*wicked: a problem that is challenging to solve because of incomplete and changing requirements that are often difficult to recognize
Background - Where We’ve Been

- Efforts start in 2013
  - VRN Trials
- Beta versions in 2013-2014 season
- Commercial Release for 2014-15 season - Encirca Nitrogen Management
- Relaunched for 2017-18+ season - (“Nitrogen 2.0”)
- Rebranded Granular Agronomy Nitrogen Management for 2019-20 season
Performance and Refinement of Nitrogen Fertilization Tools (2014-16)
A Public-Private Collaboration

David Franzen
North Dakota St. University

John Sawyer
Iowa State University

Richard Ferguson
University of Nebraska

Newell Kitchen
USDA-ARS
University of Missouri

Fabián Fernández
University of Minnesota

Carrie Laboski
University of Wisconsin

Emerson Nafziger
University of Illinois

James Camberato
Purdue University
2015-16 Campaign
14,400 NO3 & NH4 samples
Before N applications
0-6” & 6-24” depths
Agenda Overview

01 / Background
02 / Concept
03 / Application
Concept of Granular Agronomy Nitrogen Management

Proprietary corn growth model “Granular Crop Model”
Crop Model Inputs

Weather
- IBM/The Weather Company daily & forecasted
- 20 Years of Prior Weather History
  - Min/Max Temp
  - Precipitation
  - Solar Radiation

Soils
- Decision Zones
  - Proprietary Environmental Response Units (ERU) based on SSURGO & hi-res elevation
  - Multi-Year Yield Analysis (MYYA)
  - Yield Targets
- Initial Nitrogen levels

Management & Genetics
- Nitrogen applications
  - Commercial
  - Manure
  - Stabilizers
- Residue applications
  - Previous Crop
  - Manure
- Irrigation
- Seeding rate and date
- Genetics-specific parameters

Concept
Crop Model Dynamics & Outputs

Soil & Water
- Soil water
- Snow accumulation
- Runoff
- Soil temperature

Nitrogen
- Soil Nitrogen Levels
  - Nitrate
  - Ammonium
- Mineralization
- Nitrification
- Denitrification
- Leaching
- Immobilization
- Volatilization

Plant Growth
- Growth stages
- Plant N uptake
- Biomass
Agenda Overview

01 / Background

02 / Concept

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Application

User Interface - Setup
Application

User Interface - Setup
Application

User Interface - Early Season

Crop Zone Nitrogen Details

- Previous Crop: Soybeans
- Planting Date: 6/6/21
- Initial Nitrogen: 42 lbs/acre
- Current Nitrogen Level: 30 lbs/acre
- Current Growth Stage: Pre-Plant
- Average Planned N: 213 lbs/acre
- Average Plan Cost: $79/acre
- Wet Nitrates N: 60 ppm (6 lbs/acre)
- Fertilizer N: 0 lbs/acre

Nitrogen at V1/V2

- Est. Soil N: 63 lbs/acre
- Target Needed: 66 lbs/acre
- V1/V2 Deficiency: 4 lbs/acre

Water

- Precipitation:
  - Since 1/1/2019 (Initial N): 0.12" (0"
  - Since 5/1/2019 (Planting): 0"
  - Total Irrigation: 0"
  - Since 5/1/2019 (Planting): 0"

Nitrogen Application

- Year Goal: 183
- Planting Date: 6/6/19
- Seed Product: P1197AM (LL, RR, AMI)

Granular
User Interface - Later Season
Soil N Levels at VT/R1
Nitrogen Recommendations

- Yield Targets set by Decision Zone
  - Historical productivity & aspirational growth
- YT drives Soil Nitrogen Target at VT/R1
  - User-selected depth range
- Each of 10 prior years’ weather appended to current year
- Iteratively apply N to each DZ/Year combo
  - Stop when Estimated Soil N @ VT/R1 ~ Soil N Target
  - Combine 10 year results into one value per DZ
- Export as N lbs/ac or units of product/ac
  - Many common applicator controllers
Certified Service Agents

- Create Decision Zones
- Set appropriate Yield Targets
- Take initial N samples on target fields
- Enter planned/actual N, Planting & Irrigation Events
- Upload As-Planted & As-Applied machine data
- Generated & Deliver N Recs
- Evaluate performance at year-end
## Performance

<table>
<thead>
<tr>
<th>Year</th>
<th>Nitrogen management conditions</th>
<th>% wins in trials with Encirca SM Nitrogen Service</th>
<th>Bushels /A</th>
<th>Pounds of Nitrogen /A</th>
<th>$ / acre return</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Challenging</td>
<td>74%</td>
<td>+6</td>
<td>-9</td>
<td>$27</td>
</tr>
<tr>
<td>2016</td>
<td>Favorable</td>
<td>60%</td>
<td>+5</td>
<td>-8</td>
<td>$17</td>
</tr>
<tr>
<td>2017</td>
<td>Challenging</td>
<td>74%</td>
<td>+9</td>
<td>+3</td>
<td>$30</td>
</tr>
<tr>
<td></td>
<td>3 Year Average</td>
<td>69% wins</td>
<td>+7</td>
<td>-5</td>
<td>$25 /A</td>
</tr>
</tbody>
</table>
Thank you

Questions?