2019 NUE Workshop

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The N Enigma
Finding Clues with Soil Sensors
The Plot:
Nitrogen matters--$ and environment. We need to increase NUE.

The Conflict:
It’s very complicated. Many soil, weather, management, and unknown factors contribute to the optimal N rate.

The Resolution:
Clues to this mystery...

245 N rate trials in central IL (Nafziger, 2017)
Clue #1: Soil Texture
Possible Crimes: N losses due to Leaching, Denitrification
Suspicious Activity: Yield goal-based N rates
Sensor: Soil Electrical Conductivity
Clue #2: Soil Organic Matter
Wanted for questioning: mineralization of N by OM%?
Person of interest: the weather forecaster
Suspicious activity: Yield goal-based N rates
Sensor: Soil Optical
PLOT TWIST

Soil texture and OM can be accomplices in a nitrogen caper...

Or not.

Texture (Soil EC)  Organic Matter

Silt loam:
OM: 1.7%; Clay: 22%

Silty clay loam:
OM: 1.4%; Clay: 30%

OM: 3%; Clay: 36%
Using multiple sensors and data fusion...
Clue #3: Soil pH

Possible crimes: Reduced N availability at pH extremes; reduced NUE in high pH soils due to Fe and Mn deficiency

Flight risk: volatilization in warm, wet soils above 7.5 pH

Sensor: metalloid pH electrodes
pH may not be the most likely suspect, but perhaps the most nefarious...
Clue #4: Topography (aliases--landscape position, curvature, wetness index)

Escape risks: N losses due to denitrification, run-off, volatilization

Accomplices: concave & clayey (and high pH); low OM & sloping;

Sensors: Lidar, high-grade GPS; Fusion with soil EC and OM (and pH)
Clue #5: Soil Moisture
Property of interest in many cases
Possible crimes: tillage-induced compaction leading to denitrification, reduced N mineralization and diffusion of N to plant roots
Sensor: On-the-go capacitance

Moisture

25.5
Clue #6: Soil temperature
Possible crimes: loss of NH3 in soils above 50°F and volatilization of urea in warm, wet soils
Sensor: IR thermopile
Science-based Sleuthing

QC, Calibration, Validation
The Plot: nitrogen matters--$ and environment.
The Conflict: it’s very complicated.

The (partial) Resolution:

• Soil sensors can map N-relevant soil properties; providing views of the soil at a more dense spatial scale
• These tools can be used to improve N-response trial design (seek homogeneity or heterogeneity or new approaches like DIFM)
• These tools can be used to better understand yield responses to N
• These tools can be used by consultants and growers to continually improve N efficiency—through application timing, site-specific N stabilizers, N form, scouting, VR, variable tillage, other?
• But soil sensing must be based on solid science
Thank you...