Detailed LCA of Palm Oil in Malaysia
- comparing different practices in United Plantations and with European rapeseed oil

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Presentation

- Methods and data
- Indirect land use change (ILUC)
- Product system and material flows
- Results: United Plantations Berhad
- Results: Comparison with average Malaysian palm oil and European rapeseed oil
Methods and data

- **Life cycle assessment**: compliant with ISO 14040 and 14044
- **Purpose**: Document and follow performance of United Plantations palm oil over time, identify improvement options, compare with other suppliers
- **Functional unit**: 1 kg refined (NBD) vegetable oil for food purposes
- **Data**:
  - Foreground data:
    - Palm oil system: Detailed data collection at United Plantations Berhad, PhD thesis, [people.plan.aau.dk/~jannick/research.htm](http://people.plan.aau.dk/~jannick/research.htm), data exchanges with MPOB
    - Field emissions: Detailed nutrient balances and IPCC 2006 methodology
  - Background data:
    - Statistics, literature and ecoinvent LCI database, [www.ecoinvent.org](http://www.ecoinvent.org)
- **Impacts**: Focus on GHG-emissions

Methods: System boundary - Cradle to gate

![Diagram of the life cycle assessment process](image-url)
Inclusion of indirect land use changes (ILUC)

- Land = capacity for cultivation of biomass
- Market for land "land tenure" is global
- Use of land is measured in units of potential net primary production (NPP₀)

GHG-emissions from transformation: Changes in carbon stock

GHG-emissions from intensification: Additional fertiliser (Schmidt 2008: System delimitation in agricultural consequential LCA - Outline of methodology and illustrative case study of wheat)

- 1 ha yr Malaysia: 13.9 t CO₂-eq.
- 1 ha yr Brazil: 12.6 t CO₂-eq.
- 1 ha yr Central EU: 8.8 t CO₂-eq.
- 1 ha yr Canada: 6.3 t CO₂-eq.
**Product system and material flows**

**Palm oil (PO), Malaysia**

- **Oil palm plantation**
  - 4.651 t FFB
- **Palm oil mill**
  - 0.029 t CPO
  - 0.247 t kernels
- **Palm kernel oil mill**
  - 0.107 t NBD PKO
  - 0.111 t crude PKO
  - 35.5 kg ffa
  - 4.2 kg ffa
  - 0.893 t NBD PO
  - 0.107 t NBD PKO

**Inputs:**
- 1.000 t NBD PO+PKO
  - 0 kg protein
  - 92 SFU energy
  - 102 SFU energy

**Outputs:**
- 0.929 t CPO
- 0.247 t kernels
- 39.7 kg fodder fat
- 0.107 t PKC

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**Product system: Modelling of by-products**

- **Oil crop**
- **Oil mill**
- **Oil**
- **Oil meal**
- **Energy**
- **Protein**

- **Oil palm plantation**
- **Palm oil mill**
- **Oil**

- **Barley (CAN)**
- **Soybean mill**
- **Soybean agr (Brazil)**

**Marginal source veg. oil:**
- Palm oil in Malaysia/Indonesia

**Marginal source energy fodder:**
- Barley in Canada

**Marginal source fodder protein:**
- Soybean in Brazil
## Results: United Plantations Berhad 2010

<table>
<thead>
<tr>
<th>Life cycle stage</th>
<th>Specification</th>
<th>GHG-emission (kg CO2-eq./kg NBD oil)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contribution</td>
</tr>
<tr>
<td>ILUC</td>
<td>Deforestation</td>
<td>0.31</td>
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<tr>
<td></td>
<td>Intensification</td>
<td>2.44</td>
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<tr>
<td></td>
<td>Total</td>
<td>2.75</td>
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<tr>
<td>Oil palm plantation</td>
<td>Field emissions, N2O</td>
<td>0.53</td>
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<tr>
<td></td>
<td>CO2 from peat oxidation</td>
<td>0.57</td>
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<td></td>
<td>Fertiliser inputs</td>
<td>0.21</td>
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<tr>
<td></td>
<td>Fossil fuels and other</td>
<td>0.05</td>
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<tr>
<td></td>
<td>Total</td>
<td>1.36</td>
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<tr>
<td>Palm oil mill</td>
<td>CH4 from POME</td>
<td>0.95</td>
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<tr>
<td></td>
<td>By-products: exp biogas, steam, shells, elec</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>Fossil fuels and other</td>
<td>0.04</td>
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<tr>
<td></td>
<td>Total</td>
<td>0.79</td>
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<tr>
<td>Palm kernel oil mill</td>
<td>By-products: Palm kernel oil meal</td>
<td>-0.31</td>
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<td>Fossil fuels and other</td>
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<td></td>
<td>Total</td>
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<tr>
<td>Refining of palm oil</td>
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<tr>
<td>Refining of palm kernel oil</td>
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<tr>
<td></td>
<td>Total</td>
<td>4.75</td>
</tr>
</tbody>
</table>

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## Results: United Plantations time series compared with aver. MY palm oil and rapeseed oil

![GHG-emissions graph](image-url)
Results: United Plantations time series compared with aver. MY palm oil and rapeseed oil

![GHG-emissions (with ILUC)](image)

Results: Improvement options

![Improvement analysis (with ILUC)](image)
Conclusion

- **United Plantations Berhad 2010**
  - 2.28 (4.75 with ILUC) kg CO2-eq. per kg NBD palm oil
  - Most significant GHG-emissions:
    - ILUC, field emissions (N₂O and CO₂) and POME treatment (CH₄)

- **Comparison**
  - UP performs significantly better than aver. MY palm oil and rapeseed oil
  - Rapeseed oil performs better than aver. MY palm oil

- **Improvement options**
  - UP has shown significant reductions from 2004-2011
  - UP has still unexploited improvement options
  - Malaysian palm oil is associated with same/higher potential as UP
  - No significant improvement options identified for rapeseed oil