THE DEMANDS FOR THE PIG INDUSTRY TO REDUCE AMMONIA LOSSES, AND SPECIFIC CHALLENGES IN ORGANIC SYSTEMS

Kristoffer Jonassen,
Innovation – Environmental Technology

Hovborg Kro
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OVERVIEW

● Demands for pig industry – regulation

● Challenges in organic production systems regarding ammonia losses

● What is achieved by feed optimization

● Additional options by Environmental Technologies
ENVIRONMENTAL REGULATION

Specific ammonia deposition to sensitive nature areas

Odour requirements in relation to neighbours

General requirements for ammonia reductions - BAT
AMMONIA AND BAT

- Ammonia emission from animal houses
  - Standard numbers - updated every year
- General requirements for reduction of ammonia (not for organic production)
  - 30 % for finishing pigs and sows
  - 20 % for weaning piglets
- BAT – Best Available Techniques (not for organic production)
  - Emission limit values
  - The cost for reduction must not exceed 100 DKK (€ 13.5) per kg reduced N or 8 DKK (€ 1.1) per finisher
## EMISSION LIMIT VALUES
### NEW FACILITIES

<table>
<thead>
<tr>
<th>Category</th>
<th>Kg NH$_3$-N per animal (32-107 kg)</th>
<th>BAT reference (Drained floor)</th>
<th>210 DE (2,200 pen-places or 8,200 finishers y$^{-1}$)</th>
<th>400 DE (4,100 pen-places or 15,600 finishers y$^{-1}$)</th>
<th>600 DE (6,200 pen-places or 23,400 finishers y$^{-1}$)</th>
<th>750 DE (7,700 pen-places or 30,000 finishers y$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg NH$_3$-N per animal</td>
<td>0.47</td>
<td>0.30</td>
<td>0.27</td>
<td>0.23</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Reduction compared to BAT</td>
<td>-</td>
<td>36 %</td>
<td>43 %</td>
<td>51 %</td>
<td>55 %</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Kg NH$_3$-N per animal (32-107 kg)</th>
<th>210/250 DE</th>
<th>210 – 750 DE</th>
<th>750 DE</th>
<th>Standard numbers (2015)</th>
<th>After general reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning piglets</td>
<td>0.0366</td>
<td>0.0366 – 0.0326</td>
<td>0.0326</td>
<td>0.035</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>Finishing pig</td>
<td>0.30</td>
<td>0.30 – 0.21</td>
<td>0.21</td>
<td>0.44</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Sows with piglets to weaning</td>
<td>2.53</td>
<td>2.53 – 2.12</td>
<td>2.12</td>
<td>3.20</td>
<td>2.24</td>
<td></td>
</tr>
</tbody>
</table>
AMMONIA REGULATION FOR SENSITIVE NATURE AREAS

- Maximum feasible emission depends on distance to sensitive nature areas
  - Category 1 (max. 0.2, 0.4, and 0.7 kg N/hectare in total deposition)
    - Natura 2000
  - Category 2 (max. 1 kg N/hectare in total deposition)
    - High moor, heath > 10 hectare, open grazing land > 2.5 hectare
  - Category 3 (max. 1 kg N/hectare for the new facility)
    - Additional ammonia sensitive areas
AMMONIA LOSSES - CHALLENGES IN ORGANIC PRODUCTION SYSTEMS

- Feed
- Housing systems
HOUSING SYSTEMS, FINISHER PIGS (<110 KG)

Organic DK
- Open housing system
- Natural ventilation
- Area per animal (m²)
  - 2.3 in total
  - 1.0 outdoor, min. 50 % solid or drained floor
  - 0.63 lying area (solid floor) with bedding material

Conventional
- Closed building
- Mechanical ventilation
- Area per animal (m²)
  - 0.65 in total
  - 1/3 solid or drained floor (lying area)
CRUDE PROTEIN AND FREE AMINO ACIDS

- SEGES Pig Research Centre makes recommendations
- Feed industry and home mixers follow recommendations
- Danish pigs all get the "same" feed
  - Different raw materials but same nutritional standards
CRUDE PROTEIN IN FEED

Crude protein, g pr Feed unit

Year

Piglet feed
30-100 kg, feed
Sow feed

Year

N EX ANIMAL PER 100 KG LIVEWEIGHT

Reduction 1992-2012, 35 %

- growing/finisher
- piglet
- sow

Red. 35 %
Red. 40 %
Red. 33 %
EFFECT OF REDUCED PROTEIN

● A reduction of 10 % in N ex animal
  ● 11 % reduction, TAN-N sows
  ● 13 % reduction, TAN-N, 30-100 kg pigs
  ● 15 % reduction, TAN-N, weaners
  ● 0.1 lower pH
  ● 15 % reduction of ammonia emission, average

● 1992-2012 : 35 % reduction in N ex animal
  ● Expected around 50 % reduction in ammonia emission from housing
  ● Coming from less protein and better feed utilization
FEED OPTIMIZATION

- Finishing pigs
  - Reduced crude protein content in feed
    - 13 – 22 % reduction of ammonia emission
  - Benzoic acid
    - < 10 % reduction of ammonia emission
    - Addition of max. 1 % Benzoic acid
- Weaning piglets
  - No possibilities for reduction in raw protein content
  - Addition of max. 0.5 % Benzoic acid
- Sows
  - Reduced raw protein content in feed
    - 8 – 16 % reduction in ammonia emission
## PRODUCTION RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Daily gain (g)</th>
<th>Lean meat percentage (%)</th>
<th>Feed conversion (Feed unit (kg gain)^{-1})</th>
<th>Crude protein (g Feed unit^{-1})</th>
<th>N ex animal (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Finishing pigs (30-110 kg)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional production</td>
<td>922</td>
<td>60.2</td>
<td>2.84</td>
<td>145.7</td>
<td>2.93</td>
</tr>
<tr>
<td>Organic production</td>
<td>790</td>
<td>58.6</td>
<td>3.07</td>
<td>170.8</td>
<td>4.34</td>
</tr>
</tbody>
</table>

O. Jessen (2015): Notat 1523, SEGES Pig Research Centre
M.G. Christiansen (2014): Notat 1442, SEGES Pig Research Centre
H. Damgaard Poulsen (ed.) 2015: Normtal for husdyrgødning
H. Maribo (2007): Meddelelse 782, SEGES Pig Research Centre
ENVIRONMENTAL TECHNOLOGIES

- Danish EPA - List of Environmental Technologies
  - Housing systems
    - Floor design
    - Cooling of the manure
    - Acidification of the manure
  - Air cleaning
  - Manure storages
    - Rigid cover of the manure storages
  - Field application
    - Injection of manure
    - Acidification
PARTLY SOLID FLOOR

<table>
<thead>
<tr>
<th>Kg NH₃-N per animal</th>
<th>Drained floor (33 %)</th>
<th>Solid floor (25 – 49 %)</th>
<th>Solid floor (50 – 75 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission (kg NH₃-N per animal)</td>
<td>0.40 (+0.04)</td>
<td>0.33 (+0.04)</td>
<td>0.25 (+0.04)</td>
</tr>
<tr>
<td>Reduction (%)</td>
<td>-</td>
<td>17</td>
<td>34</td>
</tr>
</tbody>
</table>

Can cause trouble with fouling in the laying area

- Widely use in the organic production

H. Damgaard Poulsen (ed.) 2015: Normtal for husdyrgødning
COOLING AF SLURRY

- < 30 % reduction of NH$_3$
- Reuse of heat
- Less slurry surface to cool
- Limited effect in organic production
ACIDIFICATION OF SLURRY

- Acidification with H$_2$SO$_4$, pH 5.5
- 64 % reduction of NH$_3$ from the housing system
- 50 % reduction from storage

Possible alternatives for the organic production
- Lactic acid (generated by bacteria)
- Sugar, straw or starch
- Other organic acids
AIR CLEANING

- Biological or chemical air cleaning
- ~90 % NH₃ reduction
- Mechanical ventilation
- Use of H₂SO₄

Adapted to be used in the organic production
- Point extraction
- Oxalic or other organic acids
POINT EXTRACTION

- Optimized partial air cleaning
- Cleaning the “dirtiest” part of the ventilated air volume

- Point extraction with 10 m$^3$ h$^{-1}$ pig$^{-1}$ contains
  - 25 % of total ventilated air volume (m$^3$ year$^{-1}$)
  - 65 % of NH$_3$ emission (kg year$^{-1}$)
  - 50 % of odour emission (OU$_E$ year$^{-1}$)

10 – 100 % of ventilation capacity

10 % of ventilation of capacity – connected to an air cleaner
POINT EXTRACTION AND AIR CLEANING

- NH\(_3\) reduction (%) = 0.7 \times E \times 12
  
  \(E = \text{efficiency of the air cleaner} \ (%)\)

- ~50 % reduction from the housing facility

- Hybrid ventilation
  - Natural ventilation combined with point extraction
SUMMARIZING

- Demands for pig industry - regulation
- Challenges in organic systems
  - Feed
  - Housing systems
- Feed optimization by reduced crude protein and use of free amino acids
  - 35-50 % reduction of ammonia emission since 1992
- Additional options by Environmental Technologies
  - Floor design – already widely used
  - Cooling of the slurry – could have an effect (reduced slurry surface), but the heat has to be re-used
  - Acidification of the slurry – rethinking the acid
  - Air cleaning – biological air cleaning, modified chemical air cleaning, acceptance of (partly) use of mechanical ventilation, e.g. as point extraction