Intelligent Inputs: Nitrogen Considerations

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<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Historical</th>
<th>Nov. 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn: Nitrogen</td>
<td>3.36</td>
<td>8.99</td>
</tr>
<tr>
<td>Wheat: Nitrogen</td>
<td>2.70</td>
<td>6.73</td>
</tr>
<tr>
<td>Corn: Phosphorus</td>
<td>5.02</td>
<td>7.26</td>
</tr>
<tr>
<td>Wheat: Phosphorus</td>
<td>4.05</td>
<td>5.43</td>
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</table>
Approaches to N Recs

- Maximum Return to Nitrogen (MRTN)
  - IA, MN, WI, IL, IN, MI, OH
  - State specific
  - No profile N credit, OM credit embedded
- NDSU MRTN
  - Does account for profile N
  - No explicit OM credit
- Mechanistic
  - KSU, CSU, UNL, OSU, ServiTech, AAL

Let's talk about the mechanistic approach to N recommendations

- The overall idea is to think about peak plant uptake needs, and then work backwards

\[ N_{rec} = YG \times \text{some factor} - \text{credits} \]

- Organic Matter, Profile NO₃, PCA

Common misconception is that it's a removal based system.... NOT TRUE!

Let's talk about the mechanistic approach to N recommendations

- So why this approach vs. what other states of done?
  - Residual Nitrate. In Kansas production systems it's real, it's measurable, and it's valuable
  - Wide range of yield potentials and environmental factors
    - Irrigated vs. Dryland
    - East to West
    - Heavy silt loams vs. blow sand
Past K-State Recommendation

“Old” K-State Corn Nrec

\[
N_{rec} = YG \times 1.6 - \text{Profile N} - \text{Soil OM Credit} - \text{Other Credits}
\]

But what about lbs/bu?

“You KSU guys are nuts! It doesn’t take 1.6 lbs/bu, I can do it on 0.7!”

- The farm press as well as many producers and consultants want to think in terms of lbs/bu
  - A nice simple number for bragging rights
  - Probably not a bad approach in the corn belt
  - Maybe useful in less dynamic systems in Kansas (e.g. continuous irrigated corn)

- BUT:
  - If you don’t know NO₃ at the beginning and end of the season, it’s really not that useful of a number

\[
N_{rec} = (130 \times 1.6) - 40 \text{ lb/acre} - (2.5 \times 20)
\]

\[
208 - 40 - 50 = 118 \text{ lb/acre}
\]

\[
= 0.9 \text{ lb/bu}
\]
Let's talk about the mechanistic approach to N recommendations

- Limitations
  - At the end of the day, it's still a best guess (as is any N recommendation method)
  - Lots of moving pieces
    - Soil Efficiency
    - Fertilizer Efficiency
    - Organic Matter Mineralization

Corn

\[
N \text{ lbs/}a = \left[ \frac{ie}{fe}EY - (se)NO3 - SOM - PCA \right] \times Price_{Adj}
\]

Minimum N rate = 30 lbs/a

<table>
<thead>
<tr>
<th>ie (corn internal efficiency) lbs/bu</th>
<th>0.84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated</td>
<td>0.84</td>
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<tr>
<td>Non-Irrig</td>
<td>0.88</td>
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<table>
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<tr>
<th>fe (fertilizer recovery efficiency)</th>
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<tr>
<td>High efficiency</td>
<td>Injected + split applied</td>
</tr>
<tr>
<td>Default</td>
<td>0.65</td>
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<tr>
<td>Low efficiency</td>
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<tr>
<td>Broadcast, fall-applied</td>
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<th>se (&quot;soil&quot; NO3 efficiency)</th>
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<td>Medium texture or western KS</td>
</tr>
<tr>
<td>High N loss</td>
<td>Corse texture or eastern KS</td>
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Sorghum

\[
N \text{ lbs/}a = \left[ \frac{ie}{fe}EY - (se)NO3 - SOM - PCA \right] \times Price_{Adj}
\]

Minimum N rate = 30 lbs/a

<table>
<thead>
<tr>
<th>ie (sorghum internal efficiency), lbs/bu</th>
<th>1.2</th>
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Nitrogen Pays – Year over Year

Net Returns to Nitrogen, $/lb Applied

- $3.80 Corn, $0.35 N
- $5.00 Corn, $0.60 N

Net Returns to Nitrogen, $/lb

YG=235 bu/ac, 2.5% OM, 30 lb/ac NO3
Standard Preplant N Application

Nitrogen Pays – How bad could it get?

Net Returns to Nitrogen, $/lb Applied

- $3.80 Corn, $0.35 N
- $2.00 Corn, $0.55 N

Net Returns to Nitrogen, $/lb

YG=235 bu/ac, 2.5% OM, 30 lb/ac NO3
Standard Preplant N Application
Economic Choices in N Management

OK, we said that applying whatever N it takes to meet the yield goal is essentially a “no-brainer”, even at today’s fertilizer prices (because it’s relative to crop prices).

Economic Choices

So where is there money to be made in Nitrogen management today?

1. Importance of using a proper yield goal
   1. For us in the west, this is heavily water driven

2. Knowing what we have. This is really important if we screwed up on step 1 last year (e.g. drought).

3. Economic benefits to implementing 4R
   i.e. reducing cost through improving fertilizer efficiency
**Value of Knowing Soil Nitrate - Irrigated**

- Nrec = 140 lb/ac
- Ncost = $136/ac

\[ \text{Value of Knowing Soil Nitrate} = 140 \text{ lb/ac} \]

- Nrec = 220
- Ncost = $213/ac

\[ \text{Value of Knowing Soil Nitrate} = 220 \]

- YG = 235 bu/ac, $5.25 Corn, $0.97 N, 2.5% OM
- Standard Preplant N Application (65% eff), 100% se

\[ \text{Economics of Timing and Placement} \]

- Nrec = 195
- Ncost = $68.25/ac

\[ \text{Difference of $19.22/ac} \]

- YG = 235 bu/ac, $3.80 Corn, $0.35 N, 10.9 price ratio
- 2.5% OM, 30 lb NO₃

**Value of Knowing Soil Nitrate - Dryland**

- Nrec = 10
- Ncost = $9.70/ac

\[ \text{Value of Knowing Soil Nitrate} = 10 \]

- Nrec = 95 lb/ac
- Ncost = $92.15/ac

\[ \text{Value of Knowing Soil Nitrate} = 95 \]

- YG = 135 bu/ac, $5.25 Corn, $0.97 N, 2.5% OM, 100% SE
- Standard Preplant N Application (65% Efficiency)

\[ \text{Economics of Timing and Placement} \]

- Nrec = 195
- Ncost = $189/ac

\[ \text{Difference of $53/ac} \]

- YG = 235 bu/ac, $5.25 Corn, $0.97 N, 5.4 Price Ratio
- 2.5% OM, 30 lb NO₃

- YG = 235 bu/ac, $5.25 Corn, $0.97 N, 2.5% OM
- Standard Preplant N Application (65% Efficiency)
**Economics of Product Price, Timing, and Placement**

- **Nrec = 195 lb/ac**
  - **Ncost = $68.25/ac**
  - Difference of $31.75/ac

- **Nrec = 250 lb/ac**
  - **Ncost = $100.00/ac**

Also ignores differences in volatilization risk

**Timing**

- Some limitations in dryland, but still important
  - Moisture to move N into profile
  - Avoiding “tie-up”, minimizing volatilization potential
- Great opportunities with fertigation

**Source**

- Cost per lb. of nutrient
  - Always do the math!
- Equipment Considerations
  - VRT Equipment
- Source vs. Timing of Application
Data Quality

- The proceeding economics are based on having good data, as good of a representation of “truth” as we can reasonably obtain.
- Good decisions require good data
- Good soil test data comes from good procedures in the field

Number of Cores to Make a Good Sample

- Soils vary across very short distances in nutrient supply due to many factors including:
  - Position on the landscape
  - Past erosion
  - Parent material of the soil
- We also induce variability on the soil
  - Band applications
  - Livestock grazing
- To account for this variation you should take 10-20 cores per sample
Example of the relationship between number of soil cores per composite sample and error

Number of Cores per Sample

Number of Cores per Sample

Mean Soil P = 19 ppm

Economics of Accuracy

Profits from soil sampling at different number of points relative to an all-point composite

- No other data is available (i.e. yield data)
- Field is located in NW Kansas and was grid sampled on 2.5 ac grids
- Samples consisted of 15 cores, so an estimated CI of +/- 3.5 ppm

Soil Test Bray P1

Soil Test P Histogram

Max = 217
Min = 7
Average = 21.7
(20.1 without outlier)
Interpolated Soil Test Phosphorus

Returns to VRT

- Average gross return on VRT P for wheat = $3.81/acre/year
- Average gross return on VRT P for corn = $4.49/acre/year
- The above gross figures would need to cover sampling cost and the portion of machinery and labor cost related to VRT implementation

Can we stretch the value of intensive sampling?

- ROI on intensive sampling increases dramatically as the number crops benefiting from the information increases (spreading fixed cost)
- Checkbook approach for nutrients using initial intensive soil test and removal rates from yield monitor data
Questions?
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