Liquid Swine Manure Nutrient Utilization Project

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Liquid Swine Manure Nutrient Utilization Project

Field Demonstration Objectives:

- Work with producers to implement manure strip application demonstrations
- Calibrate liquid swine manure application
- Document manure nutrient content, variability, and intended vs. applied nutrients
- Document crop productivity based on liquid swine manure N and P
- Compare manure nutrient availability to fertilizer N and P
- Monitor agronomic and environmental soil test P
Methods and Demonstration Activities

- **2000-2003**
  - 46 sites and 16 cooperators

- **Pre-sample manure**
  - Swine finishing facilities
  - Under-building pit or outdoor cement tank (2)
  - Dip from surface or probe depth

- **Multiple manure samples during application**
  - Pits stirred during application

- **Calibrate applicator**
  - Weight, speed, flow/rate monitor
Methods and Demonstration Activities

- Replicated manure strips applied to corn and soybean
  - None, Low, and High manure rates
  - Residual-year corn following prior application
- Fall and spring injected manure
  - Except Clay sites where manure broadcast-incorporated next day
Methods and Demonstration Activities

- Fertilizer rate plots superimposed on each manure rate strip
  - 0, 40, 80, 120 lb N/acre (corn-soybean)
  - 0, 60, 120, 180 lb N/acre (corn-corn)
    - Blanket fertilizer applied to mask manure P and K
  - 0, 20, 40, 60 lb P$_2$O$_5$/acre
    - Blanket fertilizer applied to mask manure N and K

- Yield, routine soil tests, environmental P tests, soil nitrate, leaf greenness, cornstalk nitrate, post-harvest profile nitrate, aerial images
Pre-Application and At-Application Manure Analyses

Liquid Swine Manure Sample Analyses

Site Average Presample Minus At Application
Total N: -4.6%
Total P$_2$O$_5$: -9.1%
Total K$_2$O: 0.4%

Liquid Swine Manure Nutrient Utilization Project, Iowa State Univ., 2004
Liquid Swine Manure
Intended Rate versus Applied Rate

Analysis – Calibration – Application

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Intended Manure Nutrient Application Rate

Frequency Distribution
Percent of Intended Liquid Swine Manure Rate

Number of Site Applications

Percent of Intended Rate As Applied (Based on Total N or P$_2$O$_5$)

50 Applications

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**Liquid Swine Manure Sample Analyses**

**Average Site Analysis, lb N, P\(_2\)O\(_5\) or K\(_2\)O/1,000 gal**

- **Total N**: 53 lb total N/1000 gal
- **Total P**: 33 lb total P\(_2\)O\(_5\)/1000 gal
- **Total K**: 34 lb total K\(_2\)O/1000 gal
- **N:P\(_2\)O\(_5\) ratio**: 1.62

**At-Application Manure Nutrient Analyses**

- **All Site Average**
  - N: 53 lb total N/1000 gal
  - P: 33 lb total P\(_2\)O\(_5\)/1000 gal
  - K: 34 lb total K\(_2\)O/1000 gal
  - N:P\(_2\)O\(_5\) ratio: 1.62
Ammonium-N in Liquid Swine Manure

<table>
<thead>
<tr>
<th></th>
<th>Total-N</th>
<th>NH$_4$-N</th>
<th>Fraction NH$_4$-N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>6,360</td>
<td>5,267</td>
<td>83.6%</td>
</tr>
<tr>
<td><strong>Std Dev</strong></td>
<td>1,335</td>
<td>1,189</td>
<td>13%</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Wet Fields, No Problem

April 1 Edition, Lancaster Farming (PA)
Ahead or Behind Technology?

Elephant Powered
McCormick-Deering Archive
Corn Strip Yield Response to Liquid Swine Manure

- Yield increase could be due to N, P, K, or other component since all contained in the manure
- However, due to soil test levels, most increase expected from manure-N (Average: Low - 84 and High - 176 lb total N/acre)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Manure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>14 C-S</td>
<td>25</td>
</tr>
<tr>
<td>4 C-C</td>
<td>37</td>
</tr>
<tr>
<td>All</td>
<td>28</td>
</tr>
<tr>
<td>2000-2003</td>
<td></td>
</tr>
</tbody>
</table>
**Corn Yield Response to Swine Manure and Additional Fertilizer N**

<table>
<thead>
<tr>
<th>Year</th>
<th>None</th>
<th>Low Swine Manure Rate</th>
<th>High Swine Manure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Inc. to N</td>
<td>ppm</td>
<td>Total N</td>
</tr>
<tr>
<td>2000</td>
<td>31</td>
<td>12</td>
<td>77</td>
</tr>
<tr>
<td>2001</td>
<td>42</td>
<td>9</td>
<td>87</td>
</tr>
<tr>
<td>2002</td>
<td>72</td>
<td>7</td>
<td>88</td>
</tr>
<tr>
<td>2000-03</td>
<td>43</td>
<td>10</td>
<td>84</td>
</tr>
</tbody>
</table>

w/out Plymouth 2000 site; 2000-2003 16 sites.
Corn Response to Liquid Swine Manure and Fertilizer N
Mean of Five C-S Sites – 2000-2001

- Yield (bu/acre)
- Relative SPAD, %
- Stalk Nitrate (ppm)

Yield

- No Manure
- 80 lb Total-N/acre
- 154 lb Total-N/acre

Relative SPAD, %

Fertilizer N Rate (lb N/acre)

Stalk Nitrate (ppm)
Soil Nitrate

Corn Yield Increase to Fertilizer N and Liquid Swine Manure Rate
2000 - 2003

Corn Yield Increase (bu/acre)

LSNT (ppm)

None
Low
High

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Change in Soil Nitrate

Soil Nitrate Increase with Liquid Swine Manure and Fertilizer Rate
2000 - 2003

-10 0 10 20 30 40 50 60

LSNT Increase (ppm)

Low Manure
High Manure
Fertilizer - N
Fertilizer - L
Fertilizer - H

Applied Manure or Fertilizer N
(lb N/acre)
Manure Application to Soybean

- Reasons to consider applying liquid swine manure to soybean
  - Low P and K soil tests
  - Maintain surface residue cover for soil conservation and limiting P runoff
  - Allows access to more crop land for manure application
  - Wider window for spring manure application
  - Potential to increase soybean yield even in soils with adequate P and K
<table>
<thead>
<tr>
<th>Site-Year</th>
<th>Swine Manure Application</th>
<th>Manure Total-N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td><strong>2000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>48</td>
<td>49</td>
</tr>
<tr>
<td>Webster</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>Hardin</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td><strong>2001</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>47</td>
<td>51</td>
</tr>
<tr>
<td>Washington</td>
<td>49</td>
<td>51</td>
</tr>
<tr>
<td><strong>2002</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floyd</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Hamilton</td>
<td>55</td>
<td>56</td>
</tr>
<tr>
<td>Washington</td>
<td>58</td>
<td>65*</td>
</tr>
</tbody>
</table>

* Yield response to liquid swine manure significant ($P \leq 0.05$).
## Liquid Swine Manure Application to Soybean Post-harvest 0-4 ft Profile Soil Nitrate

**Eight Site Mean, 2000-2002**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Liquid Swine Manure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>ft</td>
<td>ppm  Nitrate-N ppm</td>
</tr>
<tr>
<td>0-1</td>
<td>7</td>
</tr>
<tr>
<td>1-2</td>
<td>3</td>
</tr>
<tr>
<td>2-3</td>
<td>2</td>
</tr>
<tr>
<td>3-4</td>
<td>3</td>
</tr>
</tbody>
</table>

**Profile lb/acre**

- 60
- 72
- 76

Manure applied preplant either in fall or spring before soybean planting.
Residual-Year Corn Yield Increase at Seven Sites Following Swine Manure Application to Soybean

Yield Increase to Fertilizer N

<table>
<thead>
<tr>
<th>Fertilizer N Rate, lb N/acre</th>
<th>None</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>20</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>80</td>
<td>40</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td>120</td>
<td>50</td>
<td>56</td>
<td>60</td>
</tr>
</tbody>
</table>

Leland Swine Manure Nutrient Utilization Project, Iowa State Univ., 2004
## Response to Residual Liquid Swine Manure and Additional Fertilizer-N: Corn after Soybean

### Mean Response -- Corn After Soybean Residual Sites

<table>
<thead>
<tr>
<th>Year</th>
<th>None</th>
<th>Low Swine Manure Rate</th>
<th>High Swine Manure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Inc. to N LSNT</td>
<td>Yield Inc. to N LSNT</td>
<td>Yield Inc. to N LSNT</td>
</tr>
<tr>
<td></td>
<td>bu/acre ppm</td>
<td>lb N/acre bu/acre ppm</td>
<td>lb N/acre bu/acre ppm</td>
</tr>
<tr>
<td>2001-03</td>
<td>51 7</td>
<td>114 49 7</td>
<td>221 50 7</td>
</tr>
</tbody>
</table>

Manure Total-N applied before the prior year soybean crop; 7 sites.
Summary

- Use pre-application manure sample lab analysis and analysis history
- Calibrate application equipment
  - Consider using flow monitors and rate controllers
- Work with N, P, K application rate and not just gallons per acre
  - Know the manure nutrient analysis
- Liquid swine manure N is highly crop available
  - Use total manure N to base application rate
Summary

- Managing liquid swine manure N is similar to managing fertilizer N
  - Needed N rates
  - Effects of climatic conditions
- For soybean, limit application to total-N rate that would be applied to a corn crop following soybean
- Account for manure P and K application
- Using liquid swine manure as a reliable nutrient source takes effort, but can be done
Thank you to the many cooperators, businesses, and individuals who helped make the project a success.

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  - Iowa Department of Agriculture
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  - USDA – Iowa NRCS
  - Leopold Center for Sustainable Agriculture