Life cycle assessment of heavy pig production in a sample of Italian farms


1Consiglio per la ricerca e la sperimentazione in agricoltura, CRA-FLC, Cremona, Italy.
2Consiglio per la ricerca e la sperimentazione in agricoltura, CRA-SUI, San Cesario s/P, Modena, Italy. 3ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Bologna, Italy. 4LCA-Lab SRL, Bologna, Italy.

65th annual meeting of the European Federation of Animal Science
Copenhagen 25-29 August 2014
Pig production in Italy

- About 8,9 millions pigs in 2013
- 728 thousands sows
- Four northern regions account for about 83% of total pigs (Piemonte, Lombardia, Emilia-Romagna, Veneto)
Utilization

• 13.6 millions pigs slaughtered in 2006
• 85% heavy pigs: more than 160 kg LW
• Utilization: cured ham (Prosciutto di Parma, Prosciutto di San Daniele)
## Pig production in Italy

<table>
<thead>
<tr>
<th>Area</th>
<th>Difference 1990-2010 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>+ 12.8</td>
</tr>
<tr>
<td>Piemonte</td>
<td>+ 63.1</td>
</tr>
<tr>
<td>Lombardia</td>
<td>+ 66.3</td>
</tr>
<tr>
<td>Veneto</td>
<td>+ 39.8</td>
</tr>
<tr>
<td>Emilia-Romagna</td>
<td>- 34.1</td>
</tr>
</tbody>
</table>
Some citizens’ concerns due to intensification/concentration

- Eutrophication
- Acidification
- Smell nuisance
- Noise
- Animal welfare
- GHG emissions
- Fuel and electricity consumption
- Worsening of air quality
- Heavy metals pollution
Relationships between LW and environmental impacts

- Cederberg and Flysjö, 2004
- Dourmand et al. 2012
- Pelletier et al., 2010
- Basset-Mens and van der Werf, 2005
Cases and objectives of LCA study

Case

1. Citizens’ concerns on intensive livestock productions
2. Lack of estimates of environmental impact of heavy pig production (more than 160 kg LW and 9 mo of age)
3. Evaluation of what strategies can be taken for mitigating environmental impact

Objectives

1. To estimate some environmental potential impacts: global warming (GW), acidification (AC), eutrophication (EU), abiotic depletion (AD) and photochemical oxidation (PO)
2. To evaluate the most significant piggery characteristics that affect the environmental performances
Material and methods

- Two samples of 4 breeding and 8 fattening farms
- System boundaries: cradle-to-farm gate, encompassing feed production, breeding phase and growth-fattening phase up to slaughter weight
- Functional unit:
  - 1 kg LW of piglet (breeding phase)
  - 1 kg LW of heavy pig (growth-fattening phase)
  - 1 kg LW of heavy pig (whole chain)
- Average piglet LW 37.2±8.2 kg, heavy pig 167±5 kg
- Economic allocation for culled sows
## Results: breeding phase

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Unit</th>
<th>Piglet: breeding phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>GW</td>
<td>kg CO$_2$eq.</td>
<td>4.2</td>
</tr>
<tr>
<td>AC</td>
<td>kg SO$_2$eq.</td>
<td>6.5 E-02</td>
</tr>
<tr>
<td>EU</td>
<td>kg PO$_4^{3-}$eq.</td>
<td>3.7 E-02</td>
</tr>
<tr>
<td>AD</td>
<td>kg Sbeq.</td>
<td>3.9 E-03</td>
</tr>
<tr>
<td>PO</td>
<td>kg C$_2$H$_4$eq.</td>
<td>2.1 E-03</td>
</tr>
</tbody>
</table>
## Results: growth-fattening phase and whole chain

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Unit</th>
<th>Heavy pig: growth – fattening phase</th>
<th>Heavy pig: whole chain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>CV (%)</td>
</tr>
<tr>
<td>GW</td>
<td>kg CO$_2$eq.</td>
<td>3.1</td>
<td>9.6</td>
</tr>
<tr>
<td>AC</td>
<td>kg SO$_2$eq.</td>
<td>4.3E-02</td>
<td>16.2</td>
</tr>
<tr>
<td>EU</td>
<td>kg PO$_4^{3-}$eq.</td>
<td>2.9E-02</td>
<td>11.1</td>
</tr>
<tr>
<td>AD</td>
<td>kg Sbeq.</td>
<td>3.8E-03</td>
<td>29.3</td>
</tr>
<tr>
<td>PO</td>
<td>kg C$_2$H$_4$eq.</td>
<td>1.6E-03</td>
<td>28.0</td>
</tr>
</tbody>
</table>
Contribution of the phases

% on total impact

GW | AC | EU | AD | PO

Fattening | Breeding

0 10 20 30 40 50 60 70 80 90 100
Comparison with other LCA studies

- Global warming
- Eutrophication
- Acidification
Contribution of farm activities (% of total CO$_2$eq.)

- **PT**: piglet transport
- **EF**: enteric fermentation
- **MM**: manure management
- **MA**: manure application
- **Mat**: materials
- **SF**: sow feeds
- **PF**: piglet feeds
- **PFF**: growing-fattening pig feeds
- **Cons**: fuels and electr. for anim. Husb.
- **FT**: feed transport
- **RP**: recyclable products

**Global warming**

- **Breeding phase**
- **Growth-fattening phase**

---

**Legend**:
- Breeding phase (blue)
- Growth-fattening phase (red)

---

**Axes**:
- X-axis: farm activities
- Y-axis: contribution (% of total CO$_2$eq.)
Contribution of farm activities (% of total SO$_2$eq.)

**Acidification**

- **PT**: piglet transport
- **EF**: enteric fermentation
- **MM**: manure management
- **MA**: manure application
- **Mat**: materials
- **SF**: sow feeds
- **PF**: piglet feeds
- **PFF**: growing-fattening pig feeds
- **Cons**: fuels and electr. for anim. Husb.
- **FT**: feed transport
- **RP**: recyclable products
Contribution of farm activities (% contribution of $\text{PO}_4^{3-}$-eq.)

- **PT**: piglet transport
- **EF**: enteric fermentation
- **MM**: manure management
- **MA**: manure application
- **Mat**: materials
- **SF**: sow feeds
- **PF**: piglet feeds
- **PFF**: growing-fattening pig feeds
- **Cons**: fuels and electr. for anim. Husb.
- **FT**: feed transport
- **RP**: recyclable products

**Eutrophication**

- Breeding phase
- Growth-fattening phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Breeding phase</th>
<th>Growth-fattening phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Mat</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>SF</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>PF</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>PFF</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>Cons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Contribution of farm activities (% of total Sb eq.)

- **PT**: piglet transport
- **EF**: enteric fermentation
- **MM**: manure management
- **MA**: manure application
- **Mat**: materials
- **SF**: sow feeds
- **PF**: piglet feeds
- **PFF**: growing-fattening pig feeds
- **Cons**: fuels and electr. for anim. Husb.
- **FT**: feed transport
- **RP**: recyclable products

**Abiotic depletion**

Breeding phase

Growth-fattening phase
Contribution of farm activities (% contribution of total C$_2$H$_4$eq.)

**Photochemical oxidation**

Breeding phase

Growth-fattening phase

**Legend:**
- **PT**: piglet transport
- **EF**: enteric fermentation
- **MM**: manure management
- **MA**: manure application
- **Mat**: materials
- **SF**: sow feeds
- **PF**: piglet feeds
- **PFF**: growing-fattening pig feeds
- **Cons**: fuels and electr. for anim. Husb.
- **FT**: feed transport
- **RP**: recyclable products
Relationships between farm characteristics and environmental performances (breeding phase)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>R²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GW</strong></td>
<td>Diesel - Piglet weight</td>
<td>0.93</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>AC</strong></td>
<td>Daily weight gain</td>
<td>0.82</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Daily weight gain - Piglet weight</td>
<td>0.96</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>EU</strong></td>
<td>Mortality rate</td>
<td>0.91</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Mortality rate - Daily weight gain</td>
<td>0.99</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>AD</strong></td>
<td>Piglet weight</td>
<td>0.83</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Piglet weight - Daily weight gain</td>
<td>0.99</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>PO</strong></td>
<td>Mortality rate</td>
<td>0.99</td>
<td>0.05</td>
</tr>
</tbody>
</table>

+ positive - negative correlation
Relationships between farm characteristics and environmental performances (growth-fattening phase)

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>$R^2$</th>
<th>$P$</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW</td>
<td>Diesel</td>
<td>Electricity</td>
<td>0.47</td>
<td>0.21</td>
<td>+ +</td>
</tr>
<tr>
<td>AC</td>
<td>Phase length</td>
<td>Initial weight</td>
<td>0.74</td>
<td>0.04</td>
<td>+ -</td>
</tr>
<tr>
<td>EU</td>
<td>Phase length</td>
<td>Initial weight</td>
<td>0.64</td>
<td>0.10</td>
<td>+ -</td>
</tr>
<tr>
<td>AD</td>
<td>Live weight gain</td>
<td>Final weight</td>
<td>0.43</td>
<td>0.24</td>
<td>+ +</td>
</tr>
<tr>
<td>PO</td>
<td>Final weight</td>
<td>Mortality rate</td>
<td>0.99</td>
<td>0.05</td>
<td>+ -</td>
</tr>
</tbody>
</table>

+ positive  - negative correlation
Final remarks

• Despite the heavier final weight, results of this study are similar to those of literature previous works
• Contrasting effects of farm characteristics on environmental performances
• A larger and more detailed study is required to evaluate possible mitigation strategies
Acknowledgments

Study funded by the Italian Ministry of Agricultural, Food and Forestry Policies

Project: Development of animal model for sustainability (SOS-ZOOT)