Overview

• In past
  • Chesapeake Bay
  • Oklahoma Sues Arkansas
  • City of Des Moines
• News is about Lake Erie
  • Was bad,
  • Then good
  • No bad again
    • The Problem
    • The Fix?
• Impact elsewhere
The Future will be either
How we Do Nitrogen – Corn

Option 1:
• Well, ____________ (fill in name) did it this way.

Option 2:
• What did ____________ (fill in name of guy down the road that grows good corn) do?
How N is done.

Figure 6. Frequency distribution of EONR (0.10 price ratio) for SC sites in Iowa.
<table>
<thead>
<tr>
<th>Source</th>
<th>Location</th>
<th>Years</th>
<th>Time period</th>
<th>† (O-N) Yield Range</th>
<th>+ High N Yield Range</th>
<th>*Optimum N rate kg ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundy et al. (2011)</td>
<td>WI</td>
<td>21</td>
<td>1958-1983</td>
<td>1.6-7.6</td>
<td>4.3-8.8</td>
<td>50</td>
</tr>
<tr>
<td>Bundy et al. (2011)</td>
<td>WI</td>
<td>9</td>
<td>1984-1997</td>
<td>2.7-5.6</td>
<td>5.7-9.96</td>
<td>58</td>
</tr>
<tr>
<td>Mallarino and Torres (2006)</td>
<td>IA</td>
<td>20</td>
<td>1979-2003</td>
<td>0.8-5.9</td>
<td>5.1-12.4</td>
<td>81</td>
</tr>
<tr>
<td>Mallarino and Torres (2006)</td>
<td>IA</td>
<td>14</td>
<td>1985-2010</td>
<td>1.4-6.2</td>
<td>5.3-12.8</td>
<td>134</td>
</tr>
<tr>
<td>Varvel et al. (2007)</td>
<td>NE</td>
<td>5</td>
<td>1995-2005</td>
<td>6.6-10.9</td>
<td>10.4-13.3</td>
<td>73</td>
</tr>
<tr>
<td>Jokela et al. (1989) Webster</td>
<td>MN</td>
<td>3</td>
<td>1982-1984</td>
<td>1.7-5.6</td>
<td>1.8-8.7</td>
<td>70</td>
</tr>
<tr>
<td>Fenster et al. (1976) Waseca</td>
<td>MN</td>
<td>5</td>
<td>1970-1975</td>
<td>3.2-7.4</td>
<td>7.1-10.6</td>
<td>60</td>
</tr>
<tr>
<td>Fenster et al. (1976) Martin B</td>
<td>MN</td>
<td>6</td>
<td>1971-1976</td>
<td>6.2-11.3</td>
<td>6.2-12.0</td>
<td>0</td>
</tr>
<tr>
<td>Al Kaisi et al. (2003)</td>
<td>CO</td>
<td>3</td>
<td>1998-2000</td>
<td>5.6-10.2</td>
<td>8.3-10.8</td>
<td>66</td>
</tr>
<tr>
<td>Ismail et al. (1994) NT</td>
<td>KY</td>
<td>20</td>
<td>1998-2000</td>
<td>2.1-7.4</td>
<td>5.2-10.9</td>
<td>35</td>
</tr>
<tr>
<td>Ismail et al. (1994) CT</td>
<td>KY</td>
<td>20</td>
<td>1970-1990</td>
<td>1.9-9.5</td>
<td>3.5-10.4</td>
<td>0</td>
</tr>
<tr>
<td>Rice et al. (1986) NT</td>
<td>KY</td>
<td>15</td>
<td>1970-1985</td>
<td>3.1-4.9</td>
<td>5.7-9.2</td>
<td>102</td>
</tr>
<tr>
<td>Rice et al. (1986) CT</td>
<td>KY</td>
<td>15</td>
<td>1970-1985</td>
<td>1.9-6.1</td>
<td>5.0-8.8</td>
<td>69</td>
</tr>
<tr>
<td>Stecker et al. (1993) Columbia</td>
<td>MO</td>
<td>3</td>
<td>1988-1990</td>
<td>3.3-5.6</td>
<td>6.0-10.1</td>
<td>99</td>
</tr>
<tr>
<td>Stecker et al. (1993) Corning</td>
<td>MO</td>
<td>2</td>
<td>1989-1990</td>
<td>5.0-6.0</td>
<td>8.2-8.5</td>
<td>90</td>
</tr>
<tr>
<td>Peterson et al. (1989)</td>
<td>NE</td>
<td>4</td>
<td>1983-1986</td>
<td>2.1-6.4</td>
<td>3.9-10.0</td>
<td>11</td>
</tr>
<tr>
<td>Eck (1982)</td>
<td>TX</td>
<td>2</td>
<td>1977-1978</td>
<td>2.7-4.4</td>
<td>5.6-5.9</td>
<td>59</td>
</tr>
<tr>
<td>Shapiro et al. (2006) RS 51cm</td>
<td>NE</td>
<td>3</td>
<td>1996-1998</td>
<td>6.2-8.9</td>
<td>9.4-11.1</td>
<td>69</td>
</tr>
<tr>
<td>Meisinger et al. (1985) MT</td>
<td>MD</td>
<td>4</td>
<td>1974-1977</td>
<td>1.8-2.6</td>
<td>5.8-8.2</td>
<td>127</td>
</tr>
<tr>
<td>Meisinger et al. (1985) PT</td>
<td>MD</td>
<td>4</td>
<td>1974-1977</td>
<td>2.7-4.2</td>
<td>5.1-8.1</td>
<td>36</td>
</tr>
<tr>
<td>Gehl et al. (2005) Rossville</td>
<td>KS</td>
<td>2</td>
<td>2001-2002</td>
<td>6.4-7.9</td>
<td>11.3-12.6</td>
<td>182</td>
</tr>
<tr>
<td>Gehl et al. (2005) Scandia</td>
<td>KS</td>
<td>2</td>
<td>2001-2002</td>
<td>2.7-7.4</td>
<td>3.8-11.5</td>
<td>51</td>
</tr>
</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>62</td>
<td>44</td>
</tr>
<tr>
<td>173</td>
<td>55</td>
</tr>
<tr>
<td>120</td>
<td>43</td>
</tr>
<tr>
<td>45</td>
<td>20</td>
</tr>
</tbody>
</table>
## Nitrogen in the Crop - EONR

<table>
<thead>
<tr>
<th>Source</th>
<th>Location</th>
<th>Years</th>
<th>Time period</th>
<th>† (0-N) Yield Range</th>
<th>‡ High N Yield Range</th>
<th>*Optimum N rate kg ha⁻¹</th>
<th>Min</th>
<th>Max</th>
<th>Avg.</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallarino and Torres (2006)</td>
<td>IA</td>
<td>14</td>
<td>1985-2010</td>
<td>1.4-6.2</td>
<td>5.3-12.8</td>
<td>134</td>
<td>197</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Varvel et al. (2007)</td>
<td>NE</td>
<td>5</td>
<td>1995-2005</td>
<td>6.6-10.9</td>
<td>10.4-13.3</td>
<td>73</td>
<td>193</td>
<td>131</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Jokela et al. (1989) Carroll</td>
<td>MN</td>
<td>3</td>
<td>1982-1984</td>
<td>5.5-7.3</td>
<td>7.1-9.1</td>
<td>5</td>
<td>131</td>
<td>84</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Jokela et al. (1989) Webster</td>
<td>MN</td>
<td>3</td>
<td>1982-1984</td>
<td>1.7-5.6</td>
<td>1.8-8.7</td>
<td>70</td>
<td>113</td>
<td>91</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Fenster et al. (1976) Waseca</td>
<td>MN</td>
<td>5</td>
<td>1970-1975</td>
<td>3.2-7.4</td>
<td>7.1-10.6</td>
<td>60</td>
<td>199</td>
<td>135</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Fenster et al. (1976) Martin B</td>
<td>MN</td>
<td>6</td>
<td>1971-1976</td>
<td>6.2-11.3</td>
<td>6.2-12.0</td>
<td>0</td>
<td>37</td>
<td>18</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Shapiro et al. (2006) RS 51cm</td>
<td>NE</td>
<td>3</td>
<td>1996-1998</td>
<td>6.2-8.9</td>
<td>9.4-11.1</td>
<td>69</td>
<td>96</td>
<td>83</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Shapiro et al. (2006) RS 76cm</td>
<td>NE</td>
<td>3</td>
<td>1996-1998</td>
<td>5.0-8.9</td>
<td>7.1-11.0</td>
<td>13</td>
<td>114</td>
<td>75</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Gehl et al. (2005) Rossville</td>
<td>KS</td>
<td>2</td>
<td>2001-2002</td>
<td>6.4-7.9</td>
<td>11.3-12.6</td>
<td>182</td>
<td>204</td>
<td>193</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Gehl et al. (2005) Scandia</td>
<td>KS</td>
<td>2</td>
<td>2001-2002</td>
<td>2.7-7.4</td>
<td>3.8-11.5</td>
<td>51</td>
<td>160</td>
<td>105</td>
<td>77</td>
<td></td>
</tr>
</tbody>
</table>
Stanford Equation

\[ N_{\text{fert}} = \frac{(N_{\text{crop}} - N_{\text{soil}})}{e_{\text{fert}}} \]

Douglas Beegle, Penn State University
Scott Murrell, International Plant Nutrition Institute
\[ N_{\text{fert}} = (N_{\text{crop}} - N_{\text{SIN}} - N_{\text{SON}} - N_{\text{CRN}} - N_{\text{manure RON}} - N_{\text{manure IN}} - N_{\text{manure ON}} - N_{\text{leg}}) / e_{\text{fert}} \]

- \( N_{\text{fert}} \): Total fertilizer N required
- \( N_{\text{crop}} \): Total N in Crop
- \( N_{\text{SIN}} \): Available soil inorganic N
- \( N_{\text{SON}} \): Available soil organic N
- \( N_{\text{CR}} \): Available crop residue N
- \( N_{\text{manure RON}} \): Available manure residual organic N
- \( N_{\text{manure IN}} \): Available manure inorganic N
- \( N_{\text{manure ON}} \): Available manure organic N
- \( N_{\text{leg}} \): Available legume N
- \( e_{\text{fert}} \): Fertilizer N efficiency

The diagram illustrates the total plant uptake and its partitions into different sources of N.
Theoretical Equation

\[ N_{\text{tort}} = \left( \frac{[\text{Yld} \times N_{\text{crop}}] - [N_{\text{SON}} \times e_{\text{SON}} \times R_{\text{SON}}] - [N_{\text{MON}} \times e_{\text{MON}} \times R_{\text{MON}}] - [N_{\text{MRON}} \times e_{\text{MRON}} \times R_{\text{MRON}}]}{e_{\text{fert}}} \right) \]

- \text{Soil Quality, Weather, Tillage & characteristics of source, Models}
- \text{Assess Legume Stands}
- \text{Source, Method, timing of fertilizer application, Weather}
- \text{Yield Records, PPNT, SOM Test, ISNT, Manure application records & analysis, PSNT}
- \text{Soil Quality, weather, crop residues characteristics, tillage, models}
- \text{Manure application records & manure analysis}
- \text{Soil Quality, Weather, Tillage & characteristics of source, Models}
- \text{Soil Quality, Weather,Manure application timing and method, models, PSNT, sensors}
- \text{Soil Quality, Weather, Tillage & characteristics of source, PSNT, Sensors, Models}
Nitrogen in the Crop - EONR

Average of 68 lbs with 49 BPA, 1.5 lbs N per bushel
Fine and Course Control

- Making high resolution decisions using low resolution recs.
- Recommendation maps are at < 1 acre resolution and critical value that represents a whole state.
- How Precise is that.
Where is the opportunity

- N-Crop: Is the yield Temporally Variable? Spatially Variable?
- N-Soil: Do you have 2% OM and inconsistent weather?
- E-Fert - is your texture or landscape spatially variable?
- Can you adjust based on Management.

\[ N_{\text{fert}} = \left( N_{\text{crop}} - N_{\text{soil}} \right) / e_{\text{fert}} \]
How we Do Phosphorus Recs

• **Build-Maintain (Replacement)**
  
  • Apply enough P to or K to build soil test values to a target soil test value over a planned timeframe (e.g. 4-8 years), then maintain based on crop removal and soil test levels
  
  • NOT intended to provide optimum economic returns in a given year, but minimize the probability the P or K will limit crop yields while providing for near maximum yield potential

<table>
<thead>
<tr>
<th>Crop</th>
<th>Harvest unit</th>
<th>P in yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Bushel</td>
<td>.38</td>
</tr>
<tr>
<td>Soybean</td>
<td>Bushel</td>
<td>.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>Bushel</td>
<td>.5</td>
</tr>
</tbody>
</table>
How we Do VRT Phosphorus Recs

Efaw Phosphorus 1x1 Experiment

Distance, ft

- 60.0-65.0
- 55.0-60.0
- 50.0-55.0
- 45.0-50.0
- 40.0-45.0
- 35.0-40.0
- 30.0-35.0
- 25.0-30.0
- 20.0-25.0
- 15.0-20.0
- 10.0-15.0
- 5.0-10.0
- 0.0-5.0
How we Do VRT Phosphorus Recs

Mehlich III extractable phosphorus (Mg P kg⁻¹)

Soil pH

Sampling depth (cm)

Stillwater '14
Red Rock 1
Red Rock 2
Red Rock 3
Waukomis 1
Waukomis 2
Stillwater '15
Garber '15
Waukomis '15
Nutrient Rich Strips

Use Your Cover Crops
On Farm Testing

- Recommendations are built for states or regions at best.
- We have highly spatially specific data.
- But very little spatially specific recs.
- Yield monitor and spreader.
Long Term Goal

- Be Truly Site Specific for all nutrients
- Over extended period but near neutral for Mobile Nutrients
- Targets P and K recs to soils response to addition/removal
Importance of Proper Fertility

- Soil Test
- Soil pH
- P & K
- Nitrogen
- Micronutrients
- Multi-Nutrient
  Variable Application
Outside the box.... drill
Thank You

Brian Arnall
b.arnall@okstate.edu
Twitter: @OSU_NPK
www.Facebook/OSUNPK
YouTube Channel: OSUNPK
Blog: OSUNPK.com
www.Aglandlease.info
www.NPK.okstate.edu