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**
    - \[ \text{lb N/A} = (1.2 \times \text{YG}) - \text{N credits}; \text{soybean credit} = 40 \text{ lb/A} \]
  - **Michigan/Indiana/Ohio**
    - \[ \text{lb N/A} = (1.36 \times \text{YG}) - 27 - \text{N credits}; \text{soybean credit} = 30 \text{ lb/A} \]
  - **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 OM < 3.0%; Med/High OM ≥ 3.0% soybean credit = 40 lb/A
N Recommendations

- Not yield goal based

- Iowa

<table>
<thead>
<tr>
<th></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>---------</th>
<th>Other soils</th>
<th>---------</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated</td>
<td>Non-irrigated</td>
<td>Low/Med YP</td>
<td>High/Very High YP</td>
</tr>
<tr>
<td>&lt; 2</td>
<td>200</td>
<td>120</td>
<td>150</td>
<td>180</td>
</tr>
<tr>
<td>2-9.9</td>
<td>160</td>
<td>110</td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>10-20</td>
<td>120</td>
<td>100</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>80</td>
<td>80</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>Yield Goal (bu/A):</th>
<th>Corn</th>
<th>Soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>-------------------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>IL</td>
<td>180</td>
<td>240</td>
<td>140</td>
</tr>
<tr>
<td>MI/IN/OH</td>
<td>177</td>
<td>245</td>
<td>147</td>
</tr>
<tr>
<td>MN</td>
<td>160</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>IA</td>
<td>150-200</td>
<td>100-150</td>
<td></td>
</tr>
<tr>
<td>WI</td>
<td>160</td>
<td>120</td>
<td></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)

![Graph showing the relationship between economic optimum N rate and grain yield.](image)

- Soil yield potential
  - Medium: $R^2 = 0.0002$
  - High: $R^2 = 0.0028$
Relationship between optimum N rate and yield in IA (81 site years; pc = soybean)

\[
\text{ONR} = 0.21 \text{OY} + 63.0
\]

\[
R^2 = 0.04
\]

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)

\[ EONR = 1.03 \times YG - 66 \]

\[ R^2 = 0.37 \]
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

The graph shows the relationship between yield (bu/A) and N required per bushel including N credits (lb N/bu). The data points are scattered around the mean with a standard deviation of 0.27.
N required per bushel in WI with and without 40 lb N credit added to EONR

Rotation
CC SC SC “N credit”
lb N applied/bu @ EONR
0.0
0.2
0.4
0.6
0.8
1.0
1991-1996 (CC)
1994-1996 (SC)
1997-2003
n=15 n=11 n=15 n=12
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 the contribution of soil N and fertilizer N to yield in Wisconsin between 1991-1996 and 1997-2003 for CC and SC areas. The chart includes the number of observations (n) for each category.](chart.png)
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 (eg. $2.00:$0.15)
Annual average EONR for corn in WI

![Graph showing the annual average EONR for corn in WI from 1991 to 2003. The graph includes data points for CC and SC, with trend lines indicating r^2 values of 0.01 and 0.06, respectively.](image-url)
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 Corn:N price ratios</th>
<th>Net economic return from fertilizer**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N rate</td>
<td>fertilizer N</td>
<td>8.33:1</td>
</tr>
<tr>
<td></td>
<td>lb/acre</td>
<td>bu/acre</td>
<td></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>
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<td>Meridian</td>
<td>90</td>
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<tr>
<td></td>
<td>120*</td>
<td>25.2</td>
<td>8.50</td>
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<td></td>
<td>150</td>
<td>26.7</td>
<td>5.88</td>
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<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