Nutrient Management in Crop Production

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University Extension
Focus On Agriculture

- **Water Quality**
  - Hypoxia
  - Pfiesteria piscicida
  - Nitrate
  - Tile Flow
  - Sediment
  - TMDL
  - Community Water Systems Monitoring & Reporting

- **Farm Focus**
  - Source Water Protection
  - Upstream Partners
  - Watersheds
  - Wetlands
  - Buffer Strips
  - Manure Regulations
  - CAFO
  - Nutrient Management
Focus On Agriculture

Nutrient Issues Related to Water Quality

- Surface Water
  - Sediment, Nitrate, Phosphorus
- Groundwater
  - Nitrate
Focus On Agriculture

Crossroads, T-Junction, or Straightaway

Which Way Are You Going?
Focus On Agriculture

- Opportunities
  - CCA and MOU
  - Assist Farmers
  - Improve Water Quality
  - Management of Expensive / Limited Resources
    - Nitrogen
    - Phosphorus
    - Soil
Focus On Agriculture

Challenges

- Nutrient Management Planning
  - What’s new?
    - CAFO
    - Manure Management Plans
    - Soil Conservation Requirements
  - The Key Focus
    - Crop Nutrient Needs
    - Nutrient Distribution / Allocation
      - Long-Term Input / Output Balance
      - Country - Region - Watershed - Field
Integrated P & N Management

Combining P and N indices illustrates different management objectives over the watershed.

Sharpley, Gburek, USDA-ARS, Beegle, Penn State, University Park, PA
Example Field - Soil Test P

Bray P-1, ppm
- < 10
- 10 - 20
- 20 - 25
- 25 - 40
- > 40
Annual Nitrogen Usage In Iowa

Year
N Use, million ton
Annual Phosphorus Usage In Iowa

P$_2$O$_5$ Use, million ton

Year

Annual Soybean Yield In Iowa

Soybean Yield, bu/acre vs Year
Nutrient Basics

- Profitable crop production does require adequate soil nutrient levels or adequate fertilization when soil tests are deficient
- Fertilization at rates greater than crop need does influence soil test and yield of subsequent crops
- Crop production is a soil nutrient depleting activity
Fundamental Diminishing Returns

Fertilizing for Maximum Profit

Costs or Returns, $/acre

Profit

Fertilizer Cost

Non Fertilizer Costs (land, seed, tillage, etc.)

Fertilizer Rate for Maximum Profit/acre

Fertilizer Applied, lb/acre
### Plant Available Nutrients Excreted by Livestock in Iowa, 1990

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number of Animals&lt;sup&gt;a&lt;/sup&gt; (x 1,000)</th>
<th>Available Nutrients&lt;sup&gt;b&lt;/sup&gt; Tons</th>
<th>N</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef (500 lb)</td>
<td>1,347</td>
<td></td>
<td>20,879</td>
<td>21,451</td>
<td>35,696</td>
</tr>
<tr>
<td>Dairy (&gt;500 lb)</td>
<td>443</td>
<td></td>
<td>9,968</td>
<td>6,900</td>
<td>15,838</td>
</tr>
<tr>
<td>Breeding Hogs</td>
<td>1,680</td>
<td></td>
<td>6,300</td>
<td>6,762</td>
<td>10,080</td>
</tr>
<tr>
<td>Market Hogs</td>
<td>11,820</td>
<td></td>
<td>44,325</td>
<td>47,575</td>
<td>70,920</td>
</tr>
<tr>
<td>Chickens</td>
<td>11,900</td>
<td></td>
<td>1,413</td>
<td>1,416</td>
<td>1,280</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11,820</strong></td>
<td></td>
<td><strong>82,885</strong></td>
<td><strong>84,104</strong></td>
<td><strong>133,814</strong></td>
</tr>
<tr>
<td><strong>lb/corn acre</strong></td>
<td><strong>13</strong></td>
<td></td>
<td><strong>13</strong></td>
<td><strong>13</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup> From 1990 Crop and Livestock Reporting Service.

<sup>b</sup> Assuming that 50% of the nutrients are recoverable and that 50% of the N and P<sub>2</sub>O<sub>5</sub> and 100% of the K<sub>2</sub>O is available to plants the first year of application.
Plant Available Nutrients Excreted by Livestock in Iowa, 1990

- Value of N: $24,865,000
- Value of P$_2$O$_5$: $47,098,520
- Value of K$_2$O: $34,791,120

Note: Assuming all nutrient is needed for crop production; N at $0.15/lb, P$_2$O$_5$ at $0.28/lb and K$_2$O at $0.13/lb.
Example Value of Plant Available Nutrients In Liquid Swine Manure

- At 3,000 gallons/acre and an analysis of 50 lb N, 35 lb P$_2$O$_5$ and 25 lb K$_2$O/1000 gal

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 lb N</td>
<td>22.50</td>
</tr>
<tr>
<td>105 lb P$_2$O$_5$</td>
<td>29.40</td>
</tr>
<tr>
<td>75 lb K$_2$O</td>
<td>9.75</td>
</tr>
<tr>
<td>Total</td>
<td>61.65</td>
</tr>
</tbody>
</table>

Note: Assuming all nutrient is needed for crop production; N at $0.15/lb, P$_2$O$_5$ at $0.28/lb and K$_2$O at $0.13/lb.
Manure Management Goals

- Manure production
  - Keep it on site
  - Keep it in storage

- Manure application for crop production
  - Keep it in the field
  - Keep it in the soil
  - Keep it off / out of watercourses
  - Don’t over-apply / over-load nutrients
  - Have a Whole Farm Nutrient Plan
For 500,000 gallons of manure with a chemical analysis of 50 lb N, 35 lb P$_2$O$_5$, and 30 lb K$_2$O per 1,000 gallons. The total amount of manure in storage is:

- **N**: $50 \text{ lb} \times 500 = 25,000 \text{ lb N}$
- **P$_2$O$_5$**: $35 \text{ lb} \times 500 = 17,500 \text{ lb P}_2\text{O}_5$
- **K$_2$O**: $30 \text{ lb} \times 500 = 15,000 \text{ lb K}_2\text{O}$
Low Manure Intensity Farm
(Cash Crop)
Medium Manure Intensity Farm (Small to Medium Dairy)

- Fertilizer
- Feed
- Crop
- Manure
- Milk
High Manure Intensity Farm (Poultry/Swine)
Nutrient Planning

- Long-Term Management
- Whole-Farm Management
- Site-Specific
- Comprehensive Management
- Formal, Written, Implemented
- Database stored and driven
Components of A Plan (NRCS 590 Standard)

- Location / Photos
- Fields / Acres
- Resource Assessment
  - Proven Yield / Productivity
- Environmental Assessment
  - Soil Erosion Considerations
- Soil Test Results
- Nutrient Sources / Inventory
- Legume and Manure Credits
- Crops Nutrient Needs / Application Rates
- Nutrient Product / Timing / Placement
Nutrient Planning Importance to Farmers

- Maintain Profitability
- Maintain Viability
- Balance Long-Term and Short-Term Risks
- At the Same Time Be an Environmental Steward
Future Directions in Nutrient Management

- For Phosphorus and Potassium
  - Refinement of soil tests indexes
  - Environmental phosphorus issues
    - P Index or soil test P

- For Nitrogen
  - Less emphasis on fall N
  - More emphasis on rates
  - Assessing corn N needs by in-season measurement and application
Issues Related to Manure Nutrient Management

- Manure application to soils
  - Based on N or P?
  - Alfalfa and soybean crops
  - Manure nutrient variability

- Soil P loading
  - Low phytate - P grains
  - Phytase enzyme
  - Reduced inorganic P supplement
  - Solids separation
P Loading (N vs. P?)
P and K from Liquid Swine Manure Application

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Total Nutrients from Liquid Pit Swine Manure Based on the N Application Rate</th>
<th>Crop Nutrients in Grain Based on 55 bu Soybean and 150 bu Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/acre</td>
<td>lb/acre</td>
</tr>
<tr>
<td>N</td>
<td>150 200 225</td>
<td>200 135 335</td>
</tr>
<tr>
<td>P\textsubscript{2}O\textsubscript{5}</td>
<td>105 140 158</td>
<td>44 56 100</td>
</tr>
<tr>
<td>K\textsubscript{2}O</td>
<td>75 100 113</td>
<td>83 45 128</td>
</tr>
<tr>
<td>gal/acre</td>
<td>3,000 4,000 4,500</td>
<td></td>
</tr>
</tbody>
</table>

Using book values for swine grow-finish pit system: 50 - 35 - 25 lb/1,000gal