VRT – Variable Rate Technology
A Look Back and Into the Future

Kent Shannon
Natural Resource Engineer
Boone County
The State of Precision Ag

- Technology in 20 years (at least for me)
HIGH-TECH TOOLS FOR SITE-SPECIFIC CROP NUTRIENT MANAGEMENT

- Grid sampling guided by GPS gives more accurate soil test data.
- Variable rate fertilizer application can improve efficiency.
- Variable rate seeding, variety changes, and starter can adjust for soil properties and productivity.
- Crop scouting with new technology improves field records.
- On-the-go yield monitors can quickly track variability in the field.
Technologies for Soil Sampling
Technologies for Soil Sampling
The Basis Behind VR Fertilizer

Field - Name
Gvillo (33.01 ac)

Soil P1
- 61.00 - 77.00 (3)
- 49.00 - 61.00 (2)
- 42.00 - 49.00 (3)
- 32.00 - 42.00 (1)
- 13.00 - 32.00 (7)
The Basis Behind VR Fertilizer

Soil Test P in lbs/acre
- Red: 12.3 - 31.9
- Yellow: 31.9 - 45.3
- Green: 45.3 - 60.1
- Light Blue: 60.1 - 83.2
- Dark Blue: 83.2 - 130.1
Proposed Soil Test P Recommendations

Equation Output: P Rec for Corn

If \([\text{Soil P1}] < 45.00\) Then

\[
\text{RESULT} = \left( \text{Corn Yield Goal} \times 0.450 \right) + \left( 110.00 \times (45.00^{0.500} - \left( \text{Soil P1} \times 1.000 \right)^{0.500}) \right) / \left[ \text{Build Years} \right]
\]

Else If \([\text{Soil P1}] \geq 45.00\) Then

\[
\text{RESULT} = \left( \text{Corn Yield Goal} \times 0.450 \times (1.000 - (2.000 \times \left(100.00 \times (\left(\text{Soil P1} \times 1.000\right)/45.00) - 1.000\right)/100.00)) \right) / 100.00
\]

Current MU Rec

Equation Output: P Rec for Corn

If \([\text{Soil P1}] < 30.00\) Then

\[
\text{RESULT} = \left( \text{Corn Yield Goal} \times 0.320 \right) + \left( 4.700 \times (30.00 - \text{Soil P1}) \right) / \left[ \text{Build Years} \right]
\]

Else If \([\text{Soil P1}] \geq 30.00\) Then

\[
\text{RESULT} = \left( \text{Corn Yield Goal} \times 0.320 \times (1.000 - (2.000 \times (\text{Soil P1} / 30.00) - 1.000)) \right)
\]

Proposed MU Rec
Effect on Changing Soil Test P Critical Value From 45 to 30 lbs/acre

Change in Total Amount of P
529 lbs or 16 lbs/acre
VR Fertilizer Recommendation

P removal in lbs/acre

- 11 - 27
- 27 - 40
- 40 - 50
- 50 - 62
- 62 - 89
Variable Rate Fertilizer Technology
VR Fertilizer Application
Historical Aerial Photos from the County FSA Office
Note the farmstead and two ponds prior to 1995
Only 95 ton of lime was applied instead of 294 ton if 2 ton/acre was applied as a blanket rate.
VR Lime Application
VRT to the Next Step - Soil Sensing

Veris MSP3 - Soil Mapping
Example On-Farm Experiment – Development of Management Zones

• Use of Soil Electrical Conductivity and Past Years’ Yield Maps
Example On-Farm Experiment – Development of Management Zones

Soil EC in mS/m
- 6.3 - 28
- 28 - 45
- 45 - 134.7
- Field Boundary

Productivity Zones
- Low
- Medium
- High
Example On-Farm Experiment – Development of Management Zones

<table>
<thead>
<tr>
<th>Productivity Zone</th>
<th>Soil EC (mS m⁻¹)</th>
<th>Nitrogen Rate (lbs/acre)</th>
<th>Seeding Rate (seeds/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>45-135</td>
<td>80</td>
<td>22,000</td>
</tr>
<tr>
<td>Medium</td>
<td>28-45</td>
<td>120</td>
<td>28,000</td>
</tr>
<tr>
<td>High</td>
<td>6-28</td>
<td>160</td>
<td>34,000</td>
</tr>
</tbody>
</table>
VR Planting

Video Courtesy Of: Precision Planting
VR Planting

Population: 33.7

Singulation: 99.5%

Down Force:
- Low 8: 157 lbs
- High 5: 237 lbs

Margin: 56 lbs

Ground Contact: 100%

Spacing: 96.9%

Vacuum:
- L: 21.0
- R: 21.6

Good Ride: 82%

Loss/Acre: $8.95

Row Flow Vari Rate:
- Heavy: -6 lbs

Air Force:
- Setup

Field Acres: 9.4
Example On-Farm Experiment – Implementation of Experiment

Corn was planted using a 16-row planter. Planter was equipped with a variable rate drives to control each half of the planter. This allowed the producer to plant his half of the planter with variable seeding rate and the other half to his usual whole field rate of 28,000 seeds/acre.

GPS data was collected on the variable rate side of the planter by mounting the GPS antenna in the middle of that half of the planter.
Results and Discussion – Yield Maps
Results and Discussion – Yield Summary

<table>
<thead>
<tr>
<th>Productivity Zone</th>
<th>Fixed-rate seeding</th>
<th>Variable-rate seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>115.1</td>
<td>123.1</td>
</tr>
<tr>
<td>Medium</td>
<td>141.1</td>
<td>144.8</td>
</tr>
<tr>
<td>High</td>
<td>144.5</td>
<td>149.5</td>
</tr>
<tr>
<td>Field Average</td>
<td>137.1</td>
<td>143.6</td>
</tr>
</tbody>
</table>

Yield in bushels per acre
VR Hybrids
Soil Sensors Continue to Evolve

- Measures soil organic matter
- Measures soil moisture
- Maps and controls
- VR seeding on-the-go

Precision Planting's new SmartFirmer
What have been the main research topics related to Prec Ag. over the last 5yrs?

Papers submitted to Agronomy Journal during 2013-2015

Word Cloud: an image composed of words used in a particular text or subject, in which the size of each word indicates its frequency or importance.
In-Season Variable-Rate Nitrogen Application
Greenness of Corn at Side Dress
6/3/04 – Miami, MO

Reference strip with
150 lbs N on 5/6

Target strip for side dress
Average of 175 lbs N applied
Greenness of Corn at Side Dress
6/4/04 – Emma, MO

Reference strip with 180 lbs N on 4/19

Target strip for side dress Average of 90 lbs N applied 6/4
Sensor-Based Nitrogen Application
Outcomes from the sensor demos

- 55 replicated on-farm trials
- Increased corn yield by 2 bushels/acre
- Reduced N use by 14 pounds/acre
- Increased partial profit by $17/acre
- Reduced ‘surplus N’ by 27%
- Based on Missouri interpretations for sensors
- Works with all N forms, placements
Tools for Managing Nitrogen
Tools for Managing Nitrogen

Field Recommendation

- Recommendation for 06/22/2015
- 40 / 66 / 105 / 3,520 lbs N/acre

Field Configuration

- Grower: FIPS 19 - Iowa
- Farm: FIPS 047 - Crawford
- Field: Denison
- Acres: 54

- Planting Date: 05/01/2015
- Maturity Class: Grains: 107 day
- Previous Crop: Grain Corn
- Tillage Method: No-Till
- Rainfall Since Planting: 9.4"*
- Estimated Growth Stage: V8

- Organic Matter (%):
  - min: 2.00
  - avg: 2.33
  - max: 2.70

- Harvest Population:
  - 30,000

- Yield Target (bu/acre):
  - 180
  - 191
  - 220

*Estimated Growth Stage
Utilizing Drone Technology for VRT
Turning Drone Image into N Application Map utilizing NVisionAG
Turning Drone Image into N Application Map

utilizing NVisionAG

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sidedress N Rate – lbs/acre</th>
<th>Corn Yield – bu/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer</td>
<td>40</td>
<td>207</td>
</tr>
<tr>
<td>Nvision</td>
<td>48</td>
<td>209</td>
</tr>
<tr>
<td>OptRx</td>
<td>48</td>
<td>206</td>
</tr>
</tbody>
</table>
Future of Drones / Sensor Technology

DJI Phantom 4 with Sentera Single NIR Sensor and Standard RGB Camera

4 Band Sensor
Green, Red, Red-Edge, NIR

Sunlight Sensor

Parrot Agriculture
Future of Drones / Sensor Technology

From DJI Phantom 3 with Sentera Single NIR Sensor and Standard RGB Camera
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PAST YEARS' YIELDS

SOIL TEST (K)

SOIL TEST (P)

SOIL MAP
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