Precision Ag Research: Optimizing Variable Rate Seeding in NYS

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NYS: Ideal for VRT

• High in-field variation due to glaciation
  • Soil type
  • elevation
  • slope

Implementing VR Seeding

• Create management zones
  • Based on historical data, topography, or soil type.
• Select seeding rate for each zone
  • 4,000 sds/ac difference
• Create and implement the prescription
  • With integrated checks
• Evaluate
  • Did the VR have an economic advantage

Mission:

Develop a variable rate planting model (program) that will select hybrid and rate based upon field specific properties.
• Topography
• Soil nutrients
• Soil Type
• Historical Data
Step 1: Thinking About Management Zones

Typical Zone Development
- Grower experience
- NRCS soil survey maps
- Yield maps
- Topography features
- Soil test data

Experimental Designs

Year 1 & 2
Baseline population response design

Year 3
Model validation design

Note: Grower selects the hybrid
Step 2: Assigning rates

<table>
<thead>
<tr>
<th>Location</th>
<th>Variety</th>
<th>Planting Date</th>
<th>Precip. Since May 15</th>
<th>Departure from 10 yr. average</th>
<th>GDU’s Since May 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Union Springs</td>
<td>P0533-P0216</td>
<td>12-May</td>
<td>15.6</td>
<td>1.6</td>
<td>2099</td>
</tr>
<tr>
<td></td>
<td>P0216</td>
<td>213.76</td>
<td>223.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where do we go from here?
Management Zone Conclusions

- Each field is unique
  - different dominating factors driving yield
  - Hybrids may perform differently
- Traditional wisdom may not work in every field
- We are sacrificing economic opportunity with lower resolution
- Algorithm-based grids provide highest level of management

Experimental Designs

Step 3: Implementation

Note: Grower selects the hybrid
What we saw in 2016
Evaluation
Was there an economic advantage?

Typical Strategies

• Compare yield to nearby fields
• Compare to historical yield
• Compare to check strips
• Compare to learning blocks

• We lose spatial relationships
• We lose resolution
• We lose a way to improve our design

How we build and evaluate our VR prescriptions

Year 1 & 2: Randomized population blocks
Yearly Scouting

- Seeding zone population checks
- Three populations
  - What was planted
  - What came up
  - What was harvested
- Extreme rain events
  - Or lack of
- Plant health
- Pest and disease checks

Topography Layers

- Elevation (ft):
  - 600.0 - 680.0
  - 680.0 - 640.0
  - 640.0 - 600.0
  - 600.0 - 560.0
  - 560.0 - 520.0
  - 520.0 - 480.0
  - 480.0 - 440.0
- Slope (degrees):
  - 0.0 - 0.5
  - 0.5 - 1.0
  - 1.0 - 1.5
  - 1.5 - 2.0
  - 2.0 - 2.5
  - 2.5 - 3.0

Soil Type Layer – NRCS Soil Survey

- Soil Type
  - Angola
  - Cazanovia
  - Darien
  - Honeyeck
  - Lima
  - Varick

High Resolution Grid Soil Sampling Layer

- Soil Grid Samples
- Interpolated Values
- pH:
  - 5.00 - 5.50
  - 5.50 - 6.00
  - 6.00 - 6.50
  - 6.50 - 7.00
  - 7.00 - 7.50
- pH:
  - 5.6 - 6.0
  - 6.0 - 6.4
  - 6.4 - 6.8
  - 6.8 - 7.2
  - 7.2 +
Full Model

- Topography:
  - Elevation
  - Slope
  - Aspect
  - Curvature
- NRCS Soil Survey:
  - Soil type
- Soil Grid Sampling:
  - Calcium
  - Magnesium
  - Phosphorous
  - Potassium
  - KScale
  - KMgScale
  - CaSat
  - Ksat
  - MgSat
  - Cation exchange capacity
  - pH
  - BpH
  - Organic matter content

Lott Heitmann Kuney: Percent of Soybean Yield Variation Explained by Full Model

<table>
<thead>
<tr>
<th>Seeding Rate</th>
<th>Soils + Topography</th>
<th>Soil Type</th>
<th>Topography</th>
<th>Soil Grid Sampling</th>
<th>FullModel</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.5%</td>
<td>27.9%</td>
<td>28.8%</td>
<td>44.4%</td>
<td>53.6%</td>
<td></td>
</tr>
</tbody>
</table>

Here's a grain of salt

Please take one
### 2016 Model Field Results

<table>
<thead>
<tr>
<th>Field</th>
<th>Variety</th>
<th>Flat Rate Average Yield (bu/ac)</th>
<th>Variable Rate Average Yield (bu/ac)</th>
<th>Flat Rate Average Profit ($/ac)</th>
<th>Variable Rate Average Profit ($/ac)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>McCann 3 AG2035</td>
<td>46.6</td>
<td>43.9*</td>
<td>$401.62</td>
<td>$396.79</td>
<td>($4.83)</td>
</tr>
<tr>
<td></td>
<td>Kuney P24T05</td>
<td>34.1</td>
<td>33.6</td>
<td>$432.25</td>
<td>$441.19</td>
<td>$8.94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field</th>
<th>Hybrid</th>
<th>Flat Rate Average Yield (bu/ac)</th>
<th>Variable Rate Average Yield (bu/ac)</th>
<th>Flat Rate Average Profit ($/ac)</th>
<th>Variable Rate Average Profit ($/ac)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Overhill P0157AM</td>
<td>169.5</td>
<td>165.5*</td>
<td>$572.89</td>
<td>$567.63</td>
<td>($5.26)</td>
</tr>
<tr>
<td></td>
<td>Beach 2 P0216AM</td>
<td>172.9</td>
<td>167.5*</td>
<td>$1,045.36</td>
<td>$1,022.46</td>
<td>($22.90)</td>
</tr>
<tr>
<td></td>
<td>Beach 2 P0533XR</td>
<td>146.1</td>
<td>154.4*</td>
<td>$854.58</td>
<td>$918.74*</td>
<td>$64.16</td>
</tr>
</tbody>
</table>

* denotes significance

### Importance of Hybrid Placement

- Need significant environmental differences within field
- Need hybrids that respond differently to the variation
  - drought tolerant vs soil moisture tolerant
- Important to use contrasting hybrids
  - Plant structure
  - Agronomic characteristics
- Appropriately place hybrids based on agronomic characteristics and the field environmental conditions.
Evaluate: average model yield = average flat rate yield

To test this hypothesis, we will first remove the data for which the model was optimized for the other hybrid than the one that was planted.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Yield (bu/ac)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Rate</td>
<td>158.742</td>
<td></td>
</tr>
<tr>
<td>Variable Rate Model</td>
<td>160.550</td>
<td>0.387</td>
</tr>
</tbody>
</table>

Evaluate: P0216AM average yield = P0533AM1 average yield

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Average Yield (bu/ac)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0216AM</td>
<td>169.087</td>
<td>&lt;2e-16***</td>
</tr>
<tr>
<td>P0533AM1</td>
<td>151.303</td>
<td></td>
</tr>
</tbody>
</table>

The model outperformed the flat rate, but the difference was not significant.

The P0216AM hybrid had a significantly higher yield than the P0533AM1 hybrid when planted optimally.
Now we will add these cells back in to test hypotheses like:
Evaluate: P0216AM optimized for P0216AM average yield = P0216AM optimized for P0533AM

The model didn’t have a significant effect for hybrid P0216AM

The model did significantly improve the performance of hybrid P0533AM1 over the flat rate - but only when the model was optimized for P0533AM1

Evaluate: Is this trend multi-year

Where do we go from here?
**Pairwise Test Method 2**: testing the difference in yield between pairwise grid cells planted under the same hybrid - one planted at the optimal rate for that hybrid, the other planted at the optimal rate for the other hybrid.

**P0216AM**
- p-value = 0.001428***
- Yield for P0216AM optimized rate was significantly different from yield for P0533AM1 optimized rate
- On average, yield for the P0216AM optimized rate was 7.49 bu/ac lower than for the P0533AM1 optimized rate
- Optimized P0216AM > Optimized P0533AM1: 42.42%
- Optimized P0533AM1 > Optimized P0216AM: 57.58%

**P0533AM1**
- p-value = 0.09673
- Yield for P0533AM1 optimized rate was weakly significantly different from yield for P0216AM optimized rate
- On average, yield for the P0533AM1 optimized rate was 2.16 bu/ac higher than for the P0216AM optimized rate
- Optimized P0533AM1 > Optimized P0216AM: 56.0%
- Optimized P0216AM > Optimized P0533AM1: 44.0%

**Irrespective of hybrid**
- p-value = 0.1206
- Yield for the optimized rate was not significantly different from the non-optimized rate
- On average, yield for the optimized rate was 1.94 bu/ac lower than for the non-optimized rate
- Optimized rate > Non-optimized rate: 50.2%
- Non-optimized rate > Optimized rate: 49.8%

**Hybrid Placement Conclusions**
- The value is in the process
  - Can be used nationwide
- We are at the leading edge of the scientific community
  - Design and analysis
- Diversification of genetics show promise
  - Corn hybrids are bred to be stable
  - Less than 10% are truly offensive or defensive
- More research is needed
  - Determine cost-efficiency
  - More diverse genetics?

**Summary**
- Three years of powerful data
- A strong design and analysis process
- A robust model is dependent upon multiple years of testing
- Looking to expand grower involvement to create a more robust model
  - Increase total acreage involved
  - Increase acreage with precision soil sampling data
- Interested growers are highly encouraged to inquire about participation
Thank you to our Sponsors