$S = c \cdot A^z$$

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Results – are we biased?

Results – land use (ha*y)

0.337   0.960   0.175

Legend:
- Rapeseed cultivation (DK)
- Oil palm cultivation (MY/IN)
- Soybean meal (BR)
- Barley (DK)
- Barley (CAN)

Same size

Different because of lower yield in Canada

ha y

Rapeseed oil (set-aside)
Rapeseed oil (const. area)
Palm oil

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Results – biodiversty (wS100)

Same size

Different mainly because of lower ecosystem vulnerability in Canada
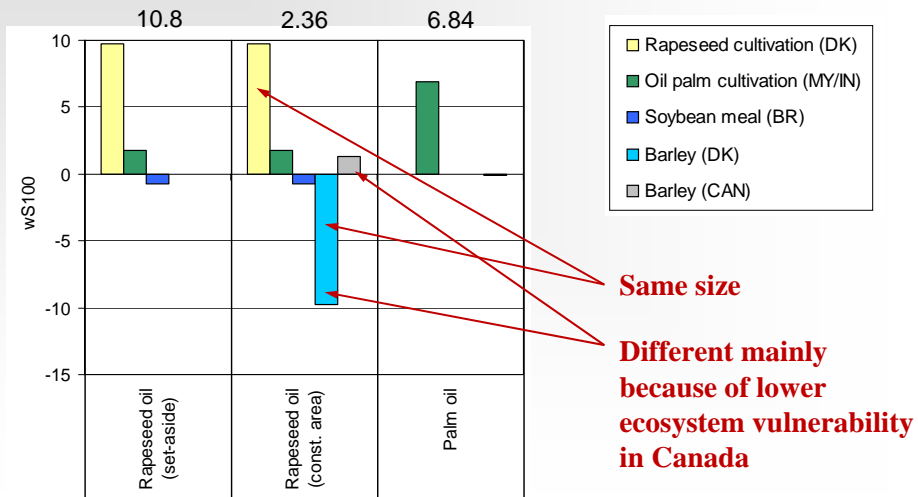
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Results – global warming (t CO_2-eq)

Different because of utilisation of straw for energy in DK

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Improvement potentials

Rapeseed oil

Drivhuseffekt

Undgå inddragelse af lerjord til andre formål   N-gødning BAT

Arealforbrug

Undgå inddragelse af lerjord til andre formål   N-gødning BAT

Palm oil

Drivhuseffekt

Undgå dyrkning af tørvejord   Biogas anlæg   EFB biomasseanlæg

Factor 6.7
42% reduction
17% reduction/19% worse

Factor 1.4
Factor 1.7
21% reduction
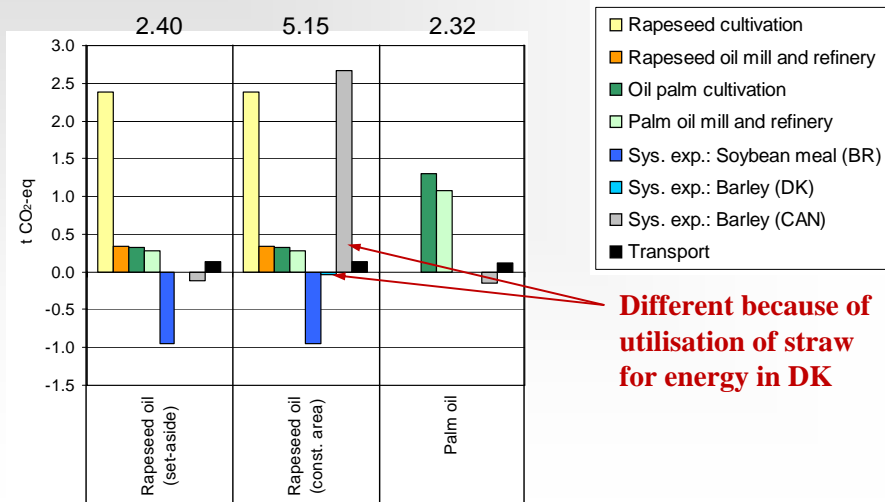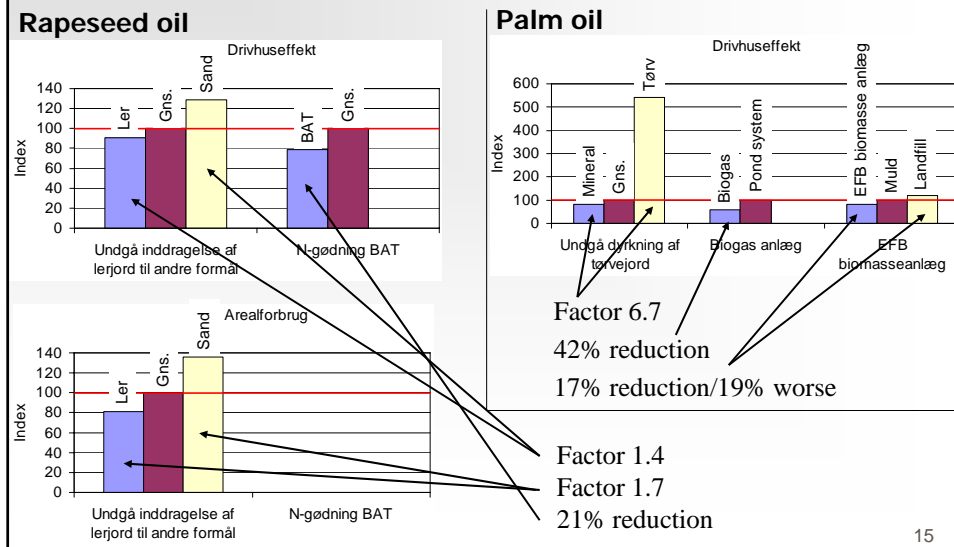
Conclusions - method

Consequential LCA

- Closer to reality than before
- Important issues:
  - Marginal crops (where and which nature is affected)
  - Marginal change in cultivation (area or yield)

Biodiversity

- Input to development of methods
- Enables inclusion of all regions and all practises

Conclusions - results

- Rapeseed oil versus palm oil
  - Rapeseed oil: 1) Area/yield, 2) Set-aside/displacement of barley
  - Palm oil: 1) Mineral/peat soil
- Improvement potentials
  - Rapeseed oil: Limited potential
  - Palm oil: Huge potential, ... and huge risk for a worse situation
- Capacity for improvements
  - Rapeseed oil in the EU: Kyoto – improvements in fertiliser industry
  - Palm oil in Malaysia: 1) RSPO, EU consumers, NGOs and retail, and 2) Kyoto

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