Environmental improvement of pig production: construction and assessment of eight models of pig farms for the future

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THIS STUDY AIMS TO evaluate the environmental improvement and the applicability of future pig production systems with combination of Best Available Techniques (BAT)

Material and methods

Eight models of pig systems constructed for the next 10-15 years by 35 experts with a goal of environmental optimization (tab 1):

- Three logics depending on, (1) the farm surface > 0.5 ha / sow for the combination of pig and crop and < 0.15 ha/sow for the specialized systems, (2) and the organization of the pig production
- Combination of BAT adapted to each system considering environmental, social and economic aspects
- Technical performances of the 10% best current husbandries of the French technical network: 25.9 pig produced/sow/year with an average weight of 117 kg and a feed conversion ratio of 2.7.

Environmental assessment of the kilogram of live pig at farm gate for the eight models constructed for the next 10-15 years.

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Environmental assessment of the kilogram of live pig at farm gate for the eight models constructed for the next 10-15 years by Life Cycle Analysis (LCA).

The LCA scope included the production and supply of inputs, the construction of the building, and the pig breeding (Fig 1). The system boundaries integrated the avoidance of the production and application of mineral fertilizer which would be applied on crops if manure were not spread.

Table 1: Characteristics of the eight optimized models on the environment

<table>
<thead>
<tr>
<th>Models</th>
<th>Combination of pig and crop production</th>
<th>Specialized production</th>
<th>Outsourcing of farrowing activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb Sows</td>
<td>175 sows</td>
<td>225 sows</td>
<td>475 sows</td>
</tr>
</tbody>
</table>

Housing

- Straw litter, open building with natural ventilation
- Closed building, slatted floor and dynamic ventilation

Feeding

- Feed production on the farm, use of soy meal not linked to deforestation
- Substitution of a part of wheat and soy meal by pea

Manure management

- Composting, spreading + exportation
- Spreading + small biogas plant with slurry and crops with energy value
- Phase separation + spreading (liquid fraction) + exportation (solid fraction)
- Biological treatment, spreading (liquid fraction) + exportation (solid fraction)
- Y scraper (fattening building), spreading (liquid fraction, exportation (solid fraction)
- Spreading + participation to a large biogas plant
- Spreading + exportation

Best available techniques applied

- Bioscrubber
- Cover of the slurry pit
- Energy efficient equipments
- Use of the heat produced by methanisation to heat the buildings
- Flare for the storage

Table 2: Result of LCA for the optimized systems, compared to baseline (average current pig system of Espagnol et al., 2012)

<table>
<thead>
<tr>
<th>LCA results / kg of live pig (% of the baseline)</th>
<th>Climate change (kg CO2eq)</th>
<th>Acidification (kg SO2eq)</th>
<th>Eutrophication (kg PO4eq)</th>
<th>Land occupation (m²/year)</th>
<th>Energy consumption (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System 1a</td>
<td>1.8 (78%)</td>
<td>0.024 (89%)</td>
<td>0.018 (78%)</td>
<td>0.017 (78%)</td>
<td>0.017 (78%)</td>
</tr>
<tr>
<td>System 1b</td>
<td>1.4 (96%)</td>
<td>0.024 (96%)</td>
<td>0.018 (86%)</td>
<td>0.017 (78%)</td>
<td>0.017 (78%)</td>
</tr>
<tr>
<td>System 1c</td>
<td>1.5 (72%)</td>
<td>0.029 (66%)</td>
<td>0.018 (78%)</td>
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</tr>
<tr>
<td>System 2a</td>
<td>1.3 (62%)</td>
<td>0.026 (96%)</td>
<td>0.017 (74%)</td>
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<td>0.017 (74%)</td>
</tr>
<tr>
<td>System 2b</td>
<td>1.2 (78%)</td>
<td>0.027 (71%)</td>
<td>0.017 (74%)</td>
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<td>0.017 (74%)</td>
</tr>
<tr>
<td>System 3a</td>
<td>1.5 (74%)</td>
<td>0.028 (99%)</td>
<td>0.017 (74%)</td>
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</tr>
<tr>
<td>System 3b</td>
<td>1.3 (61%)</td>
<td>0.025 (77%)</td>
<td>0.017 (74%)</td>
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</tr>
<tr>
<td>System 3c</td>
<td>1.7 (79%)</td>
<td>0.027 (61%)</td>
<td>0.018 (70%)</td>
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<td>0.018 (70%)</td>
</tr>
<tr>
<td>Baseline</td>
<td>2.1</td>
<td>0.044</td>
<td>0.023</td>
<td>0.023</td>
<td>0.023</td>
</tr>
</tbody>
</table>

Results and discussion

- The optimized models compared to a baseline with not BAT and current performances (Espagnol et al., 2012) show reduction of LCA impacts that could achieve up to 39%, 43%, 26%, 27% and 45% for the respective impacts of climate change, acidification (A), eutrophication (E), land occupation (LO) and energy consumption (Espagnol et al., 2012).

- The impacts CC, A and E of the system 1a are higher than the other systems despite the fact that BATs are used. This is due mainly to the use of litter in the pig buildings which emitted NOx impact on CC and to the fact that techniques like bioscrubber (for NH3 reduction) could not be used in natural ventilation conditions.

- The difference among systems on the LO impacts are due mainly to the spreading part. The nitrogen content in the manure of the optimized system, compared to the baseline, could be abated (treatment) or hold in the manure (less nitrogen losses).

- For a current husbandry with less than 500 sows (representative of current French farms), the cost of BAT increase the cost per kg carcass from 6% to 12% without any technical improvement. The husbandries of the future might have better technical performances to be able to invest in BAT and also in modernizing the buildings. The study shows that it should be higher than those of the best 10% to access a cost like the current one.

Conclusion

This study sheds light on what could be the optimized pig systems for the future by taking into account a reduction of the environmental impacts. Important reductions of impacts have been measured and indicate the level of global gain which could be achieved. Different options of BAT combinations could be used and all have results on an impact reduction. This allows the farmers to find the best solution for their system and its location. The economical assessment underlines difficulties of applying BATs in current French pig husbandries. The evolution will be correlated by the European pig market on which the price is defined by supply and demand.