Manure: An ancient fertilizer in a precision age

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@DrManure
Nitrogen - 2016
What’s Manure Worth

- Typical Swine Finishing Manure – Deep Pit
  - 60-25-30 pounds N, P2O5, K2O per 1000 gallons

- Ammonia - $0.29/lb N
- MAP - $0.43/lb P2O5
- Potash - $0.28/lb K2O

- About $36 worth of nutrient value per 1000 gallons
Manure Value – Varied Greatly
Lots of Potential Value

• But are we capturing that value?
  – Getting it to the right field
  – At the right amount
  – At the right time
  – Right way?
  – Minimizing losses of N before and as we apply?

  – Other aspects of protecting water quality
How do we collect value of manure?

- **Need to use the nutrients!**
  - This means getting it to fields where all the nutrients (N, P, K) are needed

<table>
<thead>
<tr>
<th>Break Even Hauling Distance</th>
<th>Swine Slurry</th>
<th>Dairy Slurry</th>
<th>Beef Solids</th>
<th>Layer Manure</th>
<th>Turkey Litter</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Nutrients</td>
<td>12 (5-20)</td>
<td>8 (2-13)</td>
<td>14 (9-20)</td>
<td>25 (16-34)</td>
<td>16 (13-19)</td>
</tr>
<tr>
<td>N Only</td>
<td>1 (0-4)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (0-3)</td>
<td>2 (1-2)</td>
</tr>
<tr>
<td>P &amp; K Only</td>
<td>5 (0-10)</td>
<td>6 (2-11)</td>
<td>11 (8-13)</td>
<td>21 (13-28)</td>
<td>11 (9-13)</td>
</tr>
</tbody>
</table>
How far can we haul?

• $0.02 per gallon to apply
• $0.001 per gallon per mile to haul
• (these numbers are approximate)

• $36 worth of value ($14 from nitrogen)

• About $20 to apply 1000 gallons
• How far can you afford to haul for $16 dollars?
Is P Level Getting too low?

• Corn-Soybean Rotation
  – Want about 150 lbs N to 100 lbs P2O5 (3:2)

• Corn-Corn Rotation
  – Want about 200 lbs N to 50 lbs P2O5 (4:1)

• Average Swine Manure
  – Have about 50 lbs N to 35 lbs P2O5 (3:2)

• Low P Swine Manure
  – Have about 50 lbs N to 15 lbs P2O5 (3:1)
Broadcast 100 lb P$_2$O$_5$/a to Soybean Residue With or Without Incorporation Averages of Two Fields

Source, Runoff Timing, and Incorporation

Runoff P Loss (kg ha$^{-1}$)

- No P
- Poultry Manure
- Liquid Swine Manure
- Fertilizer

24-hr Event, Not Incorporated

<table>
<thead>
<tr>
<th>Source</th>
<th>Runoff P Loss</th>
<th>Dissolved P</th>
<th>Total P</th>
<th>DRP % of TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P</td>
<td>21%</td>
<td>5%</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Poultry Manure</td>
<td>57%</td>
<td>20%</td>
<td>20%</td>
<td>47%</td>
</tr>
<tr>
<td>Liquid Swine Manure</td>
<td>68%</td>
<td>47%</td>
<td>47%</td>
<td>69%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>52%</td>
<td>52%</td>
<td>52%</td>
<td>63%</td>
</tr>
</tbody>
</table>

24-hr Event, Incorporated

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<th>Runoff P Loss</th>
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<th>Total P</th>
<th>DRP % of TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Poultry Manure</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>47%</td>
</tr>
<tr>
<td>Liquid Swine Manure</td>
<td>47%</td>
<td>47%</td>
<td>47%</td>
<td>69%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>52%</td>
<td>52%</td>
<td>52%</td>
<td>63%</td>
</tr>
</tbody>
</table>

10-day Event, Not Incorporated

<table>
<thead>
<tr>
<th>Source</th>
<th>Runoff P Loss</th>
<th>Dissolved P</th>
<th>Total P</th>
<th>DRP % of TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P</td>
<td>11%</td>
<td>5%</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Poultry Manure</td>
<td>47%</td>
<td>20%</td>
<td>20%</td>
<td>47%</td>
</tr>
<tr>
<td>Liquid Swine Manure</td>
<td>69%</td>
<td>69%</td>
<td>69%</td>
<td>69%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>63%</td>
<td>63%</td>
<td>63%</td>
<td>63%</td>
</tr>
</tbody>
</table>

Allen, Haq, & Mallarino, ISU
Timing and N-Management

• Nitrogen is a complex beast
  – Availability
  – Loss
  – Timing
  – Weather

There is lots going on, and every year is a little different, but.. we’ll take a look at the big picture issues.
Rate

• Yield Goal vs MRTN
  – Yield Goal Method – Based on historic yield times a nitrogen need factor
    • (method outlined in manure management plans)
  – MRTN – economic optimum rate based on yield response trials
    • ISU recommended approach
    • Based on spring application rate
Rates and Charts

State: Iowa
Region: Main
Number of sites: 219
Rotation: Corn Following Soybean

Nitrogen Price ($/lb): 0.29
Corn Price ($/bu): 3.50
Price Ratio: 0.08
MRTN Rate (lb N/acre): 145
Profitable N Rate Range (lb N/acre): 131 - 160
Net Return to N at MRTN Rate ($/acre): $193.14
Percent of Maximum Yield at MRTN Rate: 99%
Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre): 176
Anhydrous Ammonia (82% N) Cost at MRTN Rate ($/acre): $42.05

Return to N

N Rate, lb N/acre

Gross Return to N
Net Return to N
Fertilizer N Cost
MRTN at 145 lb N/acre
Injection

- Want 134 lbs N/acre
- Swine manure, 60 lb/1000 gallons, 95% available
- Surface App: 25% volatilized, 3150 gallons per acre, about $30 application cost
- Inject: 1% volatilized, 2400 gallons an acre, about $48 application cost
- Surface application used ~$18 worth of extra N
Manure Injection
In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, some nitrate is lost to waterways.
The science of 50-degrees and cooling
# Corn Grain Yield – LSM Timing

<table>
<thead>
<tr>
<th>Application</th>
<th>N Source</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>3-year Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 1</td>
<td>AA</td>
<td>214</td>
<td>209</td>
<td>195</td>
<td>206a</td>
</tr>
<tr>
<td>Oct. 1</td>
<td>LSM</td>
<td>185</td>
<td>191</td>
<td>173</td>
<td>183c</td>
</tr>
<tr>
<td>Nov. 1</td>
<td>AA</td>
<td>211</td>
<td>204</td>
<td>192</td>
<td>202a</td>
</tr>
<tr>
<td>Nov. 1</td>
<td>LSM</td>
<td>192</td>
<td>209</td>
<td>179</td>
<td>193b</td>
</tr>
</tbody>
</table>

**Main Effect of Timing**

<table>
<thead>
<tr>
<th>Timing</th>
<th>200</th>
<th>200</th>
<th>184</th>
<th>195</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov. 1</td>
<td>202</td>
<td>206</td>
<td>185</td>
<td>198</td>
</tr>
</tbody>
</table>

**Main Effect of N Source**

<table>
<thead>
<tr>
<th>Source</th>
<th>212a</th>
<th>206</th>
<th>193a</th>
<th>204a</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSM</td>
<td>189b</td>
<td>200</td>
<td>176b</td>
<td>188b</td>
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</tbody>
</table>

**Control**

<table>
<thead>
<tr>
<th></th>
<th>120</th>
<th>128</th>
<th>108</th>
<th>119</th>
</tr>
</thead>
</table>

**Timing x Source (p>F)**

<table>
<thead>
<tr>
<th></th>
<th>0.408</th>
<th>0.132</th>
<th>0.483</th>
<th>0.060</th>
</tr>
</thead>
</table>

Letters indicate significant difference at p = 0.10.


J.E. Sawyer, Iowa State Univ.
• Manure Timing Data – Yield Impact
  – Nashua ~ 30 bushel/acre
  – Ames ~10 bushel/acre

  – Let’s say average is around 20 bushel/acre

  – 20 bushel/acre x $3/bushel = $60/acre

  – What does manure application cost?
Choosing a cover crop

• Easy entry points
  – Corn silage
  – Seed corn production

• Focus areas
  – Erosion-prone
  – Low organic matter
Choosing a cover crop

- Species options
  - Grasses
    - Smalls grains or Annual ryegrass
  - Brassicas
  - Legumes
  - Others

- Considerations
  - GOALS
  - Time/method of seeding
  - Herbicides used
  - Cost
Seeding into a standing crop

Photos by Brian Lang and Mark Licht
Drilling after crop removal

Photos by Meaghan Anderson and Elyssa McFarland
Manure application with cover crops

Photos by Steve Berger and Dan Andersen
Summary

• Look for cover crop opportunities
• Start small and simple
  – Cereal rye or oats, other proven choices
• Consider other factors – seeding options, herbicide residues, manure application
• Terminate early and use best management practices
What’s new in manure application equipment?
Figure 1. Diagram of on board control system used to set and control manure application rate
Figure 2. Dragline or tank-mounted manifold for distribution of liquid manure to tool-bar points.
Problem Statement

• Producer confidence in manure nutrient availability

• Poor distribution can lead one to believe that manure nutrients are not available leading to a decision for supplemental nutrients to be applied

• Need to verify distribution from a manifold
Low Distribution Variability

Photograph of low variability
What’s this mean to me?

<table>
<thead>
<tr>
<th>Knife #</th>
<th>N Application (lb N/acre)</th>
<th>N Application (lb N/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>135</td>
<td>160</td>
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<td>3</td>
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<td>4</td>
<td>210</td>
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<td>6</td>
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<td>120</td>
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<tr>
<td>8</td>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>Ave.</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>SDev.</td>
<td>53</td>
<td>15</td>
</tr>
<tr>
<td>COV</td>
<td>35</td>
<td>10</td>
</tr>
</tbody>
</table>
But what’s the impact?

<table>
<thead>
<tr>
<th>Knife #</th>
<th>Corn Yield (CS) (bu/acre)</th>
<th>Corn Yield (CS) (bu/acre)</th>
<th>Corn Yield (CC) (bu/acre)</th>
<th>Corn Yield (CC) (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>187</td>
<td>194</td>
<td>162</td>
<td>179</td>
</tr>
<tr>
<td>2</td>
<td>193</td>
<td>195</td>
<td>175</td>
<td>182</td>
</tr>
<tr>
<td>3</td>
<td>196</td>
<td>196</td>
<td>183</td>
<td>184</td>
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<tr>
<td>4</td>
<td>198</td>
<td>195</td>
<td>190</td>
<td>182</td>
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<tr>
<td>5</td>
<td>198</td>
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<tr>
<td>6</td>
<td>197</td>
<td>193</td>
<td>186</td>
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<tr>
<td>7</td>
<td>191</td>
<td>191</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>8</td>
<td>178</td>
<td>194</td>
<td>146</td>
<td>179</td>
</tr>
<tr>
<td>Average</td>
<td><strong>192</strong></td>
<td><strong>194</strong></td>
<td><strong>175</strong></td>
<td><strong>179</strong></td>
</tr>
</tbody>
</table>
Distribution Variability

• High total nitrogen manure analytical results
  – 70 lbs / 1,000 gallons

• Maximum Return to Nitrogen Rate Calculator
  – Nitrogen to Corn Price Ratio = 0.08
  – Nitrogen Rate = 141 lb/ac ±10%

• Can the variability of manure distribution be 10%?
Verifying a Manifold
Verifying a Manifold

• Drive speed – 5 miles per hour
• Knife spacing – 30 inches
• Discharge hoses attached to a common beam for uniform collection
• 15 second time interval
• Slope setting of 0, 3, and 6 percent
• Uniform test methods across all measurements
Manifold 1 - Crescent Moon

- CV - 0 % Slope
- CV - 3 % Slope
- CV - 6 % Slope

Coefficient of Variation, percent

Application Rate, gallons per acre
Manifold 2 - Outlets on Full Circumference

- CV - 0 % Slope
- CV - 3 % Slope
- CV - 6 % Slope

Coefficient of Variation, percent

Application Rate, gallons per acre

- CV - 0 % Slope
- CV - 3 % Slope
- CV - 6 % Slope
Manifold 4 - Inverted Outlets

Coefficient of Variation, percent

- CV - 0% Slope
- CV - 3% Slope
- CV - 6% Slope

Application Rate, gallons per acre

1000 2000 3000 4000 5000 6000
Manifold 4 - Inverted Outlets

Coefficient of Variation, percent

- CV - 0% Slope
- CV - 3% Slope
- CV - 6% Slope

Application Rate, gallons per acre

1000 2000 3000 4000 5000 6000
Conclusions

• Caution to use results for high viscosity manures
• The results did not show a direct correlation between increase in slope and change in coefficient of variation. Change in slope did effect the coefficient of variation in case of certain manifolds.
• Eliminate any loops in the discharge hoses connected with the manifold outlets
• Any air vents provided on the manifold outlets need to be clean and functioning
• Coefficient of Variation can be managed to a certain extent by increase in drive speed or increasing knife spacing
Healthy Soils

- Tilth
- Water holding capacity
- Hydraulic conductivity
- Erosion resistance

Healthy SOILS store CARBON. Depleted soils CANNOT be "CLIMATE-SMART." Take CARE of your soils so they take care of YOU.
Soil Heath

• Soil Health Means Carbon
  – Feed soil microbes
  – Holds nutrients
  – Stabilizes soil aggregates
The inter-particle space (voids) is filled with either water or air. The amount of voids depends upon the soil texture and the soil condition (ie. tilled, compacted, etc.).
12% of Organic Carbon in Manure becomes soil organic matter.

This is true for all manure types.