Sludge and Nutrient Assessment of Inactive Lagoons in NC

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Background

- Anaerobic lagoons are the dominant swine manure storage and treatment system
  - ~ 6,000 lagoons on 4,500 farms in NC
- Environmental Issues
  - Lagoon ruptures
  - Seepage
  - Emissions (Odors, NH₃, H₂S)
  - Inactive lagoons
Objectives

• To evaluate the risk of inactive swine lagoons on the environment:
  – Estimate the volume of sludge in lagoons of various ages
  – Assess of concentration of supernatant and sludge
  – Estimate the cost and land required to land apply lagoon contents at agronomic rates
Sampling Methods

• 30 Inactive swine lagoons
  – Johnson and Greene counties, NC
  – single cell lagoons
  – no manure or waste inputs since depopulation
  – no sludge removal, while active or inactive

• Lagoon dimensions

• Supernatant and sludge volume

• Sludge and supernatant concentration
## Lagoon Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Acres</th>
<th>Supernatant</th>
<th>Sludge</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>0.66</td>
<td>561,000</td>
<td>535,000</td>
<td>1,096,000</td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>0.21</td>
<td>39,000</td>
<td>29,000</td>
<td>207,000</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>2.51</td>
<td>1,670,000</td>
<td>2,481,000</td>
<td>3,594,000</td>
</tr>
</tbody>
</table>
Sludge Volume vs. Years Active

![Graph showing sludge volume versus years active.]
Sludge Volume vs. Years Inactive

![Graph showing the relationship between sludge volume and years inactive.](image-url)
Sludge Volume

- Wide variation of sludge volume from lagoons of similar years in production and years since depopulation
- No statistically significant reduction in sludge volume as the lagoon sits inactive
- Average sludge volume per square foot should not be used due to the high variability of data
## Supernatant Concentration

Average Concentrations as mg/l

<table>
<thead>
<tr>
<th></th>
<th>Inactive</th>
<th>Active Lagoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH$_3$-N</td>
<td>4</td>
<td>456</td>
</tr>
<tr>
<td>TN</td>
<td>34</td>
<td>563</td>
</tr>
<tr>
<td>P$_2$O$_5$</td>
<td>36</td>
<td>98</td>
</tr>
<tr>
<td>K</td>
<td>47</td>
<td>484</td>
</tr>
<tr>
<td>Cu</td>
<td>0.63</td>
<td>1.18</td>
</tr>
<tr>
<td>Zn</td>
<td>1.5</td>
<td>3.1</td>
</tr>
</tbody>
</table>
# Sludge Concentration

Average Concentrations as mg/l

<table>
<thead>
<tr>
<th></th>
<th>Inactive</th>
<th>Active Lagoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH$_3$-N</td>
<td>161</td>
<td>710</td>
</tr>
<tr>
<td>TN</td>
<td>2676</td>
<td>2925</td>
</tr>
<tr>
<td>P$_2$O$_5$</td>
<td>1545</td>
<td>6296</td>
</tr>
<tr>
<td>K</td>
<td>162</td>
<td>781</td>
</tr>
<tr>
<td>Cu</td>
<td>140</td>
<td>36</td>
</tr>
<tr>
<td>Zn</td>
<td>140</td>
<td>95</td>
</tr>
</tbody>
</table>
Sludge Removal
Sludge Removal

- **NC**: $0.01 to $0.035/gal.
  - As high as $0.05/gal
  - **NCAGSP**: $42,000/ac

- **30 Inactive lagoons**
  - Average cost of $11,000 - $55,000 ($0.01 - $0.05/gal)
    - @ $0.01/gal - 8 lagoons > $15,000 to remove
    - @ $0.05/gal - 10 lagoons > $70,000 to remove
Land Application

• Crops
  – Corn       100 bu./ac  1.25#-PAN/ac  0.35#PAP/ac
  – Wheat      50 bu./ac   2.40#-PAN/ac  0.63#PAP/ac
  – Soybeans   35 bu./ac   4.00#-PAN/ac  0.82#PAP/ac

• PAN = 0.5 (TKN-NH$_3$-N) + 0.6 (NH$_3$-N) + NO$_3$-N (irrigate)
• PAN = 0.5 (TKN-NH$_3$-N) + 0.9 (NH$_3$-N) + NO$_3$-N (incorporate)
• PAP = 1.1 $P_2O_5$
# Land Application

Average acres required; ( ) = Average of 4 highest

<table>
<thead>
<tr>
<th></th>
<th>N (irrigate)</th>
<th>N (incorporate)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>68.0 (320)</td>
<td>73.3 (334)</td>
<td>252.6 (1124)</td>
</tr>
<tr>
<td>Wheat</td>
<td>70.8 (321)</td>
<td>76.4 (348)</td>
<td>282.9 (1260)</td>
</tr>
<tr>
<td>Soybeans</td>
<td>60.7 (286)</td>
<td>65.5 (298)</td>
<td>308.0 (1372)</td>
</tr>
</tbody>
</table>
Conclusion

- Cost and land requirement dominated buy the volume and concentration of lagoon sludge
- Sludge volume is highly variable
- No statistically significant evidence of natural reductions in sludge volume
Conclusion

• Due to variability of sludge volume, average values reported here should not be used for making agronomic recommendations

• Lagoons sludge volumes as well as supernatant and sludge samples should be collected and analyzed prior to sludge removal or application