Life Cycle Assessment of apple crop protection strategies

Frank Hayer
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• Inventories
• Impact categories
• Results
  – Resource management
  – Pollutant management
• Summary
• Inventory data
  - Data from system description collected in Orchard System Case Study
  - other inventory data from ecoinvent Version 2.0 (Frischknecht et al. 2007)
  - SALCA-database (Nemecek et al. 2004).

• Assessment tool
  - Swiss Agricultural Life Cycle Assessment (SALCA) developed by Agroscope
<table>
<thead>
<tr>
<th>Group</th>
<th>Abbr.</th>
<th>Impact Category</th>
<th>Method</th>
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<tbody>
<tr>
<td>Resource-Management</td>
<td>NRE</td>
<td>Non renewable energy demand</td>
<td>ecoinvent-method</td>
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<td>GWP</td>
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<td>Pollutant-Management</td>
<td>TeE</td>
<td>Terrestrial ecotoxicity</td>
<td>USES-LCA</td>
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<td>HT</td>
<td>Human toxicity</td>
<td>USES-LCA</td>
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</table>
• Production of inputs
  – N-, P-, K-Fertilisers, Pesticides, Machinery
• Field operations
  – Fertiliser application
  – Application pesticides
  – Mulching
• Hail net
• Field emissions
  – Pesticides, N\textsubscript{2}O, NO\textsubscript{3}, NH\textsubscript{3} ...
System Boundary

System boundary

Resources

Infrastructure:
- Buildings
- Machinery

Inputs:
- Fertilisers
- Pesticides
- Energy carriers

Field production

Field work processes:
- Soil cultivation
- Fertilisation
- Plant protection
- Mechanical treatment
- Transport
- …

Products:
- Apple 1st class
- Apple 2nd class

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Non renewable energy demand

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Non renewable energy consumption (MJ-eq.)

- Production: Fertiliser
- Plant Protection: Production Pesticides
- Plant Protection: Machinery
- Plant Protection: Hail net
- Machinery: Maintenance, Harvest, Fertilisation
- Plant Protection: Machinery

Relative Impact (BS = 1)
Global warming (kg CO2 eq.)

- Production: Fertiliser
- Plant Protection: Production Pesticides
- Plant Protection: Machinery
- Plant Protection: Hail net

Relative Impact (BS = 1)

- CH
- DE
- ES
- FR
- NL

Production station Agroscope, Switzerland
Aquatic ecotoxicity

USES-LCA aquatic ecotoxicity (kg 1,4 DCB eq.)

- **Herbicides**
- **Fungicides**
- **Insecticides**
- **other products**
- **other emissions**
Terrestrial ecotoxicity

USES-LCA terrestrial ecotoxicity (kg 1,4 DCB eq.)

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Human toxicity

USES-LCA human toxicity (kg 1,4 DCB eq.)

<table>
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<tr>
<th>Country</th>
<th>Herbicides</th>
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• NRE and GWP

- With the exception Switzerland the AS have a lower energy demand/GWP than the BS
  - Less active ingredient applied
  - Lower no. of passages

- These effects are partly counterbalanced by the higher percentage of area under hail nets

- IS comparable or lower NRE/GWP than the AS
  - Less active ingredient applied
  - Lower no. of passages
• Toxicity according to USES-LCA
  – AS and IS in all regions with lower impacts across categories
  – Ecotoxicity in BS dominated by single active ingredients e.g.
    ▪ Fungicide: Copper fungicides
    ▪ Herbicide: Diuron
    ▪ Insecticide: Trichlorfon
  – the non-pesticide emissions play a more important role in the Human toxicity
    ▪ Herbicides with a high impact: Diuron and Amitrol
Thank you for your attention!

Bart Heijne, Andreas Naef, Jesus Avilla, Joan Solé, Benoit Saupanor, Aude Alaphilippe, Andrea Patocchi, Jörg Samietz, Heinrich Höhn, Jörn Strassemeyer