# Proceedings of the 4th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference


# Effect of Fertilizer Timing and Variable Rate N on Nitrate-N Losses from Tile Drained Corn/Soybean

David Mulla, Ph.D.

Director Precision Ag. Center

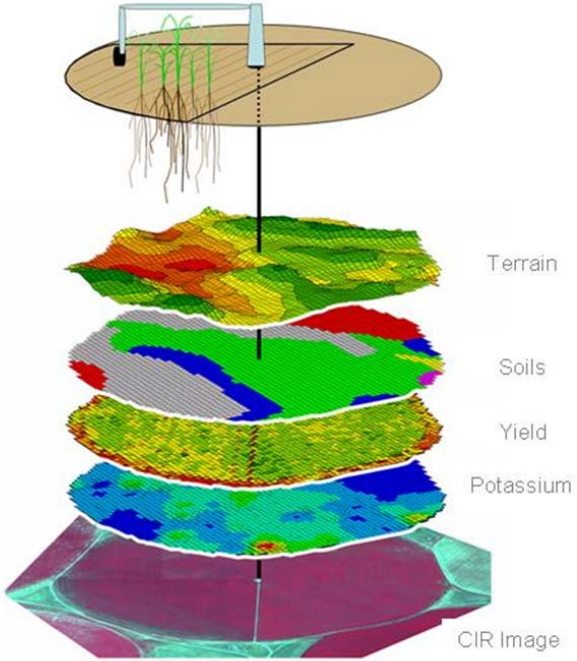
Dept. Soil, Water & Climate

University of Minnesota

Co-authors: Aicam Laacouri, Tyler Nigon and Jeff Vetsch

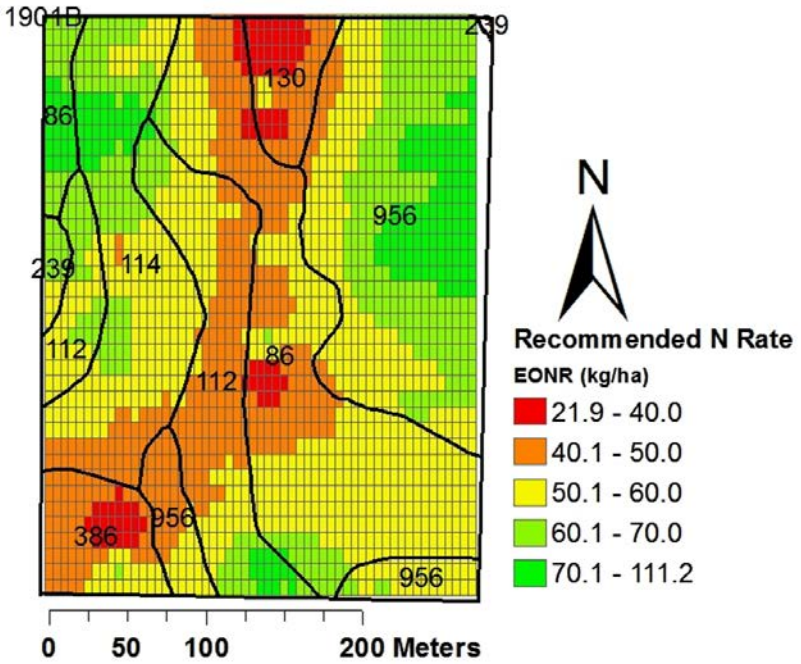
# What is Precision Agriculture?

- A management practice applied at the right rate, right time and right place
  - Customized field management
  - Nutrients
  - Drainage or Irrigation
  - Pests and Weeds
  - Tillage and Seeding Operations



# Benefits of Precision Agriculture

- Increased profitability
- Increased efficiency of inputs
- Reduced environmental pollution

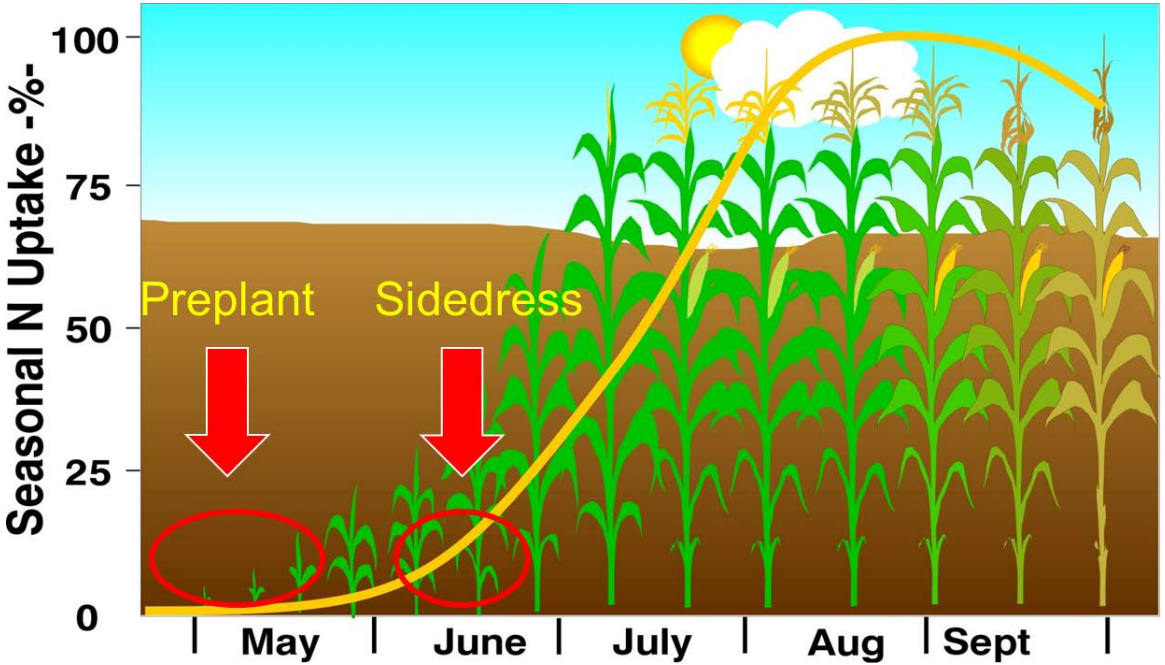


# Conventional Agriculture

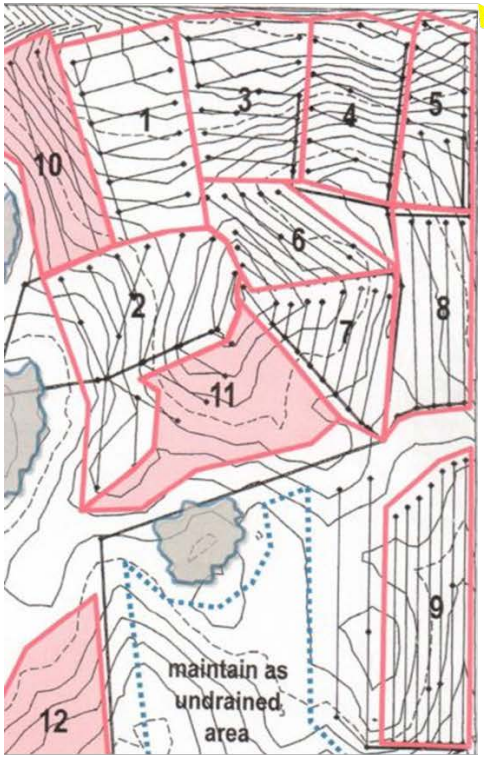
- Most nitrogen fertilizer in Minnesota is fall applied
- Uniform management based on
  - Average or best field conditions
- Uniform management ignores spatial and temporal variability in crop growth, soil or landscape features and denitrification or leaching losses of N
- It leads to overuse of farm inputs

# Variable Rate Side-Dress Nitrogen (VRN)

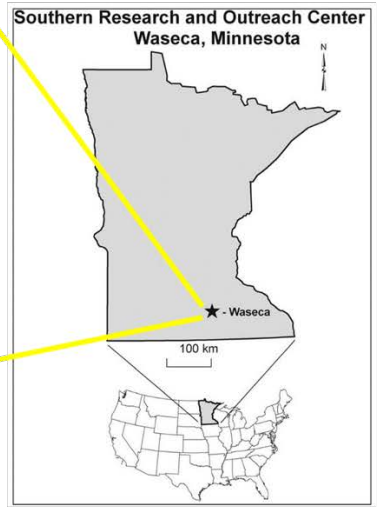
- Match side-dress N fertilizer application to crop growth patterns
- Use remote or proximal sensing to detect N deficiency in leaves



# Study Area Agricultural Ecology Research Farm, Waseca




Site 2 is used for VRN rate estimation




Sites 1, 4, 6, 8 are uniform N
Sites 3, 5, 7, 9 are VRN

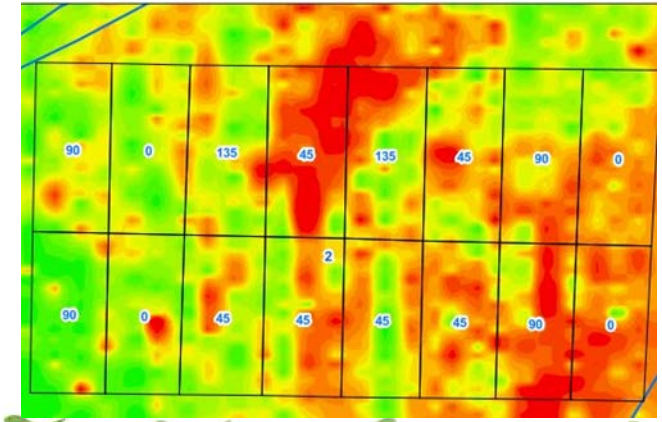
# Methods

- Conventional Treatment: EONR (135 lb/ac N in 2016 and 180 lb/ac N in 2017)
  - Corn after soybean in 2016
  - Corn after corn in 2017

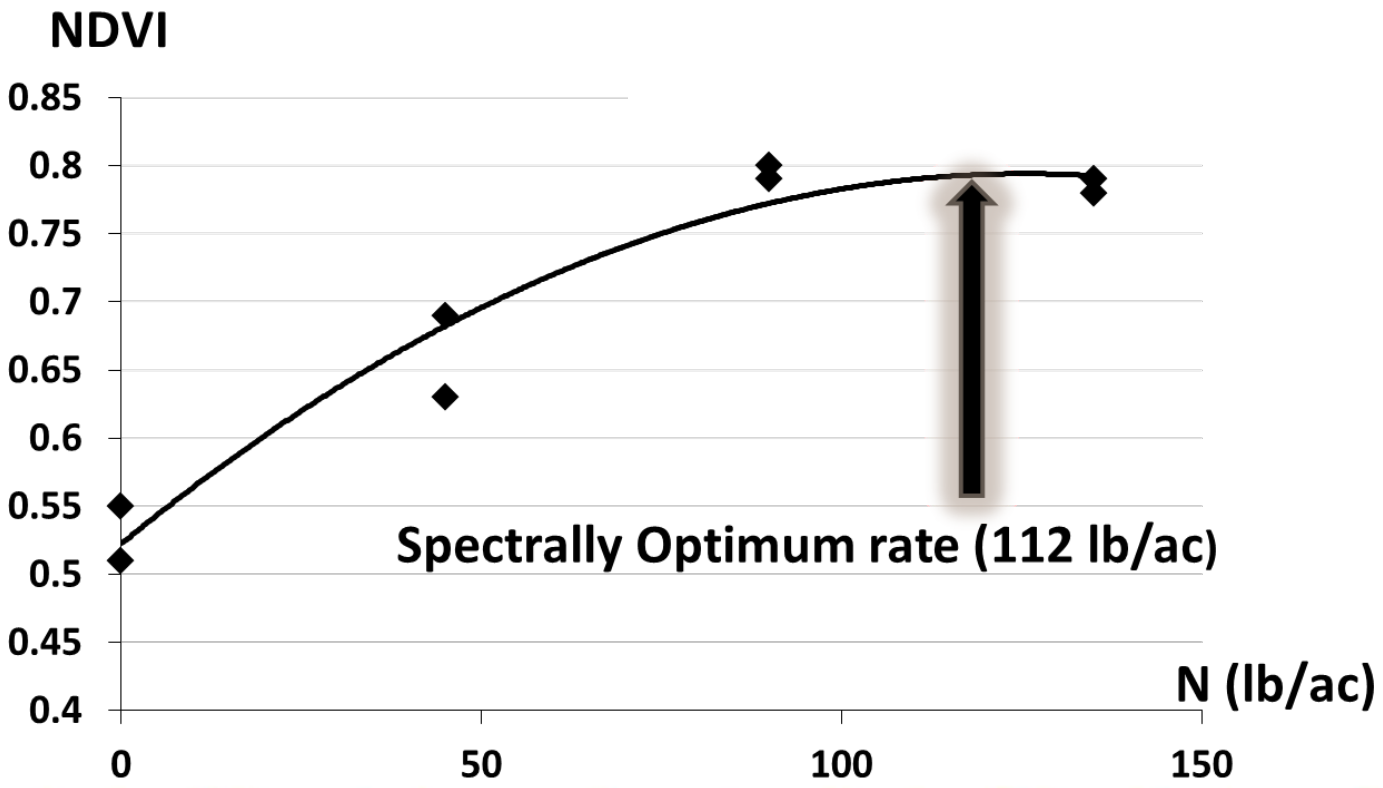
- VRN Treatment: 30% of EONR (PP) + VRN Side-dressed based on Proximal Sensing with CropCircle ®

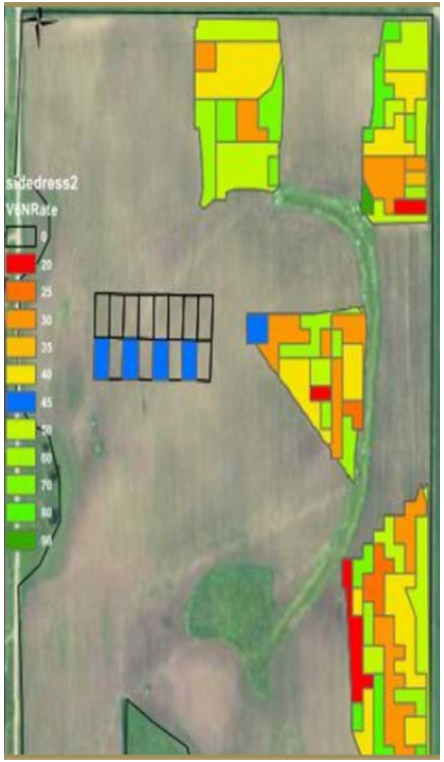
# Variable Rate N Fertilizer Recommendations Based on CropCircle® NDVI

- Three N Response Zones (2016)
  - Zone 1: high N response (lower OM, lower NDVI)
  - Zone 2: low N response (higher OM, higher NDVI)
  - Zone 3: Average of 1 and 2



# EONR Fertilizer Rate based on NDVI (2016)



# VRN Fertilizer Side-Dressing at V6-V7


Raven Controller

Toolbar

# Results

**120 lb N/ac**

**VRN subfields in green received 20-30% less N than uniform subfields, with no significant impact on yield (2017)**

| Subfields | Yield (bu/ac) |
|---|---|
| 1 | 194 |
| 3 | 199 |
| 4 | 204 |
| 5 | 204 |
| 6 | 198 |
| 7 | 203 |
| 8 | 212 |
| 9 | 198 |

**Control**

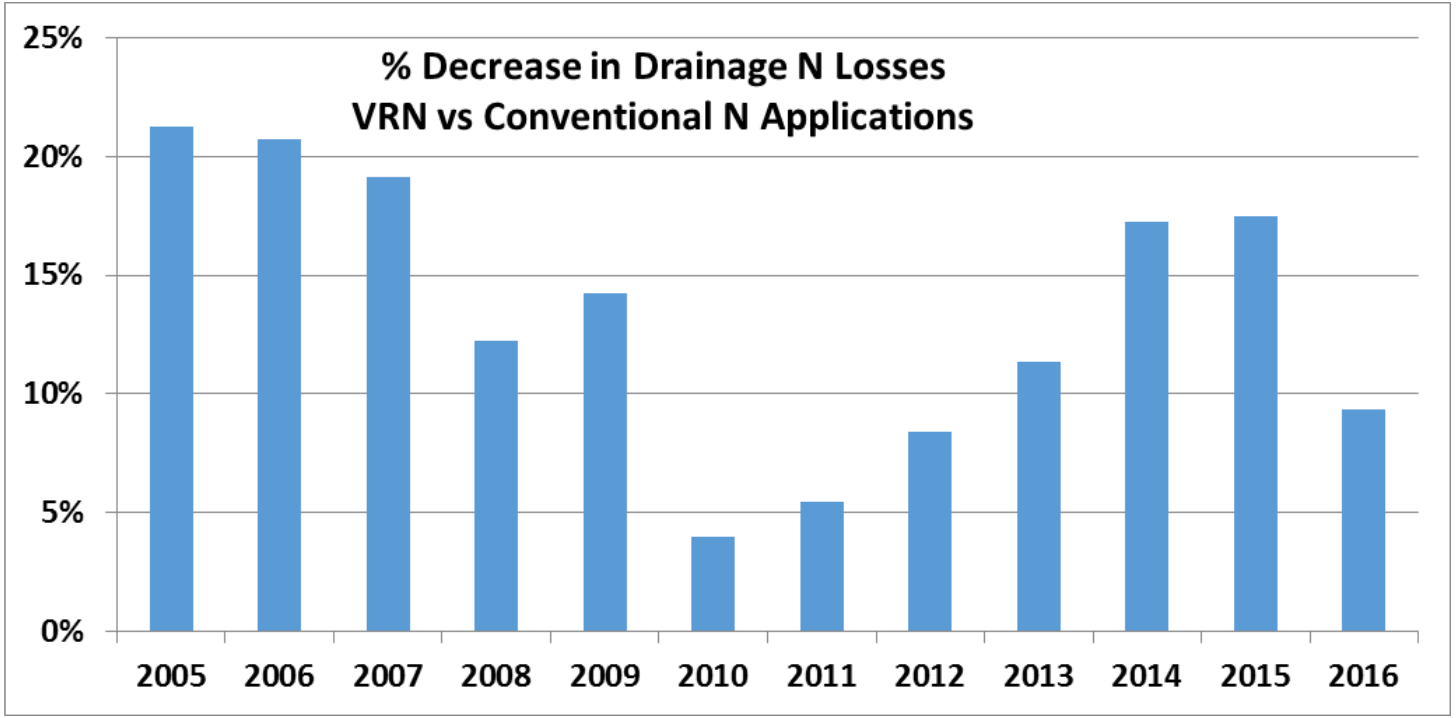
# Economics of VRN Fertilizer Management

- Urea fertilizer and market price of $0.35/lb N
- $5/ac cost for variable rate prescription and application

| VRN Sub-fields | 2016 ROI (Per acre) | 2017 ROI (Per acre) |
|---|---|---|
| 3 | $13.5 | $15.75 |
| 5 | $13.5 | $15.75 |
| 7 | $11.5 | $12.5 |
| 9 | $16 | $19 |

# Environmental Benefits of VRN

- Benefits vary across years due to changes in weather



# Challenges For Implementation

- How much N to apply pre-plant?
  - 60 lb N/ac is generally appropriate
  - Applying more than 90 lb N/ac is excessive
- How should N response zones be identified?
  - A combination of soil organic matter and historical crop yields
  - Crop modeling (Adapt-N, Encirca, ClimateCorp)

# Challenges to Implementation

- What algorithm should be used to estimate N fertilizer recommendation?
  - UofM is developing algorithms based on many site years of research
  - One alternative is to use a sufficient N reference in the field (180 lb N/ac in corn-soybean rotation)
  - Another alternative is to use a virtual reference N location, the location with highest biomass growth
  - GreenSeeker®, CropCircle® and Yara® have proprietary algorithms not specific to Minnesota

# Conclusions

- VRN side-dressing at V6 reduced nitrogen fertilizer rate by 25-30% without impacting yield
- High ROI even in the absence of yield improvement
- VRN side-dressing reduces nitrate leaching from 4-21% relative to a uniform N application in spring
  - This effect depends on climate, drainage intensity and differences in soil organic matter

# Thanks! Funding from: DEPARTMENT OF AGRICULTURE

**David Mulla**
mulla003@umn.edu
**(612) 625-6721**