Verifying Liquid Manure
Hydraulic Distribution

Daniel Andersen, Iowa State University
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
Area – Volume Calibration

- Calibrate to ensure manifold chamber is exposed to appropriate flow rate
- Know volume over a measured area
- AE 3601 (Revised version of PM 1948)
- Alternatively, convert application rate to flow rate, capture volume of liquid that is input into the manifold chamber over a known time
Distribution Variability

• How poor can this variability be?
• For low application rates, the manifold chamber is typically not pressurized
• Flow momentum and direction can potentially lead to variability
• Can some outlets not be discharging while others are discharging twice or three times the amount?
What’s this mean to me?

![Graph showing percent of maximum yield against N rate (lb N/acre)]

<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>
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<td>150</td>
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<tr>
<td>Average</td>
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<td>150</td>
</tr>
<tr>
<td>St. Dev.</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>
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<td>1</td>
<td>187</td>
<td>194</td>
<td>162</td>
<td>179</td>
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<td>193</td>
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<td>8</td>
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<tr>
<td>Average</td>
<td>192</td>
<td>194</td>
<td>175</td>
<td>179</td>
</tr>
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</table>
Distribution Variability

- Why operate manifolds at low application rates?
- Split application
- Manure application to soybeans
- High total nitrogen manure analytical results
- Maximum Return to Nitrogen Rate Calculator
<table>
<thead>
<tr>
<th>ANALYTE</th>
<th>ACTUAL ANALYSIS</th>
<th>TOTAL NUTRIENTS</th>
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</thead>
<tbody>
<tr>
<td>Moisture, Total</td>
<td>90.6 %</td>
<td>76.0 lbs/1000 Gal</td>
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<tr>
<td>Nitrogen, Total</td>
<td>0.91 %</td>
<td>36.7 lbs/1000 Gal</td>
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<tr>
<td>Phosphorus</td>
<td>0.44 % as P2O5</td>
<td>40.1 lbs/1000 Gal</td>
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<tr>
<td>Potassium</td>
<td>0.48 % as K2O</td>
<td>13.1 lbs/1000 Gal</td>
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<tr>
<td>Sulfur</td>
<td>1560 ppm</td>
<td>0.93 lbs/1000 Gal</td>
</tr>
<tr>
<td>Zinc</td>
<td>111 ppm</td>
<td></td>
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</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 Testing Results

• Each manifold has different configuration
• Inlet size and location
• Manifold chamber size
• Outlet size, location, and number
• Each manifold has its own performance capabilities
• Some may be better suited for lower application rates while others for higher
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

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 3 - Outlets on 2/3 Circumference

Coefficient of Variation, percent

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

Application Rate, gallons per acre

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
Manifold 6 - Coupled Outlets

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

Coefficient of Variation, percent

Application Rate, gallons per acre
Manifold 7 - 24-outlets on Circumference

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

Coefficient of Variation, percent

Application Rate, gallons per acre
Manifold 8 - Rectangular Box on a Cylindrical Drum

Coefficient of Variation, percent

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

Application Rate, gallons per acre

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

• Caution to use results for high viscosity manures
• Two of the six tested manifolds produced coefficient of variation below 10% for all three slope settings at the average application rates of 2,000 to 6,000 gallons per acre
• Three additional manifolds produced coefficient of variation around 20% or lower for all three slope settings at the average application rates of 1,000 to 6,000 gallons per acre
• Caution should be exercised to select the appropriate manifold
Conclusions

- 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