Evaluation of the environmental sustainability of different European pig production systems using life cycle assessment

JY Dourmad, JRyschawy, TTrousson, J Gonzalez, HWJ Houwers, M Hviid, TLTNguyen, LMorgensen
Summary

✓ Introduction
  ✓ Q-PorkChains EU program

✓ Data collection and LCA calculations
  ✓ Collection of data
  ✓ LCA calculations

✓ Results
  ✓ Per dimension
  ✓ Multi-dimensional analysis

✓ Conclusions & perspectives
Q-PorkChains EU Program

✓ General objective

⇒ Improve the quality of pork and pork products and develop innovative and sustainable pork production chains with low environmental impact

✓ Six research modules

1. Consumer, citizens & market
2. Pork production
3. Product development
4. Chain management
5. Molecular quality control
6. Knowledge synthesis

✓ Two application modules
Q-PorkChains – module II

✓ Diversity, Flexibility and Sustainability of Farm-level Production Systems

✓ Two-step approach
  ⇒ Assessment and development of tools for sustainability evaluation
  ⇒ Integrated sustainability evaluation of a selected number of European production systems
    • Conventional
    • Adapted conventional
    • Traditional
    • Organic
Multi-dimension evaluation

- **Economy**
  - Animal health
  - Genetic resources
  - Economy
  - Working conditions

- **Environment**
  - Meat safety
  - Meat quality
  - Environmental impact

- **Society**
  - Animal welfare

---

*ALIMENTATION*  
*AGRICULTURE*  
*ENVIRONNEMENT*  

*INRA* - *PORK CHAINS*
Collection of data for environmental evaluation

- 12 systems in 4 countries (3 / country)
- Enquiries in 10 farms from each system
- Data collected
  - Animal performance (sows, piglets, fatteners)
  - Feed amount and nutritional composition (ME, crude protein, total phosphorus)
  - Housing (type of floor, ventilation)
  - Use of land when outdoor raising
  - Manure collection and management (liquid/solid, evacuation & storage, treatment, spreading…)
Simplified description of the system

Pig unit

- land
- feed
- energy

- sows
- weaners
- fattening pigs

- avoided fertilizers
- energy for spreading

- manure as fertilizer
- finished pigs
- culled sows
System description

- Feed composition => feed ingredients
  combination of energy (cereals), protein (meals & peas), and phosphorus
  sources to achieve target ME, CP and P
- Calculation of N, OM and P excretion (Rigolot et al., 2010)
- Emissions calculated from excretion and specific EF
  (IPCC, 2006, Rigolot et al., 2010)

LC inventory of feed ingredients

- Conventionnal : ecoinvent database adapted to France (Mosnier et al. 2011)
- Organic (Denmark)

Five impact categories

Two functional units : kg live pig & ha land use
## Description of pig units

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Adapted Conven.</th>
<th>Traditional</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>n° farms (sys)</td>
<td>40 (4)</td>
<td>40 (4)</td>
<td>20 (2)</td>
<td>10 (1)</td>
</tr>
<tr>
<td>n° fat. pigs/year/farm</td>
<td>5390</td>
<td>3440</td>
<td>165</td>
<td>2840</td>
</tr>
<tr>
<td>Piglets/sow/year</td>
<td>27.5</td>
<td>26.3</td>
<td>12.0</td>
<td>19.8</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaners</td>
<td>1.67</td>
<td>1.75</td>
<td>2.74</td>
<td>2.40</td>
</tr>
<tr>
<td>Fatteners</td>
<td>2.73</td>
<td>2.81</td>
<td>6.52</td>
<td>3.00</td>
</tr>
<tr>
<td>Feed CP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sows</td>
<td>13.3</td>
<td>13.0</td>
<td>12.9</td>
<td>16.5</td>
</tr>
<tr>
<td>Weaners</td>
<td>17.3</td>
<td>16.8</td>
<td>14.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Fatteners</td>
<td>15.6</td>
<td>15.5</td>
<td>13.5</td>
<td>18.0</td>
</tr>
</tbody>
</table>
Global warming
eq CO₂

CONVENTIONAL
ADAPTED CONVENTIONAL
TRADITIONAL
ORGANIC

kg eq.CO₂ / 1000 kg pig

Piglets production  Post weaning  Fattening

per t live pig

kg eq.CO₂ / hectare

Feed  Housing  Slurry management

per ha land use

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT
Acidification
\[ \text{eq SO}_2 \]
Eutrophication eq PO₄

- Piglets production
- Post weaning
- Fattening

- Feed
- Housing
- Slurry management

- Conventional
- Adapted
- Traditional
- Organic

- per t live pig
- per ha land use
Energy use
MJ

**Energy use per t live pig**

- Piglets production
- Post weaning
- Fattening

**Energy use per ha land use**

- Feed
- Housing
- Slurry management

Agriculture
Environment
Land use

Bar charts showing land use for different pig production systems:

- **Conventional**
- **Adapted Conventional**
- **Traditional**
- **Organic**

The charts display land use in square meters per ton of live pig for piglet production, post-weaning, and fattening stages.

Additionally, there is a graph showing kg of pig produced per hectare of land use for the same systems.

The graphs are labeled with **m² per t live pig** and **kg pig per ha land use**.
Integrated evaluation

• **Selection of criteria**
  – Local impact (per ha of land use)
    • Eutrophication
    • Acidification
  – Global impact (per kg product)
    • Global warming
    • Energy use
    • Acidification
  – Land use
    • Feed
    • Outdoor raising
Results for conventional systems
Conclusion

✓ LCA approach
  ✓ Allows the discrimination of production systems

✓ Results
  ✓ Highly dependent on functional units
  ✓ Conventional systems => better for global impact (/kg)
  ✓ Alternative systems = better for local impact (/ha)

✓ Perspectives
  ✓ Use of others functional units : € of pork
    => the value of products are very different
  ✓ Integrate with the others dimensions of sustainability