PIG MANURE AND EFFLUENT MANAGEMENT IN VIETNAM

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2) Institute for Global Environmental Strategies

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Farm size and its distribution across the country

Table 1: Distribution of pig population per geographical locations

<table>
<thead>
<tr>
<th>Regions</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red river delta</td>
<td>7,092.2</td>
<td>6,855.2</td>
<td>6,759.5</td>
<td>6,824.8</td>
<td>7,061.3</td>
</tr>
<tr>
<td>Northern midlands &amp; mountainous areas</td>
<td>6,424.9</td>
<td>6,346.9</td>
<td>6,328.8</td>
<td>6,626.4</td>
<td>6,841.2</td>
</tr>
<tr>
<td>North &amp; South Central coastal areas</td>
<td>5,253.3</td>
<td>5,084.9</td>
<td>5,099.4</td>
<td>5,270.5</td>
<td>5,368.1</td>
</tr>
<tr>
<td>Central Highlands</td>
<td>1,711.7</td>
<td>1,704.1</td>
<td>1,722.3</td>
<td>1,742.4</td>
<td>1,797.3</td>
</tr>
<tr>
<td>Southeast</td>
<td>2,801.4</td>
<td>2,780.0</td>
<td>2,758.8</td>
<td>2,890.1</td>
<td>3,093.6</td>
</tr>
<tr>
<td>Mekong River Delta</td>
<td>3,772.5</td>
<td>3,722.9</td>
<td>3,595.6</td>
<td>3,470.4</td>
<td>3,589.3</td>
</tr>
</tbody>
</table>

Unit: thousands
Figure 1: Distribution of pig farms according to geographical locations

Source: Vietnam GSO, 2013
## Scale of pig farming in Vietnam

Table 2: Distribution of Small – scale pig farming households according to pig quantity

<table>
<thead>
<tr>
<th>Regions</th>
<th>Total</th>
<th>According to quantity of pig per household</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-2 pigs</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4,131.6</td>
<td>2,144.0</td>
</tr>
<tr>
<td>Red river delta</td>
<td>870.7</td>
<td>454.4</td>
</tr>
<tr>
<td>Northern midlands &amp; mountain areas</td>
<td>1,204.3</td>
<td>615.5</td>
</tr>
<tr>
<td>North Central &amp; Central coastal areas</td>
<td>1,238.8</td>
<td>709.9</td>
</tr>
<tr>
<td>Central Highlands</td>
<td>210.8</td>
<td>106.3</td>
</tr>
<tr>
<td>South East</td>
<td>110.2</td>
<td>30.1</td>
</tr>
<tr>
<td>Mekong River Delta</td>
<td>496.7</td>
<td>227.9</td>
</tr>
</tbody>
</table>

*Unit: thousands*

*Source: Vietnam GSO, 2012*
## Scale of pig farming household

**Table 3: Size of pig households in study sites**

<table>
<thead>
<tr>
<th>Study sites</th>
<th>Value</th>
<th>&lt; 5 pigs</th>
<th>5–20 pigs</th>
<th>20–50 pigs</th>
<th>&gt;50 pigs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thai Binh</td>
<td>Number</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>40</td>
<td>50</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Bac Giang</td>
<td>Number</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>50</td>
<td>40</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Ha Noi</td>
<td>Number</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Thanh Hoa</td>
<td>Number</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>40</td>
<td>60</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Number</td>
<td>13</td>
<td>17</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(%)</td>
<td>32.5</td>
<td>42.5</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>
Wastewater characterization

Table 4: Characteristic of piggeries wastewater in Gia Lam District, Ha Noi

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Type of pig production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Porker</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>6.73</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/l</td>
<td>4,735</td>
</tr>
<tr>
<td>TN</td>
<td>mg/l</td>
<td>106.03</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>mg/l</td>
<td>4.21</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>mg/l</td>
<td>97.72</td>
</tr>
<tr>
<td>TP</td>
<td>mg/l</td>
<td>62.33</td>
</tr>
</tbody>
</table>

Source: Nguyen Thi Thuy Dung et al, 2015
Table 5: Fish ponds’ water quality of VAC systems in Hung Yen

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>QCVN08: 2008/BTNMT Column A2</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.11-7.41</td>
<td>7.30</td>
<td>6.0-8.5</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>120-240</td>
<td>160</td>
<td>15</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>3.50-5.54</td>
<td>4.52</td>
<td>&gt;= 5</td>
</tr>
<tr>
<td>NH₄⁺ (mg/L)</td>
<td>1.36-4.64</td>
<td>3.00</td>
<td>0.2</td>
</tr>
<tr>
<td>NO₃⁻ (mg/L)</td>
<td>1.16-2.88</td>
<td>2.20</td>
<td>5.0</td>
</tr>
<tr>
<td>PO₄³⁻ (mg/L)</td>
<td>1.90-4.87</td>
<td>3.20</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Cao Truong Son et al, 2010
Current practices and existing technical approaches for pig manure management and treatment

Table 6: Proportion of piggery waste treatment methods in some provinces

<table>
<thead>
<tr>
<th>Effluent management</th>
<th>Province (Unit: %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hung Yen¹</td>
</tr>
<tr>
<td>Biogas</td>
<td>47.6</td>
</tr>
<tr>
<td>Compost</td>
<td>9.5</td>
</tr>
<tr>
<td>Used for plant</td>
<td>38.1</td>
</tr>
<tr>
<td>Directly discharge into environment</td>
<td>28.6</td>
</tr>
<tr>
<td>Discharge to fish ponds</td>
<td>52.4</td>
</tr>
<tr>
<td>Collection for sale</td>
<td>28.6</td>
</tr>
<tr>
<td>Stored</td>
<td>-</td>
</tr>
</tbody>
</table>

Waste management at farm scale

Figure 2: Application of waste treatment technology at farm scale
Figure 3: The rate of applicable treatment of waste disposal as household scale
National technical standards on pig’s manure management

Table 7: Regulations and Legislations on livestock sector and pig farming

<table>
<thead>
<tr>
<th>National technical standards</th>
<th>Regulations and Legislations on livestock sector and pig farming</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1   81/2009/TT-BNNPTNT</td>
<td>Circular on National Technique regulations on animal feed</td>
<td>25/12/2009</td>
</tr>
<tr>
<td>2   04/2010/TT-BNNPTNT</td>
<td>Circular on promulgating national technical regulations on conditions for biosafety pig farms, poultry farms;</td>
<td>15/01/2010</td>
</tr>
<tr>
<td>3   61/2011/TT-BNNPTNT</td>
<td>Circular on National Technique regulations on animal feed</td>
<td>12/09/2011</td>
</tr>
<tr>
<td>4   23/2012/TT-BNNPTNT</td>
<td>Circular on amending and supplementing some national technical standards of animal feed.</td>
<td>18/06/2012</td>
</tr>
</tbody>
</table>
Estimation of the emission coefficient

**Silts (120 days)**
- Bran: 276 kg/head
- DrinKing water: 1,020 l/head
- Washing water: 2628 L/head
- Urine: 408 l/head
- Washing: 2.628 l/head
- Manure: 168 kg/head

**Nursuring (25 days)**
- Bran: 57.5 kg/head
- Drinking water: 110 l/head
- Washing water: 547.5L/head
- Urine: 115 l/head
- Washing: 547.5 l/head
- Manure: 55 kg/head

**Pig weight <15kg (30 days)**
- Bran: 12 kg/con
- Drinking water: 21 L/head
- Washing water: 966L/head
- Manure: 3kg/con
- Urine: 6L/head
- Washing water: 966L/head

**Pig weight 15-30kg (30 days)**
- Bran: 24kg/con
- Drinking water: 69L/con
- Washing water: 495L/con
- Manure: Urine: 9L/head
- Washing water: 495L/head

**Pig weight :30-60kg (120 days)**
- Bran: 50kg/con
- Drinking water: 185L/con
- Washing water: 1115L/con
- Manure: Urine: 30kg/con
- Washing water: 495L/con

**Pig weight : >60kg (45 days)**
- Bran: 117kg/con
- Drinking water: 202,5L/con
- Washing water: 927L/con
- Manure: Urine: 90kg/con
- Washing water: 495L/con

**Procedure for sows production**
- Life cycle: 145 days (5 months): silts 120 days, nursering 25 days
- Bran: 333,5 kg/head
- Drinking water: 1.130L/head
- Washing water: 3.175,5L/head
- Manure: 223 kg/head
- Urine: 523L/head

**Porker Lifetime:**
- 150 days
- Bran: 233kg
- Drinking water: 477,5L/head
- Manure: 135kg/head
- Urine: 254L/head
- Washing water: 3.503L/head

**Figure 4: Estimation of the quota on material consumption and waste generation at a farm scale**
Table 8: Material usage and waste generation per head of a pig in a process at scale farming households

<table>
<thead>
<tr>
<th>Material</th>
<th>Type of pig</th>
<th>Sows</th>
<th>Porker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quota</td>
<td>Time</td>
<td>Total waste</td>
</tr>
<tr>
<td></td>
<td>(kg/head/day)</td>
<td>(day)</td>
<td>(l/head)</td>
</tr>
<tr>
<td>Input</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comercial bran</td>
<td>2.0</td>
<td>190</td>
<td>380</td>
</tr>
<tr>
<td>Rice bran</td>
<td>2.4</td>
<td>190</td>
<td>456</td>
</tr>
<tr>
<td>Corn bran</td>
<td>2.6</td>
<td>190</td>
<td>494</td>
</tr>
<tr>
<td>Vegetable</td>
<td>3.8</td>
<td>190</td>
<td>722</td>
</tr>
<tr>
<td>Drinking water</td>
<td>9.0</td>
<td>190</td>
<td>1,710</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure</td>
<td>1.4</td>
<td>190</td>
<td>266</td>
</tr>
<tr>
<td>Urine</td>
<td>3.4</td>
<td>190</td>
<td>646</td>
</tr>
<tr>
<td>Washing water</td>
<td>21.9</td>
<td>190</td>
<td>4,161</td>
</tr>
</tbody>
</table>

N = 40 (household)
Development of a scientific framework for better understanding of nutrient flows (MFA) from pig farms

**INPUTS**

1. Pig breeds
2. Industry bran
3. Rice bran
4. Corn bran
5. Mating fee
6. Electric power
7. Water
8. Veterinary medicine
9. Anti-microbial

**OUTPUTS**

- Manure
- Urine
- Waste water
- BOD
- COD
- pH
- TSS
- T-N
- T-Coliform

**Figure 5: Nutrient flow in the pig farm**
(Volatile, compost, runoff lost, selling production)
Table 9: The volume of pollutants generated per pig life cycle at farm scale

<table>
<thead>
<tr>
<th>Types of pig</th>
<th>Wastewater (L/head)</th>
<th>COD kg/head</th>
<th>BOD kg/head</th>
<th>TS kg/head</th>
<th>TN kg/head</th>
<th>TP kg/head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silts</td>
<td>408</td>
<td>0.43</td>
<td>0.40</td>
<td>0.67</td>
<td>0.112</td>
<td>5.182</td>
</tr>
<tr>
<td>Nursering</td>
<td>115</td>
<td>0.37</td>
<td>0.24</td>
<td>0.56</td>
<td>0.261</td>
<td>0.105</td>
</tr>
<tr>
<td>Life cycle</td>
<td>523</td>
<td>0.80</td>
<td>0.64</td>
<td>1.23</td>
<td>0.373</td>
<td>5.287</td>
</tr>
<tr>
<td>Porker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15 kg</td>
<td>6</td>
<td>0.01</td>
<td>5.56</td>
<td>0.006</td>
<td>0.003</td>
<td>0.030</td>
</tr>
<tr>
<td>15-30 kg</td>
<td>9</td>
<td>0.03</td>
<td>18.71</td>
<td>0.041</td>
<td>0.018</td>
<td>0.090</td>
</tr>
<tr>
<td>30 - 60 kg</td>
<td>95</td>
<td>0.29</td>
<td>187.48</td>
<td>0.040</td>
<td>0.203</td>
<td>1.197</td>
</tr>
<tr>
<td>&gt; 60 kg</td>
<td>144</td>
<td>0.50</td>
<td>324.72</td>
<td>0.073</td>
<td>0.536</td>
<td>1.872</td>
</tr>
<tr>
<td>Life cycle</td>
<td>254</td>
<td>0.83</td>
<td>536.47</td>
<td>0.16</td>
<td>0.76</td>
<td>3.189</td>
</tr>
</tbody>
</table>
Table 10: Load of pollution generated per pig head from washing water during a production cycle

<table>
<thead>
<tr>
<th>Types of pigs</th>
<th>Wastewater (L/head)</th>
<th>COD kg/head</th>
<th>BOD kg/head</th>
<th>TS kg/head</th>
<th>TN kg/head</th>
<th>TP kg/head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gilts</td>
<td>408</td>
<td>0.49</td>
<td>0.39</td>
<td>1.11</td>
<td>0.11</td>
<td>5.18</td>
</tr>
<tr>
<td>Nursering</td>
<td>115</td>
<td>0.40</td>
<td>0.23</td>
<td>0.28</td>
<td>0.02</td>
<td>1.58</td>
</tr>
<tr>
<td>Life cycle</td>
<td>523</td>
<td>0.89</td>
<td>0.72</td>
<td>1.39</td>
<td>0.13</td>
<td>6.76</td>
</tr>
<tr>
<td>Porker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15 kg</td>
<td>6</td>
<td>0.004</td>
<td>0.003</td>
<td>0.003</td>
<td>0.001</td>
<td>0.040</td>
</tr>
<tr>
<td>15-30 kg</td>
<td>9</td>
<td>0.005</td>
<td>0.004</td>
<td>0.004</td>
<td>0.001</td>
<td>0.064</td>
</tr>
<tr>
<td>30 - 60 kg</td>
<td>95</td>
<td>0.140</td>
<td>0.080</td>
<td>0.060</td>
<td>0.010</td>
<td>0.990</td>
</tr>
<tr>
<td>&gt; 60 kg</td>
<td>144</td>
<td>0.290</td>
<td>0.170</td>
<td>0.370</td>
<td>0.020</td>
<td>1.680</td>
</tr>
<tr>
<td>Life cycle</td>
<td>254</td>
<td>0.439</td>
<td>0.257</td>
<td>0.437</td>
<td>0.032</td>
<td>2.774</td>
</tr>
</tbody>
</table>
Table 11: Load of pollution generated per pig head from waste manure during a production cycle

<table>
<thead>
<tr>
<th>Type of pig</th>
<th>Waste manure (kg/head)</th>
<th>OM kg/head</th>
<th>TN kg/head</th>
<th>TP kg/head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows</td>
<td>Manure</td>
<td>223</td>
<td>4.3</td>
<td>2</td>
</tr>
<tr>
<td>Porker</td>
<td>Manure of porker &lt;15 kg</td>
<td>3</td>
<td>4.24</td>
<td>2.99</td>
</tr>
<tr>
<td></td>
<td>Manure of porker 15-30 kg</td>
<td>12</td>
<td>8.43</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>Manure of porker 30-60 kg</td>
<td>30</td>
<td>3.72</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>Manure of porker &gt; 60kg</td>
<td>90</td>
<td>4.17</td>
<td>2.06</td>
</tr>
<tr>
<td>Total production cycle</td>
<td></td>
<td>135</td>
<td>20.56</td>
<td>6.59</td>
</tr>
</tbody>
</table>
Table 12: Parameters and equations for estimating nitrogen flow in pig production

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description of data</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a feed_porker</td>
<td>Daily food for porker</td>
<td>kg food/head/day</td>
<td>1.4</td>
<td>0.3</td>
</tr>
<tr>
<td>d porker</td>
<td>Growing duration of porker</td>
<td>day</td>
<td>180.0</td>
<td>0.0</td>
</tr>
<tr>
<td>a feed_sow</td>
<td>Daily food for sow</td>
<td>kg food/head/day</td>
<td>2.7</td>
<td>0.1</td>
</tr>
<tr>
<td>d sow</td>
<td>Growing duration of sow</td>
<td>day</td>
<td>150.0</td>
<td>0.0</td>
</tr>
<tr>
<td>CN feed_pig</td>
<td>Nitrogen content in commercial food for pig</td>
<td>gN/kg food</td>
<td>26.0</td>
<td>0.0</td>
</tr>
<tr>
<td>n man-porker</td>
<td>Daily manure of porker</td>
<td>kg/head/day</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>n man-sow</td>
<td>Daily manure of sow</td>
<td>kg/head/day</td>
<td>1.5</td>
<td>0.2</td>
</tr>
<tr>
<td>aN man-porker</td>
<td>Nitrogen load in porker' manure</td>
<td>gN/kg</td>
<td>26.1</td>
<td>0.0</td>
</tr>
<tr>
<td>aN man_sow</td>
<td>Nitrogen load in sow' manure</td>
<td>gN/kg</td>
<td>39.2</td>
<td>0.0</td>
</tr>
<tr>
<td>n urine_porker</td>
<td>Daily urine of porker</td>
<td>l/head/day</td>
<td>1.6</td>
<td>0.9</td>
</tr>
<tr>
<td>n urine_sow</td>
<td>Daily urine of sow</td>
<td>l/head/day</td>
<td>3.2</td>
<td>0.4</td>
</tr>
<tr>
<td>aN urine_porker</td>
<td>Nitrogen load in porker' urine</td>
<td>g/l</td>
<td>3.7</td>
<td>0.0</td>
</tr>
<tr>
<td>aN urine_sow</td>
<td>Nitrogen load in sow' urine</td>
<td>g/l</td>
<td>7.4</td>
<td>0.0</td>
</tr>
<tr>
<td>n wastewater_porker</td>
<td>Daily wastewater of porker</td>
<td>l/head/day</td>
<td>20.5</td>
<td>9.6</td>
</tr>
<tr>
<td>n wastewater_sow</td>
<td>Daily wastewater of sow</td>
<td>l/head/day</td>
<td>21.7</td>
<td>2.8</td>
</tr>
<tr>
<td>aN wastewater_porker</td>
<td>Nitrogen load in porker' wastewater</td>
<td>g/l</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>aN wastewater_sow</td>
<td>Nitrogen load in sow' wastewater</td>
<td>g/l</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>rN emis_pig man</td>
<td>Ratio of N gas losses to N manure pigs</td>
<td></td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Y pork</td>
<td>Yield of porker</td>
<td>kg/head</td>
<td>123.3</td>
<td>11.6</td>
</tr>
<tr>
<td>CN pork</td>
<td>Nitrogen content in pork</td>
<td>gN/kg meat</td>
<td>26.0</td>
<td>0.0</td>
</tr>
<tr>
<td>N piglet</td>
<td>Number of piglet</td>
<td>No/head</td>
<td>12.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Weight of pitlet</td>
<td>Weight of pitlet</td>
<td>kg</td>
<td>7.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Table 13: Parameters and equations for estimating nitrogen flow in pig production

<table>
<thead>
<tr>
<th>Flow</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Balance equation</strong></td>
<td>Porker $\text{IN}<em>{\text{porker}} - (\text{OUT}</em>{1} + \text{OUT}<em>{2} + \text{OUT}</em>{3} + \text{OUT}<em>{4} + \text{OUT}</em>{5})$</td>
</tr>
<tr>
<td></td>
<td>Sow $\text{IN}<em>{\text{sow}} - (\text{OUT}</em>{6} + \text{OUT}<em>{7} + \text{OUT}</em>{8} + \text{OUT}<em>{9} + \text{OUT}</em>{10})$</td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td>IN_porker $a \text{feed}<em>{\text{porker}} \times d</em>{\text{porker}} \times CN_{\text{feed}_{\text{pig}}}$</td>
</tr>
<tr>
<td></td>
<td>IN_sow $a \text{feed}<em>{\text{sow}} \times d</em>{\text{sow}} \times CN_{\text{feed}_{\text{pig}}}$</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>OUT_porker 1 $n \text{man}<em>{\text{porker}} \times d</em>{\text{porker}} \times aN_{\text{man}_{\text{porker}}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_porker 2 $n \text{urine}<em>{\text{porker}} \times d</em>{\text{porker}} \times aN_{\text{urine}_{\text{porker}}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_porker 3 $n \text{wastewater}<em>{\text{porker}} \times d</em>{\text{porker}} \times aN_{\text{wastewater}_{\text{porker}}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_porker 4 $n \text{man}<em>{\text{porker}} \times aN</em>{\text{man}<em>{\text{porker}}} \times d</em>{\text{porker}} \times rN_{\text{emis}<em>{\text{pig}}}</em>{\text{man}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_porker 5 $Y_{\text{pork}} \times CN_{\text{pork}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_sow 6 $n \text{man}<em>{\text{sow}} \times d</em>{\text{sow}} \times aN_{\text{man}_{\text{sow}}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_sow 7 $n \text{urine}<em>{\text{sow}} \times d</em>{\text{sow}} \times aN_{\text{urine}_{\text{sow}}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_sow 8 $n \text{wastewater}<em>{\text{sow}} \times d</em>{\text{sow}} \times aN_{\text{wastewater}_{\text{sow}}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_sow 9 $n \text{man}<em>{\text{sow}} \times d</em>{\text{sow}} \times aN_{\text{man}<em>{\text{sow}}} \times rN</em>{\text{emis}<em>{\text{pig}}}</em>{\text{man}}$</td>
</tr>
<tr>
<td></td>
<td>OUT_sow 10 $n \text{piglet} \times \text{weight of piglet} \times CN_{\text{piglet}}$</td>
</tr>
</tbody>
</table>
Key findings

• Recently, increase of pig population posed high pressure on treatment systems

• Almost effluents of treated wastewater from biogas digesters higher than the national standards

• Given newly established regulation (QCVN:62-MT:2016/BTNTM), the number of observed parameters remains only 6 (pH, BOD, COD, TN, Coliform, TSS).

• Farmer used so much water during a life cycle of pigs.