Approaches to N Recommendations in the North Central Region

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N Recommendations

- Two prevailing theories
  - Yield goal based
  - Non-yield goal based
## N Recommendations

- **Yield goal based**
  - **Illinois**
    - \( \text{lb N/A} = (1.2 \times YG) - N \text{ credits}; \) \( \text{soybean credit} = 40 \text{ lb/A} \)
  - **Michigan/Indiana/Ohio**
    - \( \text{lb N/A} = (1.36 \times YG) - 27 - N \text{ credits}; \) \( \text{soybean credit} = 30 \text{ lb/A} \)
  - **Minnesota**

<table>
<thead>
<tr>
<th>PC</th>
<th>OM*</th>
<th>100-124</th>
<th>125-149</th>
<th>150-174</th>
<th>175-199</th>
<th>200+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Low</td>
<td>130</td>
<td>160</td>
<td>190</td>
<td>210</td>
<td>230</td>
</tr>
<tr>
<td>Corn</td>
<td>Med/High</td>
<td>100</td>
<td>130</td>
<td>160</td>
<td>180</td>
<td>200</td>
</tr>
<tr>
<td>Soybean</td>
<td>Low</td>
<td>90</td>
<td>120</td>
<td>150</td>
<td>170</td>
<td>190</td>
</tr>
<tr>
<td>Soybean</td>
<td>Med/High</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>140</td>
<td>160</td>
</tr>
</tbody>
</table>

*Low \( \text{OM} < 3.0\%; \) Med/High \( \text{OM} \geq 3.0\% \) \( \text{soybean credit} = 40 \text{ lb/A} \)
## N Recommendations

### Not yield goal based

- **Iowa**

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>PC</th>
<th>N rec. (lb N/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td></td>
<td>150 to 200</td>
</tr>
<tr>
<td>Soybean</td>
<td></td>
<td>100 to 150</td>
</tr>
</tbody>
</table>

### Wisconsin

<table>
<thead>
<tr>
<th>OM %</th>
<th>Sands/loamy sands</th>
<th>Other soils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated</td>
<td>Non-irrigated</td>
</tr>
<tr>
<td>&lt; 2</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>2-9.9</td>
<td>160</td>
<td>110</td>
</tr>
<tr>
<td>10-20</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

(soybean credit = 40 lb N/A)
## N Recommendation Comparison

<table>
<thead>
<tr>
<th>Previous Crop:</th>
<th>Corn</th>
<th>Soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield Goal (bu/A):</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>IL</td>
<td>180</td>
<td>140</td>
</tr>
<tr>
<td>MI/IN/OH</td>
<td>177</td>
<td>147</td>
</tr>
<tr>
<td>MN</td>
<td>160</td>
<td>120</td>
</tr>
<tr>
<td>IA</td>
<td>150-200</td>
<td>100-150</td>
</tr>
<tr>
<td>WI</td>
<td>160</td>
<td>120</td>
</tr>
</tbody>
</table>

Soil with 3.1% OM, considered high yield potential
Are Yield Goal Based N Recommendations Valid?

- If so, there will be a relationship between economic optimum N rate (EONR) and yield obtained at EONR.
Relationship between optimum N rate and corn yield (101 WI sites; 1989-1999)

Soil yield potential
- Medium $R^2=0.0002$
- High $R^2=0.0028$

Economic Optimum N Rate (lb N/A)

Grain Yield (bu/A)
Relationship between optimum N rate and yield in IA (81 site years; pc = soybean)

ONR = 0.21OY + 63.0

$R^2 = 0.04$

From Nafziger et al., 2004
Relationship between optimum N rate and yield in IL (72 site years; pc = soybean)

\[ \text{ONR} = 0.46 \text{OY} + 46.6 \]

\[ R^2 = 0.08 \]

From Nafziger et al., 2004
Relationship between optimum N rate and yield in MI (14 site years; 2002-2003)

\[ \text{EONR} = 1.03 \times \text{YG} - 66 \]

\[ R^2 = 0.37 \]
Relationship between optimum N rate and yield in MN

- Data across southern and south east MN show a poor/no relationship between yield and economic optimum N rate
Are Yield Goal Based N Recommendations Valid?

- If so, there will be a relationship between economic optimum N rate (EONR) and yield obtained at EONR
  - Relationship is poor

- If so, the pounds of N required per bushel would be relatively stable over time/across sites
N required per bushel in MI (2002-2003)

- Mean = 0.74
- Standard deviation = 0.27
N required per bushel in WI with and without 40 lb N credit added to EONR

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n=15</td>
<td>n=11</td>
<td>n=15</td>
</tr>
<tr>
<td>CC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC &quot;N credit&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lb N applied/bu @ EONR

n=15
n=11
n=15
n=12

Rotation
Are Yield Goal Based N Recommendations Valid?

- If so, there will be a relationship between economic optimum N rate (EONR) and yield obtained at EONR
  - Relationship is poor

- If so, the pounds of N required per bushel would be relatively stable over time/across sites
  - N required per bushel is:
    - Highly variable
    - Much less than 1.2
Let's look at factors in Wisconsin’s N recommendations

- **Yield potential**
  - Based on:
    - Drainage
    - Depth of root zone
    - Water holding capacity
    - Length of growing season

- **Soil organic matter**
How much N does soil supply?
Contribution of soil N and fertilizer N to yield in WI

![Bar chart showing yield in bu/acre for different years and locations with control and fertilizer treatments.]

- **Yield, bu/acre**
  - 0
  - 50
  - 100
  - 150
  - 200

- **Soil (No N control)**
  - CC: n=15
  - '91-'96
  - '97-'03
  - SC: n=11
  - '94-'96
  - '97-'03

- **Fertilizer at EONR**
  - '91-'96
  - '97-'03
  - '94-'96
  - '97-'03
  - n=15
  - n=12
How much N does soil supply?

- A majority of N needed is supplied by the soil
  - WI: Soil N contributed 79% of total yield
    - 53 sites, 1991-2003, v. high/high YP sites
    - PC = corn and soybean
  - MI: Soil N contributed 74% of total yield
    - 14 sites, 2002-2003
    - PC = corn, wheat, soybean, dry bean, alfalfa

- Varies with temperature and moisture
- Acts as a buffer for climate variability
Stability of EONR over time
Optimum N rates for corn in high- & low-yielding years (1967-90), Lancaster, WI

Economic optimum N rates calculated at corn:N price ratio of 13.3:1 (e.g. $2.00:$0.15)
Annual average EONR for corn in WI
Comparison of corn yield response to N recommendations based on yield goal and soil-specific N response approaches, Arlington, WI
Profitability of Wisconsin’s N recommendation system
Net economic return from fertilizer N for corn production on several WI soils

<table>
<thead>
<tr>
<th>Soil</th>
<th>N rate</th>
<th>Yield increase from fertilizer N</th>
<th>Net economic return from fertilizer**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/acre</td>
<td>bu/acre</td>
<td>8.33:1</td>
</tr>
<tr>
<td>Plano</td>
<td>130</td>
<td>31.4</td>
<td>14.75</td>
</tr>
<tr>
<td></td>
<td>160*</td>
<td>34.7</td>
<td>14.38</td>
</tr>
<tr>
<td></td>
<td>190</td>
<td>36.5</td>
<td>12.13</td>
</tr>
<tr>
<td>Withee</td>
<td>90</td>
<td>24.3</td>
<td>11.88</td>
</tr>
<tr>
<td></td>
<td>120*</td>
<td>27.5</td>
<td>11.38</td>
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<tr>
<td></td>
<td>150</td>
<td>28.2</td>
<td>7.75</td>
</tr>
<tr>
<td>Meridian</td>
<td>90</td>
<td>21.7</td>
<td>8.63</td>
</tr>
<tr>
<td></td>
<td>120*</td>
<td>25.2</td>
<td>8.50</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>26.7</td>
<td>5.88</td>
</tr>
<tr>
<td>Plainfield</td>
<td>170</td>
<td>101.8</td>
<td>96.75</td>
</tr>
<tr>
<td></td>
<td>200*</td>
<td>106.9</td>
<td>98.63</td>
</tr>
<tr>
<td></td>
<td>230</td>
<td>108.1</td>
<td>95.63</td>
</tr>
</tbody>
</table>

* Recommended N rate prior to taking legume/manure N credits

** Value of yield increase due to N – cost of N – cost of application ($5/acre). All calculations were based on $0.15/lb N and $1.25, $1.50, $2.00, and $2.50 per bushel corn for 8.33:1, 10:1, 13.3:1, and 16.7:1 ratios, respectively.
Conclusions

- There is no relationship between yield goal and optimum N rate
  - Even in states that use yield goal to make N recommendations
  - Yield goal based recommendations do not follow curves of corn yield response to N
    - Results in over or under application of N at high and low yield goals, respectively

- Wisconsin’s current method of N recommendations allows for profitability as well as environmental protection
So what’s next?

- Regional N rate recommendations
- Discussions between WI, MN, IA, IL, IN, OH, MI
  - Pooling data sets to evaluate yield response over range of soils and climates
  - May evaluate probability of N sufficiency for given N rates
    - Producers could determine the level of risk with which they are comfortable and economic outlook