PROTECTING THE ENVIRONMENT THROUGH REDUCTION OF AMMONIA EMISSIONS FROM SLURRY.

Quentin Kelly-Edwards
Regional Manager UK & RoI
JH Agro A/S
TOPICS

1. The problem and the causes
2. Introduction to slurry acidification
3. JH ACIDIFICATION NH4+
   1. Advantages in-house
   2. Advantages in-store
   3. Advantages in-field
4. Verified Technology and Tests
5. Distribution of plants
6. Benefits
7. Overview
8. Contacts
Eutrophication, or more precisely hypertrophication, is the depletion of oxygen in a body of water, which kills aquatic species. It is a result of the build up over time of excess nitrogen. 60% of the Baltic sea is dead because of eutrophication.
1 FACTORS DRIVING EMISSION REDUCTION

- IPPC climate panel.
- Planetary boundaries.
1 PARADIGM SHIFT

Data provided by Leif Knudsen, Knowledge Centre for Agriculture.
Table 22.5 Unit damage costs for health impacts by airborne NO\textsubscript{x} and NH\textsubscript{3} (euro per kg N r:\textsuperscript{c)}; using VOLY 40 000 euro per life year and the CAFE/WHO methodology (Methodex, 2010)

<table>
<thead>
<tr>
<th></th>
<th>NH\textsubscript{3} euro per kg N</th>
<th>NO\textsubscript{x} euro per kg N</th>
<th>NH\textsubscript{3} euro per kg N</th>
<th>NO\textsubscript{x} euro per kg N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>15</td>
<td>29</td>
<td>Latvia</td>
<td>4</td>
</tr>
<tr>
<td>Belgium</td>
<td>36</td>
<td>17</td>
<td>Lithuania</td>
<td>2</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>24</td>
<td>24</td>
<td>Luxembourg</td>
<td>30</td>
</tr>
<tr>
<td>Denmark</td>
<td>10</td>
<td>14</td>
<td>Netherlands</td>
<td>27</td>
</tr>
<tr>
<td>Estonia</td>
<td>3</td>
<td>3</td>
<td>Poland</td>
<td>12</td>
</tr>
<tr>
<td>Finland</td>
<td>3</td>
<td>2</td>
<td>Portugal</td>
<td>4</td>
</tr>
<tr>
<td>France</td>
<td>15</td>
<td>25</td>
<td>Slovakia</td>
<td>17</td>
</tr>
<tr>
<td>Germany</td>
<td>22</td>
<td>32</td>
<td>Slovenia</td>
<td>16</td>
</tr>
<tr>
<td>Greece</td>
<td>4</td>
<td>3</td>
<td>Spain</td>
<td>5</td>
</tr>
<tr>
<td>Hungary</td>
<td>13</td>
<td>18</td>
<td>Sweden</td>
<td>7</td>
</tr>
<tr>
<td>Ireland</td>
<td>3</td>
<td>12</td>
<td>United Kingdom</td>
<td>21</td>
</tr>
<tr>
<td>Italy</td>
<td>13</td>
<td>19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The good news

- In Denmark, better manure management technologies, in both storage and on application to crops, applied as part of normal fertiliser plans, have reduced the consumption of Nitrogen in mineral fertilisers by approximately 50% over the past 25 years.
- saves Danish farmers about €100 per ha, for N alone.
- Improves animal health, higher returns per animal.
- Healthier working conditions.
- Lower environmental impact.
- Benefits the environment with less nutrients leaching into the eco-system and oceans.
2 INTRODUCTION TO ACIDIFICATION

- Primarily we are losing too much ammonia to the atmosphere through animal production!
- Ammonia in the form NH₃ evaporates from livestock production in housing, storage and in the field.
2 WHY ACIDIFICATION?

- Slurry acidification is an efficient technology for reducing ammonia emissions.
- In Denmark, 20% of all slurry is acidified prior to application.
- Slurry acidification is in the Danish environmental legislation.
- In the UK, slurry acidification is included in the BREF 2017 for the Intensive Rearing of Poultry and Pigs, and listed as “a best available technology” for reducing ammonia emissions.
- In addition to ammonia, slurry acidification also reduces emissions of harmful greenhouse gases to the atmosphere,
  - CH4 - Methane gas.
  - N2O - Nitrous Oxide.
  - H2S - Sulphur. (New research)
2 REDUCING pH LEVELS AT SOURCE

- Reducing pH value of slurry at step 1 (the source).
- Reduction of ammonia emissions.
  - In-house
  - In-store
  - In-field
- More Nitrogen is retained in the slurry and available to plants in the field.
2 REDUCING pH LEVELS AT SOURCE

• The pH of slurry is lowered from to 5.5, at this level it is converted to NH₄⁺, stabilizing and retaining it in the slurry.
• This prevents ammonia from evaporating to the atmosphere.
3 JH ACIDIFICATION NH4+ SYSTEM

Fully automatied pH reduction system.
• Continuous monitoring.
• Full reporting and documentation of the operation.
• The farmer does not handle acid at any time.

PC-controlled

All data is logged
3 WHY ACID IN SLURRY

• Chemicals in balance
  • NH₃ (ammonia)
  • NH₄⁺ (ammonium)
• Lowering pH in slurry with acid displaces the balance towards NH₄⁺.
• The formation of NH₃ stops at <6 pH level.
• Result: lowered ammonia emissions.
• 50 % reduction from cow slurry.
• 64 % reduction from pig slurry.
3 WHY SULFURIC ACID

Reasons for use of sulfuric acid, $\text{H}_2\text{SO}_4$

• Its cheap.
• Crops need Sulphur.
• Only moderately corrosive to concrete & inventory.
• Addition of sulfuric acid does not increase levels of $\text{H}_2\text{S}$.
• Biological activities for anaerobic processes is reduced by 98%.
• $\text{H}_2\text{S}$ does not build up in slurry being mixed every day (acidified slurry).
• Sulfate ($\text{SO}_4^{2-}$) from $\text{H}_2\text{SO}_4$ is stable in the slurry for over 11 months!

Source: J. Eriksen et al., 2008 + LDM Ottosen et al., 2009
3 THE PROCESS

Pig farm:

Slurry is treated every day in a mixing tank outside the stable.

Parts of the acidified slurry is continuously pumped to the storage tank.
3 JH AGRO NH4+ SLURRY ACIDIFICATION

PIG FARM

SEPERATOR

ACID TANK

PROCESS TANK

TECH WELL
3:1 ADVANTAGES IN-HOUSE

- Easy pumping and mixing.
- Slurry is continuously moving in channels preventing blockages.
- Less flies and disease problems.
- Less manual work with moving slurry from stable to pits.
- Better working and living environment in stable.
- Slurry is more homogenous.
- Less ammonia and greenhouse gasses in the air.
## 3:1 ADVANTAGES IN-HOUSE

<table>
<thead>
<tr>
<th>Replicate</th>
<th>Section</th>
<th>Number of measurements</th>
<th>Temperature Out [°C]</th>
<th>Temperature in the stable [°C]</th>
<th>NH₃ [ppm]</th>
<th>Ammonia emission [kg NH₃-N pr. prod. swine]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. Control</td>
<td>1900</td>
<td>3.0</td>
<td>17.2</td>
<td>12.7</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>2. Acidified</td>
<td></td>
<td></td>
<td>17.9</td>
<td>5.5</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>3. Acidified</td>
<td></td>
<td></td>
<td>16.8</td>
<td>4.6</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>4. Control</td>
<td></td>
<td></td>
<td>17.7</td>
<td>16.8</td>
<td>0.57</td>
</tr>
<tr>
<td>2</td>
<td>1. Control</td>
<td>1540</td>
<td>4.7</td>
<td>18.6</td>
<td>15.4</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>2. Acidified</td>
<td></td>
<td></td>
<td>18.4</td>
<td>3.9</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>3. Acidified</td>
<td></td>
<td></td>
<td>19.4</td>
<td>5.2</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>4. Control</td>
<td></td>
<td></td>
<td>19.7</td>
<td>14.5</td>
<td>0.27</td>
</tr>
<tr>
<td>3</td>
<td>1. Control</td>
<td>2257</td>
<td>19.0</td>
<td>21.1</td>
<td>5.9</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>2. Acidified</td>
<td></td>
<td></td>
<td>21.4</td>
<td>1.8</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>3. Acidified</td>
<td></td>
<td></td>
<td>21.5</td>
<td>1.6</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>4. Control</td>
<td></td>
<td></td>
<td>22.0</td>
<td>3.8</td>
<td>0.43</td>
</tr>
</tbody>
</table>
3:1 ADVANTAGES IN-HOUSE

- Increased animal welfare.
- With acidified slurry under the slatted floor, the slurry channels will not clog because of straw as what drops through is removed daily and separated.
### 3:1 ADVANTAGES IN-HOUSE

- Better animal health

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Acidified slurry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antal hold</strong></td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Antal producerede slagtesvin</strong></td>
<td>1793</td>
<td>1890</td>
</tr>
<tr>
<td><strong>Vægt indsættelse, kg</strong></td>
<td>25,6</td>
<td>24,3</td>
</tr>
<tr>
<td><strong>Slagtevægt, kg</strong></td>
<td>74,9</td>
<td>76,3</td>
</tr>
<tr>
<td><strong>Daglig tilvækst, g</strong></td>
<td>794</td>
<td>816</td>
</tr>
<tr>
<td><strong>Foderforbrug, FEsv</strong></td>
<td>2,72</td>
<td>2,61</td>
</tr>
<tr>
<td><strong>Kødprocent, %</strong></td>
<td>61,0</td>
<td>61,2</td>
</tr>
<tr>
<td><strong>Døde og kasserede, %</strong></td>
<td>4,1</td>
<td>3,2</td>
</tr>
</tbody>
</table>

Source: [Danish Pig Research Centre](http://vsp.lf.dk/Publikationer/Kilder/lu_medd/2004/683.aspx?full=1)
3:1 ADVANTAGES IN-HOUSE

- Better animal health
  - Less lung disease.
  - Less hoof disease.
  - Better feed intake, slaughter weight increase, higher weight to feed ratio, daily weight gain = +1%.
  - Lower mortality = +0.9%.
  - Example: 25,000 pigs unit produced/year (on farm test):
    - Normal slurry: * 4.1% = 1.025 mortalities & unsaleable pigs.
    - Acidified slurry: * 3.1% = 800 mortalities & unsaleable pigs.
    - Difference 0.9% = 225 Gain.
  - All small gains but are consistent and add up towards return on investment.
3:2 ADVANTAGES IN SLURRY STORAGE

Aug. 2002 – May 2003 – 9 months

<table>
<thead>
<tr>
<th>Slurry</th>
<th>Loss of N [kg]</th>
<th>Loss of N [%]</th>
<th>pH Start</th>
<th>pH End of storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidified slurry</td>
<td>0.01</td>
<td>0.3</td>
<td>5.45</td>
<td>5.89</td>
</tr>
<tr>
<td>Untreated slurry</td>
<td>0.19</td>
<td>4.6</td>
<td>6.89</td>
<td>7.22</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Slurry</th>
<th>Loss of N [kg]</th>
<th>Loss of N [%]</th>
<th>pH Start</th>
<th>pH End of storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidified slurry</td>
<td>0.18</td>
<td>5.3</td>
<td>5.45</td>
<td>6.56</td>
</tr>
<tr>
<td>Untreated slurry</td>
<td>1.84</td>
<td>45.0</td>
<td>6.89</td>
<td>7.52</td>
</tr>
</tbody>
</table>
3:3 ADVANTAGES IN FIELD

**Not acidified slurry**
- **Animals:** 100 kg N
  - **Stable:** 84 kg N
  - **Storage:** 76 kg N
  - **Slurry on field:** 68 kg N
- **Pigs + Cattle:** 16 kg N

**Acidified slurry**
- **Animals:** 100 kg N
  - **Stable:** 1 kg N
  - **Storage:** 3 kg N
  - **Slurry on field:** 3 kg N
  - **Fertilizer:**
    - **Animals:**
      - **Stable:**
        - **Storage:**
          - **Slurry on field:**
            - **Fertilizer:**
              - **Pigs:** 91 kg N
              - **Cattle:** 88 kg N
              - **Pigs 95 kg N**
              - **Cattle 92 kg N**

From Sven G. Sommer 2009
3:3 ADVANTAGES IN FIELD

\[ \text{Ammonia emissions rate (kg N per ha per hour)} \]

- June 15 – cattle slurry to cut gras

- Reference
- Injection
- Infarm (JH)
- SyreN

Time after spreading (days)
3:3 ADVANTAGES IN FIELD

Loss of ammonia (% of reference)

- Reference
- Injection
- (JHI Agro)
- Storage & Field

The chart shows the percentage of ammonia loss relative to a reference. The categories are compared in terms of their loss percentage, with different values for each category.
3:3 ADVANTAGES IN FIELD

- More plant available N in the slurry.
- N stays in the slurry instead of evaporating.
- Increased fertilizer value of slurry.
- Faster N uptake in fields with acidified slurry.
- No incorporation of slurry into fields necessary.
- Minimal manganese deficiency.
- Full supply of Sulphur to crops.
- Yield Increase up to 15%
3:3 ADVANTAGES IN FIELD
4 VERIFIED TECHNOLOGY

- JH NH4+ has been tested according to the VERA test protocols.
- VERA Statement documents the Environmental benefit is 64% verified reduction in ammonia emissions (in pig finishing units).
- Demonstrated operational stability.
4 TEST RESULTS

- Corrosion inside the stables was examined and found to be less than in houses without acidification.
- Concrete quality is not affected (Aalborg Portland Report).
- Using acidified slurry in a biogas plant.
  - Slurry fibers from the acidified slurry gives 50% more gas than non-acidified fiber, and can be added at up to 30% of the biomass.
- Alternative commercially available acids that can also be used in the system.
  - acetic acid
  - lactic acid
  - higher cost than sulphuric acid
5 DISTRIBUTION OF JH NH4+ SYSTEMS

Denmark
- 151 systems.
- 76 pig systems.
- 75 cattle systems.

Poland
1. Expanding into new markets:
- Germany.
- Italy.
- United Kingdom.
- Ireland.
6 SUMMARY FINANCIAL BENEFITS

- Automatic slurry handling.
- Better animal health.
- Increased daily weight gain.
- Improved feed to weight gain ratio.
- No need to cover storage.
- Faster uptake of nutrients by plants.
- Increased yield in crops.
- Fertiliser costs savings.
- No incorporation of slurry to field required.
- All contribute positively to the economics of the farm.
6 SUMMARY ENVIRONMENTAL BENEFITS

• Technology exceeds new reduction in emissions targets.
• Lower emissions to the atmosphere of harmful gases.
• Better animal health and environment.
• Improved working environment for people.
• Better soil conditions and residual nutrients.
• Less leaching of nutrients into the eco-system helping to reduce eutrophication to large bodies of water.

• THANK YOU!
• Delegates are welcome to contact us for more information or to visit operational plants in Denmark.
  • Denmark and other International – Kurt West
    kw@jhagro.com
  • Germany South – Thomas Franke
    tf@jhagro.com
  • Germany North – Holger Schulz
    hs@jhagro.com
  • United Kingdom & Ireland – Quentin Kelly-Edwards
    qke@jhagro.com
  www.linkedin.com/in/quentin-n-kelly-edwards-279719a