Manure production and handling techniques on large-scale farms in the Baltic Sea Region

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Contents

• Manure handling - techniques used on case-study farms in BSR

• Manure processing - examples of farm implemented technology

• Management impacts on manure quality

• Conclusions & recommendations
Manure handling chain

Feed and production → Housing system → Storage → Field application

Processing

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Plus farm examples of manure processing

- 5 farms per country
  - 2 dairy
  - 2 pig
  - 1 poultry
- X 6 countries
- 10 extra farms

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Livestock density

Livestock units per ha

Dairy n=13, pigs n=12, poultry n=4. Error bars = 1 SD.
*2 poultry farms do not have land for spreading manure so livestock density could not be calculated
## Manure handling systems

<table>
<thead>
<tr>
<th></th>
<th>Total LU</th>
<th>Solid manure (%)</th>
<th>Slurry (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy*</td>
<td>6 736</td>
<td>37.6</td>
<td>62.4</td>
</tr>
<tr>
<td>Pigs</td>
<td>66 169</td>
<td>0.2</td>
<td>99.8</td>
</tr>
<tr>
<td>Poultry</td>
<td>36 769</td>
<td>86.7</td>
<td>13.3</td>
</tr>
</tbody>
</table>

* Total herd including heifers and calves

% of total manure amounts in EE, FI, LT, LV, PL, SE from Sari Luostarinen (ed.)2013

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GABBS, 2013
## Mucking out frequency

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Daily</th>
<th>1-2 times a week</th>
<th>Every 2-3 weeks</th>
<th>Once per batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>11</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pigs</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Poultry</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>9</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Manure production (ex-storage)

Manure, 1000 t per farm and yr

Dairy n=13, pigs n=12, poultry n=6. Error bars = 1 SD.
## Manure processing on 29% of farms

<table>
<thead>
<tr>
<th>Technology</th>
<th>Number of farms</th>
<th>Livestock type</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobic digestion</td>
<td>5 + 2*</td>
<td>Dairy, pig (dairy, poultry)</td>
<td>Sweden, Finland, Latvia, Poland</td>
</tr>
<tr>
<td>Mechanical separation</td>
<td>2</td>
<td>Dairy, pig</td>
<td>Lithuania, Poland</td>
</tr>
</tbody>
</table>

*(exported manure to biogas plant)*
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Types of storage for slurry and solid manure

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Use of covers on manure storages

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Volume of slurry spread with various techniques

- **Broadcast**
  - Umbilical: 0 m³ yr⁻¹
  - Tanker: 50 m³ yr⁻¹

- **Bandspreading**
  - Umbilical: 300 m³ yr⁻¹
  - Tanker: 200 m³ yr⁻¹

- **Injection**
  - Umbilical: 10 m³ yr⁻¹
  - Tanker: 10 m³ yr⁻¹

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### Application rates on different crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>2.5*</th>
<th>5*</th>
<th>10*</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>NI</th>
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</thead>
<tbody>
<tr>
<td>Grassland</td>
<td></td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
<td>x</td>
<td>xx</td>
<td>xx</td>
<td>x</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring cereal</td>
<td>x</td>
<td>x</td>
<td>xx</td>
<td>x</td>
<td>xx</td>
<td>xxx</td>
<td>xxx</td>
<td>x</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter cereal</td>
<td>x</td>
<td>x</td>
<td>xx</td>
<td>x</td>
<td>xx</td>
<td>xxx</td>
<td>xxx</td>
<td>x</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapeseed</td>
<td>x</td>
<td></td>
<td></td>
<td>xxx</td>
<td>x</td>
<td>x</td>
<td>xxx</td>
<td>x</td>
<td>xx</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>xxx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar beet</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green manure</td>
<td></td>
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<td>x</td>
<td></td>
</tr>
<tr>
<td>Peas</td>
<td>x</td>
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</tr>
<tr>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>7</strong></td>
<td><strong>1</strong></td>
<td><strong>11</strong></td>
<td><strong>12</strong></td>
<td><strong>11</strong></td>
<td><strong>7</strong></td>
<td><strong>7</strong></td>
<td><strong>5</strong></td>
<td><strong>4</strong></td>
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</table>

*poultry manure

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### Application time

<table>
<thead>
<tr>
<th></th>
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<tbody>
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<td>xx</td>
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<tr>
<td>Spring cereal</td>
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<tr>
<td>Winter cereal</td>
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<td></td>
<td></td>
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<tr>
<td>Rapeseed</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Maize</td>
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<tr>
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<td>Before ploughing</td>
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<td></td>
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<td>x</td>
<td>xxxxx</td>
<td></td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>20</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>14</td>
<td>5</td>
<td>2</td>
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</table>
Percentage manure exported off-farm

Livestock density (LU per ha)

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Bottlenecks for utilizing manure

<table>
<thead>
<tr>
<th>4 types of barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cost / economic factors</td>
</tr>
<tr>
<td>2. Technological limitations</td>
</tr>
<tr>
<td>3. Lack of knowledge</td>
</tr>
<tr>
<td>4. Regulations or lack of support mechanisms for adopting BAT</td>
</tr>
</tbody>
</table>
Manure processing technology – examples used on farms

Concentration technologies

Pellon

Storage for solid fraction
Solid-liquid separation
Aerobic biological treatment

Biotain

Stripping columns
Precipitation tanks
Scrubbing container
Biosolids screw conveyor
Roller press

UNDER DEVELOPMENT
NOT YET COMMERCIALLY AVAILABLE

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Manure processing technology – examples used on farms

Mechanical separation
Manure processing technology – examples used on farms

Drum composting

ESCAB
Manure processing technology – examples used on farms

Acidification

- Fronttank with sulphuric acid, iron sulphate and water.
- Tractor with computer control
- Slurry tanker with acid injection

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Manure processing technology – examples used on farms

Slurry cooling

Pellon
Manure processing technology – examples used on farms

Anaerobic digestion
Management factors that impact manure utilization

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Management factors that impact manure utilization

Feeding - feed to ex-animal

*calculated

\[ P_{\text{in feed}} = R^2 = 0.9682 \]

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Management factors that impact manure utilization

Feeding - ex-animal to ex-housing

\[ R^2 = 0.4901 \]

*calculated
Management factors that impact manure
Feeding - ex-animal to ex-storage

\[ R^2 = 0.3076 \]

*calculated
Management factors that impact manure utilization

Additives – Phosphorus reduction

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Management factors that impact manure utilization:

Additives – on dairy farms

<table>
<thead>
<tr>
<th></th>
<th>DM</th>
<th></th>
<th></th>
<th>TN</th>
<th></th>
<th></th>
<th>P</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ex-</td>
<td>Ex-</td>
<td>Ex-</td>
<td>Ex-</td>
<td>Ex-</td>
<td>Ex-</td>
<td>Ex-</td>
<td>Ex-</td>
</tr>
<tr>
<td></td>
<td>animal</td>
<td>housing</td>
<td>storage</td>
<td>animal</td>
<td>housing</td>
<td>storage</td>
<td>animal</td>
<td>housing</td>
</tr>
<tr>
<td>Average</td>
<td>100</td>
<td>59</td>
<td>60</td>
<td>100</td>
<td>52</td>
<td>59</td>
<td>100</td>
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<tr>
<td>Max</td>
<td>83</td>
<td>80</td>
<td></td>
<td>75</td>
<td>78</td>
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<td>86</td>
<td>108</td>
</tr>
<tr>
<td>Min</td>
<td>41</td>
<td>35</td>
<td></td>
<td>24</td>
<td>41</td>
<td></td>
<td>32</td>
<td>40</td>
</tr>
</tbody>
</table>
Management factors that impact manure

Measured additions

SE Farm 3 - Pigs
1821 t/yr dilution

SE Farm 1 – Dairy
2961 t/yr dilution

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Conclusions

• Most large-scale farms handled manure as slurry
• Large variation in manure produced per LU even for similar livestock types
• Examples of environmentally friendly technology found in all countries
• Manure handling after storage was least well-described part of handling chain
• Cost greatest barrier for implementing innovative handling and processing technology
Recommendations

• Increase storage capacity

• Increase the use of environmentally friendly technology to reduce ammonium emissions from storage and during spreading

• Decrease dilution of slurry as much as possible

• Spreading technology must have high precision
  – Correct dose in the right place at the right time
  – When needed by plants
  – Application rates based on actual nutrient content
  – Site specific conditions
  – Spreading evenness
Seals on Gotska Sandön, August 2013

www.balticmanure.eu