Crediting Soil Organic Matter and Cover Crops in a Variable Rate Nitrogen Prescription

PennState Extension

NORTHEAST SARE Sustainable Agriculture Research & Education

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Cover cropping is a key nutrient management strategy

And farmers in the Northeast are doing a lot of it!!

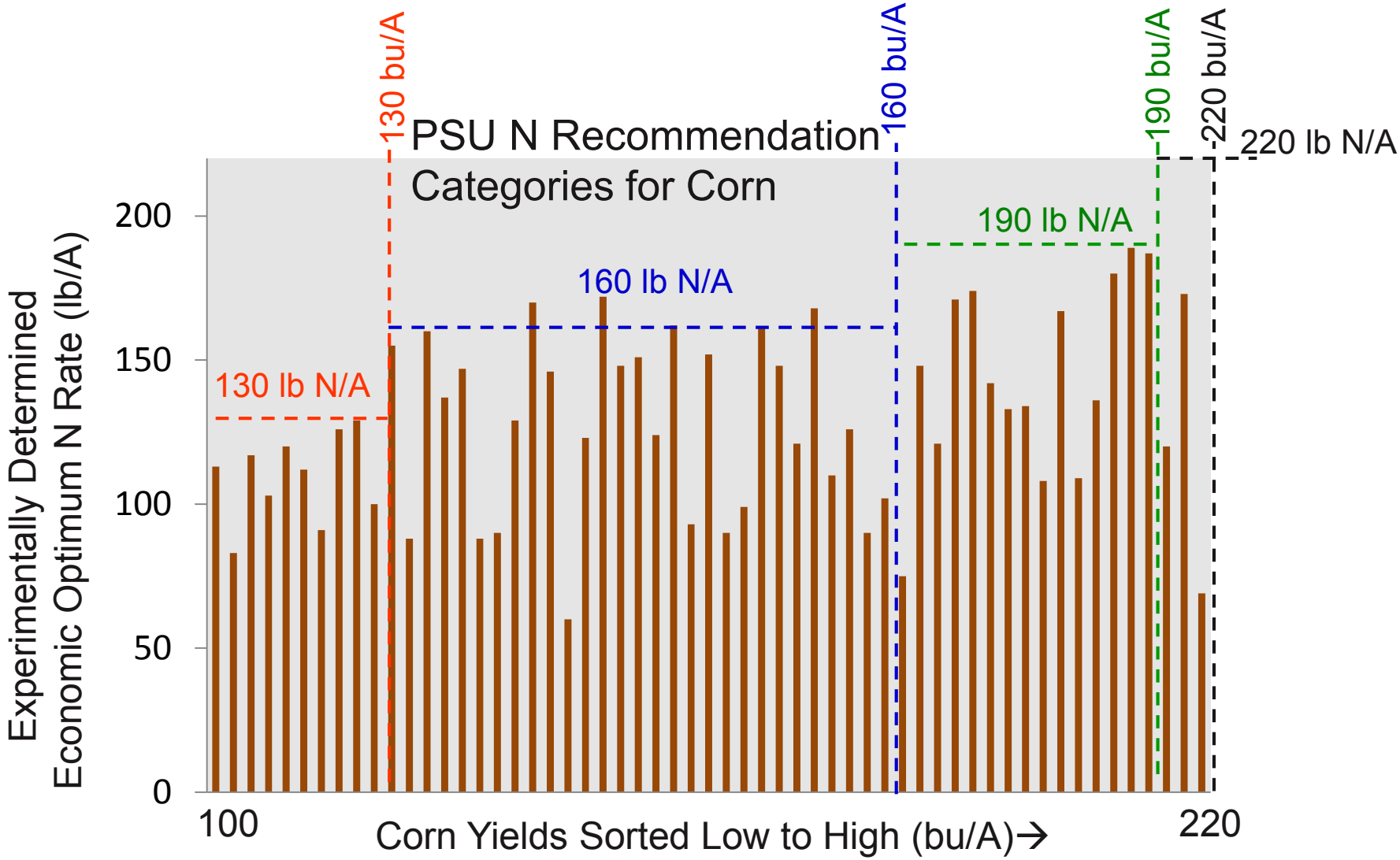
<u>Some regions and crop rotations in PA have even higher cover crop adoption rates</u>

- 52-75% of acreage post-corn was cover cropped in Berks, Lancaster, Lebanon, and York counties in 2013

Hively et al. 2015. J Soil and Water Conservation

Hamilton, Mortensen and Kammerer-Allen 2017. J Soil and Water Conservation

Current N fertilizer recommendations don't take into account N supply from cover crops and soil organic matter



Adapted from D. Beegle

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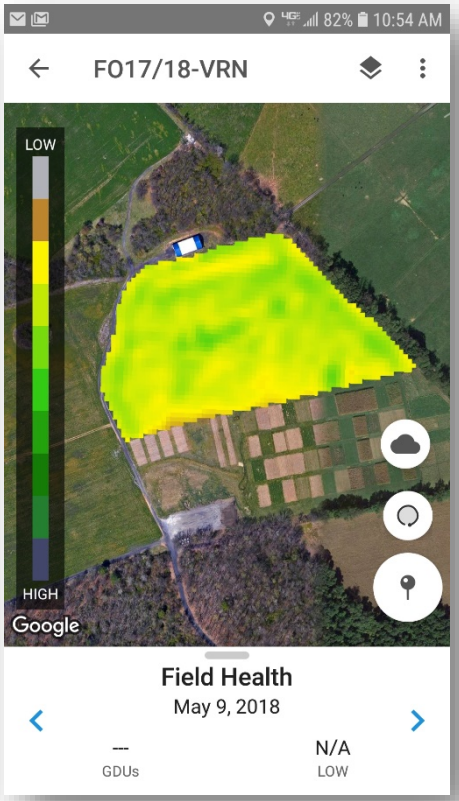
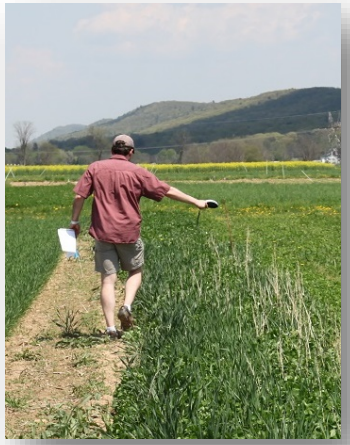
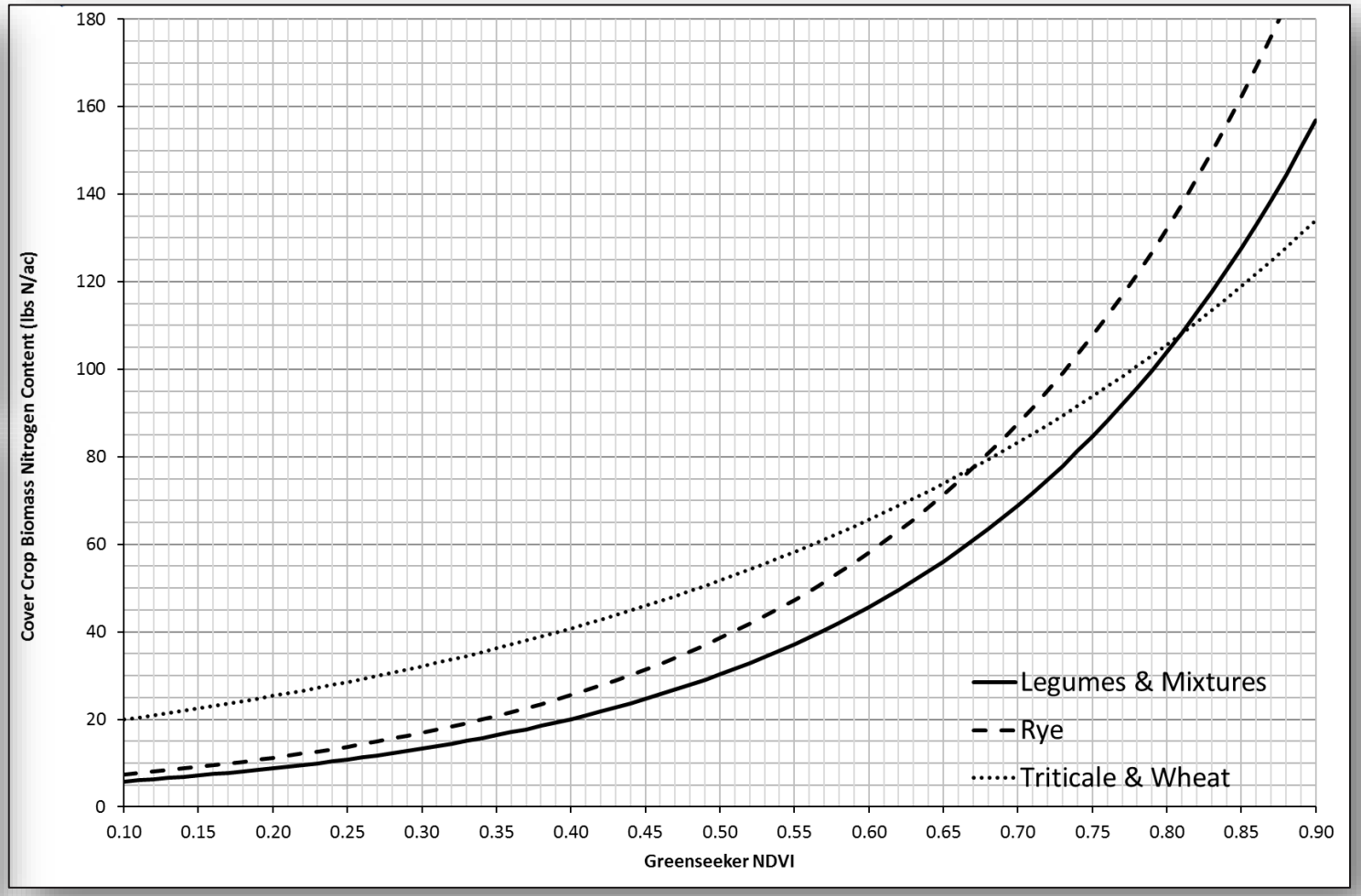
Cover crop growth in a field can be highly variable



Climate FieldView satellite NDVI imagery on a smartphone

Calibrating Greenseeker sensors to predict cover crop biomass N content





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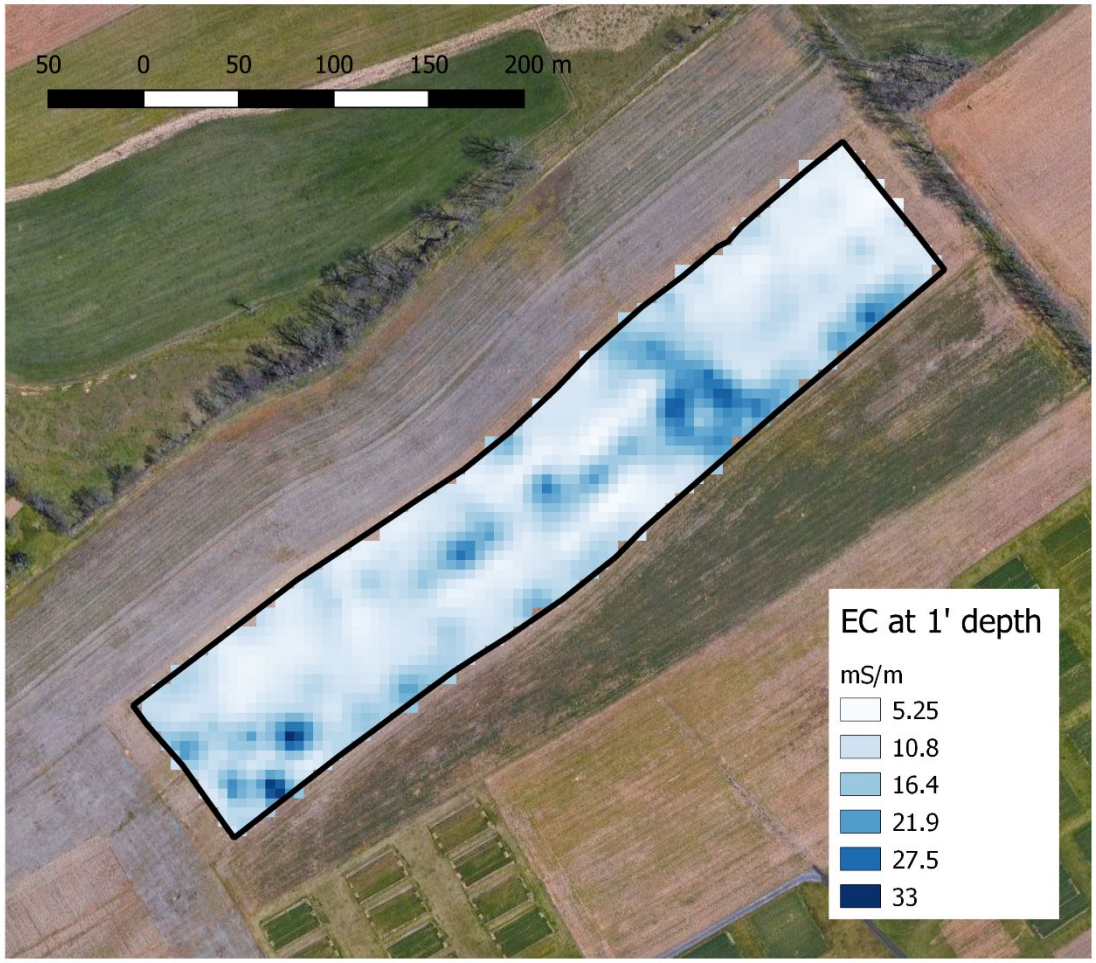
Soil organic matter content can also vary across a field

SmartFirmer made by Precision Planting, Inc.

Soil organic matter map from SmartFirmer data courtesy Mike Gardner, Growmark FS

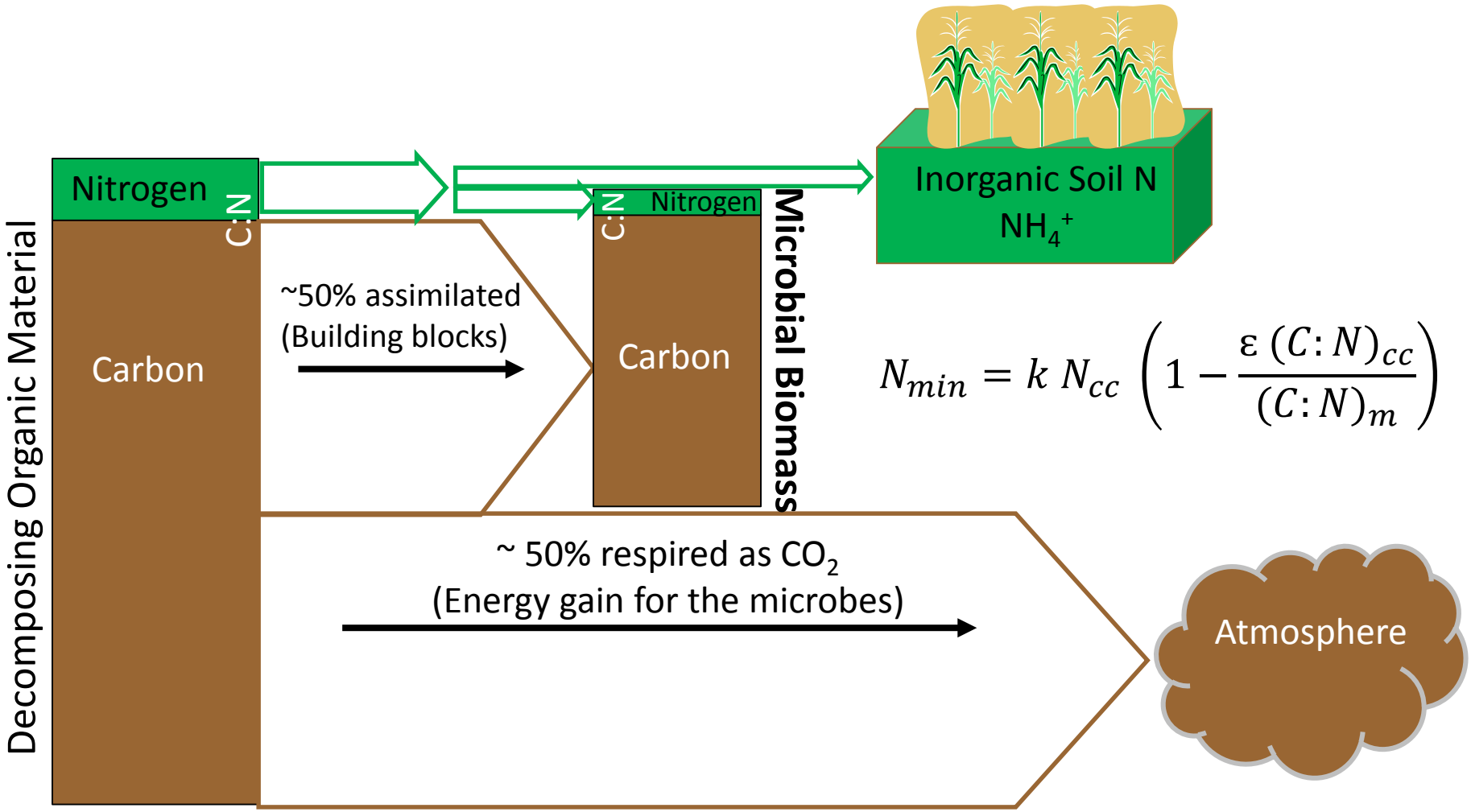
Soil texture regulates N mineralization and can vary across a field

Veris 3100 used to map soil electrical conductivity



Electrical conductivity map of a field at PSU Agronomy Research Farm. Greater EC values correspond to greater clay content.

Understanding and predicting N mineralization



$$N_{min} = k\, N_{cc} \left(1 - \frac{\varepsilon\,(C:N)_{cc}}{(C:N)_m}\right)$$

A new set of equations to predict N mineralization from soil organic matter and cover crop residues

Microbial carbon use efficiency

Corn yield supported by N mineralization from soil organic matter

Corn yield supported by N mineralization from cover crop residues

Total corn yield supported by N mineralization of SOM and CC

$$\varepsilon = 0.52 + 0.0036 \times \%Clay - 0.0097 \times \%Sand \quad \text{Eq. 1}$$

$$\Delta Y_{SOM} = 154 \times \%SOM \times (1 - \varepsilon) \quad \text{Eq. 2}$$

$$\Delta Y_{cc} = \alpha \times N_{cc} \times \left(1 - \frac{\varepsilon \times (C:N)_{cc}}{10}\right) \quad \text{Eq. 3}$$

Where, α = 0.55 when cover crops are N mineralizing and α = 1.8 when N immobilizing

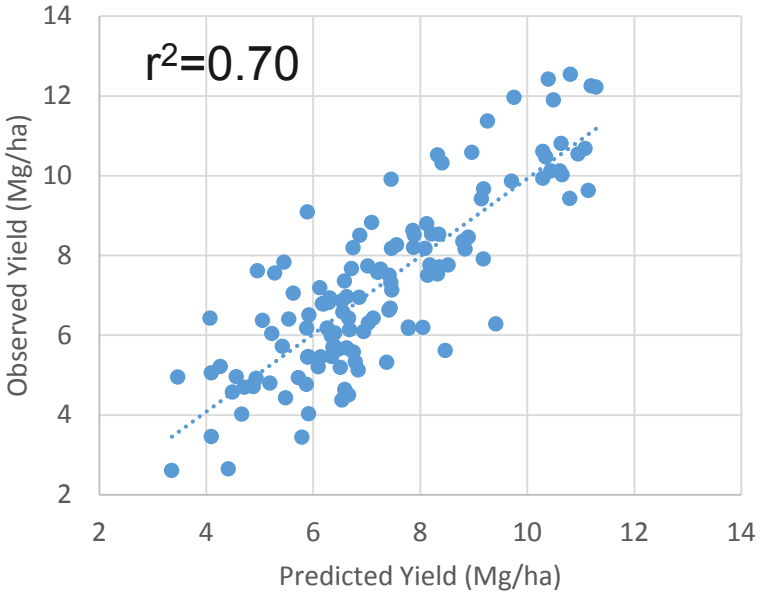
$$Y_T = (\Delta Y_{SOM} + \Delta Y_{cc}) - 0.00094\,(\Delta Y_{SOM} + \Delta Y_{cc})^2 - 51 \quad \text{Eq. 4}$$

Google “Charlie White Water Insight Seminar” for a fact sheet with equations

https://agsci.psu.edu/enri/what-we-do/multi-college/water/VariableRateNitrogenCoverCropsandSOMWriteup.pdf

A new set of equations to predict N mineralization from soil organic matter and cover crop residues

Calibration dataset of unfertilized corn yields



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$$Y_T = (\Delta Y_{SOM} + \Delta Y_{cc}) - 0.00094\,(\Delta Y_{SOM} + \Delta Y_{cc})^2 - 51 \quad \text{Eq. 4}$$

N fertilizer requirement = [(Yield Goal - Y_T) * 1.2 lbs N/bu] / % N Efficiency

Testing the new N fertilizer recommendation in a variable rate prescription on 3 production scale fields

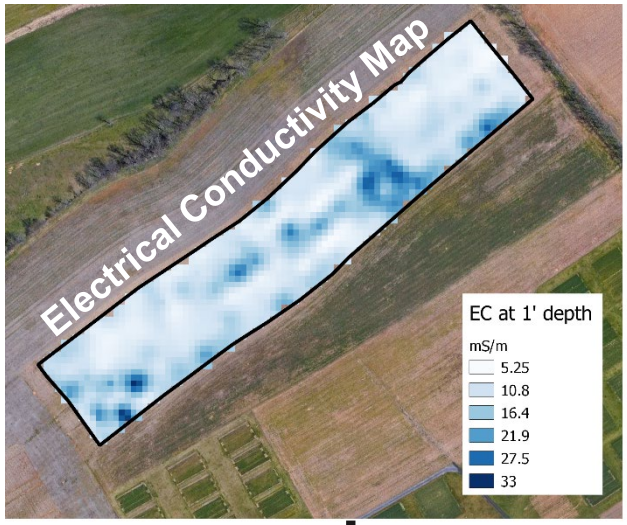
On-Farm Exp., Spruce Creek, PA
Cereal Rye to Silage Corn

PSU Agronomy Research Farm, Rock Springs, PA
Cereal Rye to Grain Corn

PSU Farm Services Unit, State College, PA
Triticale to Grain Corn

All photos taken on 5/3/18

Data layers used to make the N fertilizer prescription (Agronomy Research Farm)



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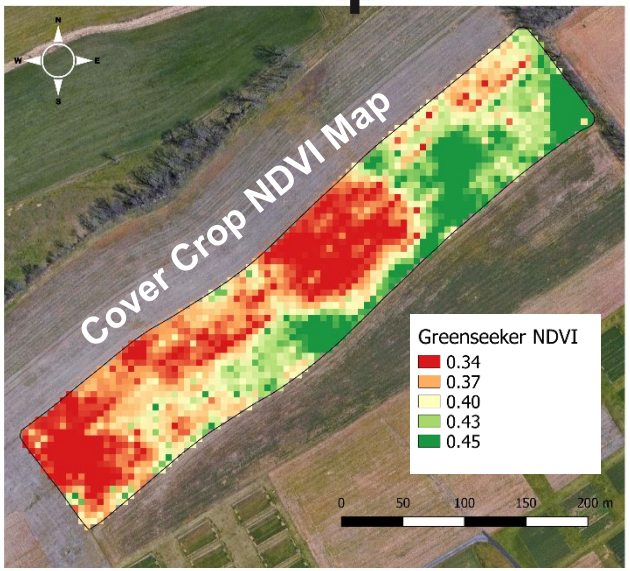

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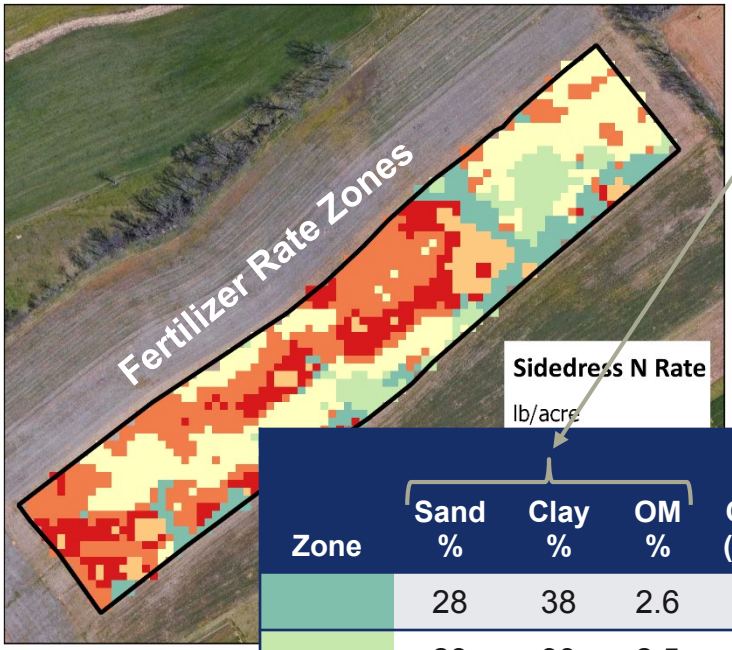


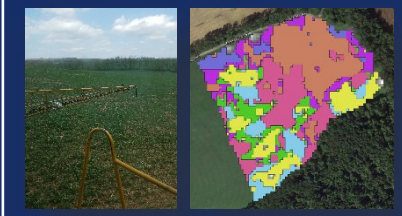
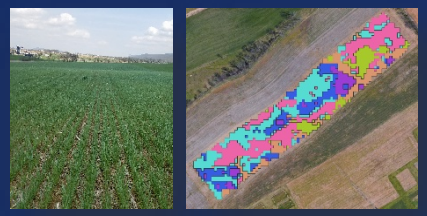
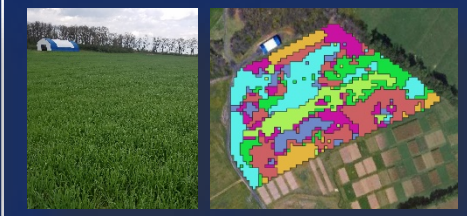
Soil sample by zone

Tissue test by zone

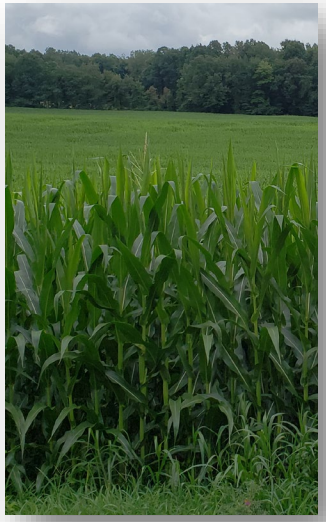
Zone	Sand %	Clay %	OM %	Cover Crop N (lbs/ac)	Cover Crop C:N	Total N Req.* (lbs/ac)
	28	38	2.6	77	19	48
	28	33	2.5	48	23	52
	27	33	2.4	18	23	67
	24	45	2.7	42	23	70
	22	38	2.2	34	25	101
	22	44	2.1	17	25	110

*Assumes 100% recovery of applied N fertilizer; corn yield goal is 185 bu/ac

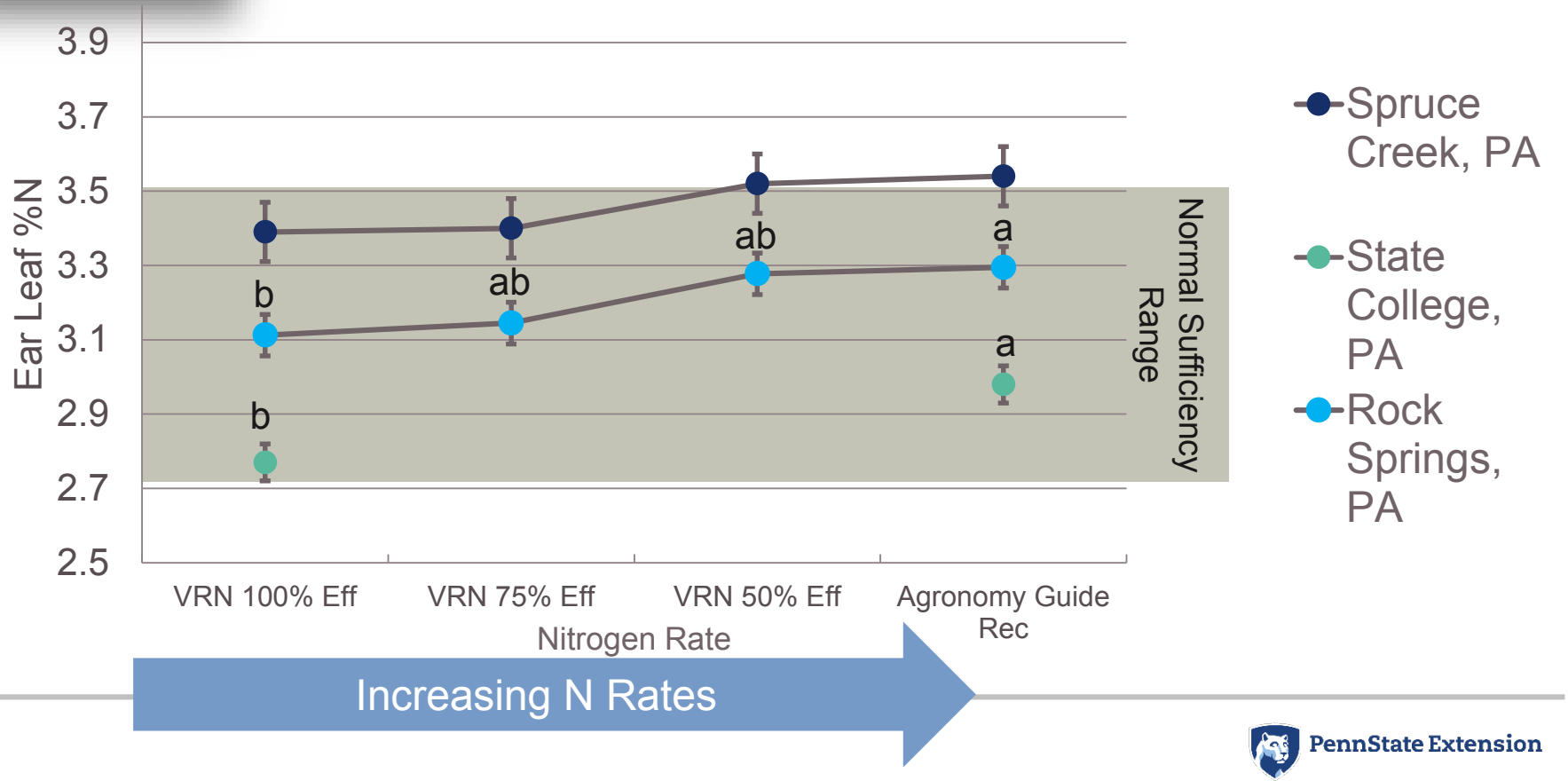
Summary of N prescriptions for each field

	 On-Farm Exp. Spruce Creek, PA	 PSU Agronomy Farm Rock Springs, PA	 PSU Farm Services State College, PA
Yield Target	250 bu/ac	185 bu/ac	165 bu/ac
Minimum N Rate*	83 lbs N/ac	48 lbs N/ac	Sufficient N
Maximum N Rate*	125 lbs N/ac	110 lbs N/ac	Sufficient N
Area Weighted Average N Rate*	101 lbs N/ac	79 lbs N/ac	65 lbs N/ac used as herbicide carrier
Agronomy Guide Recommendation	215 lbs N/ac	185 lbs N/ac	145 lbs N/ac

*Assumes 100% recovery of applied N fertilizer



Corn Ear Leaf %N Results



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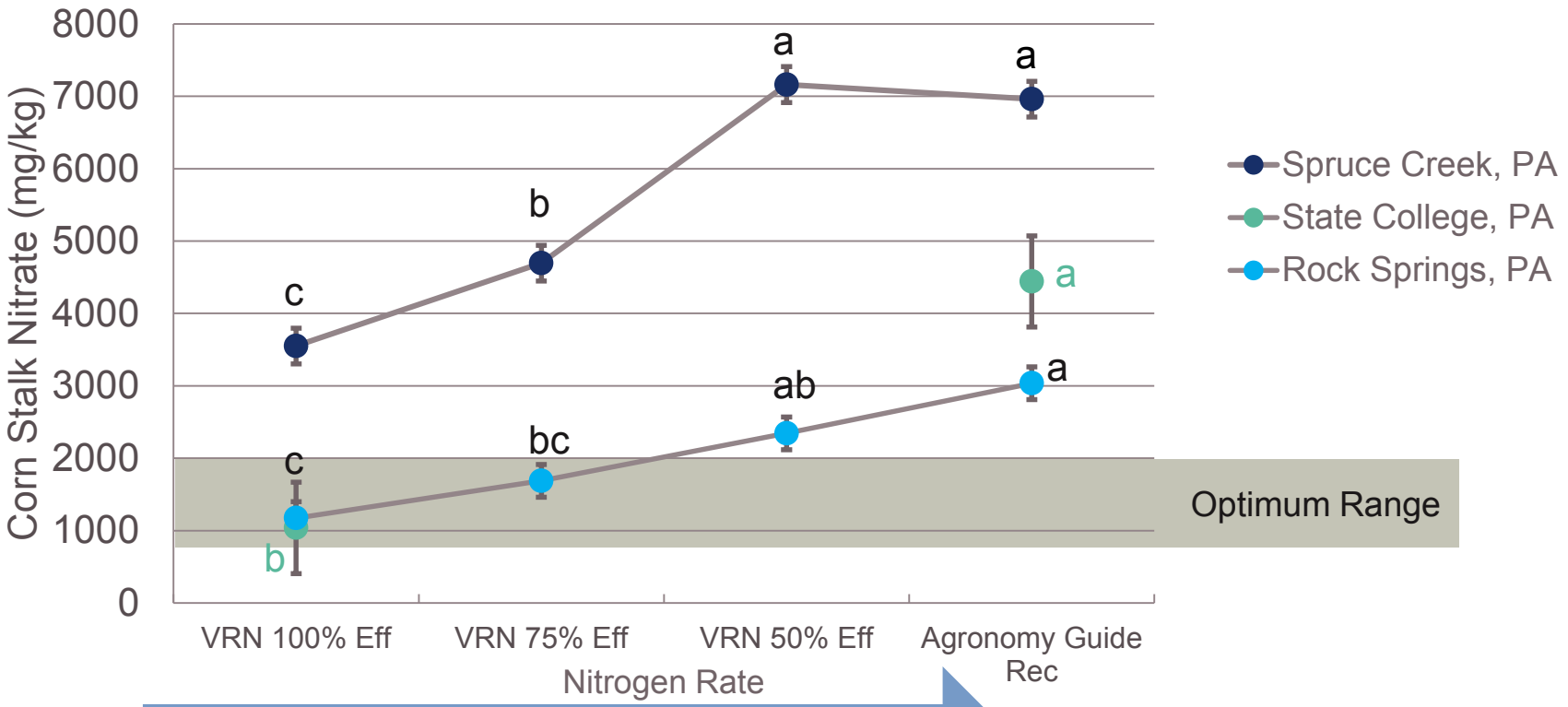
Corn Stalk Nitrate Results



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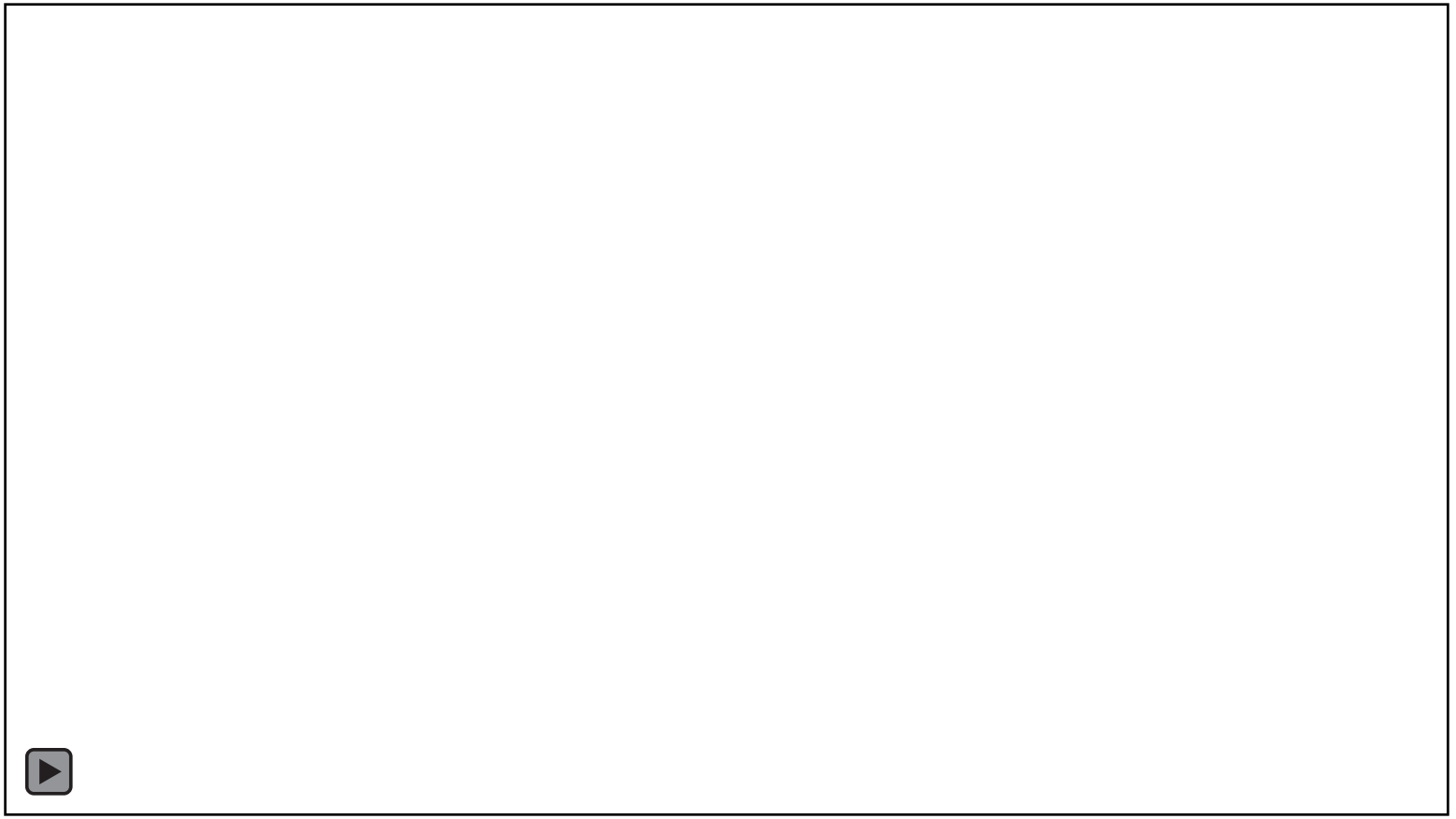
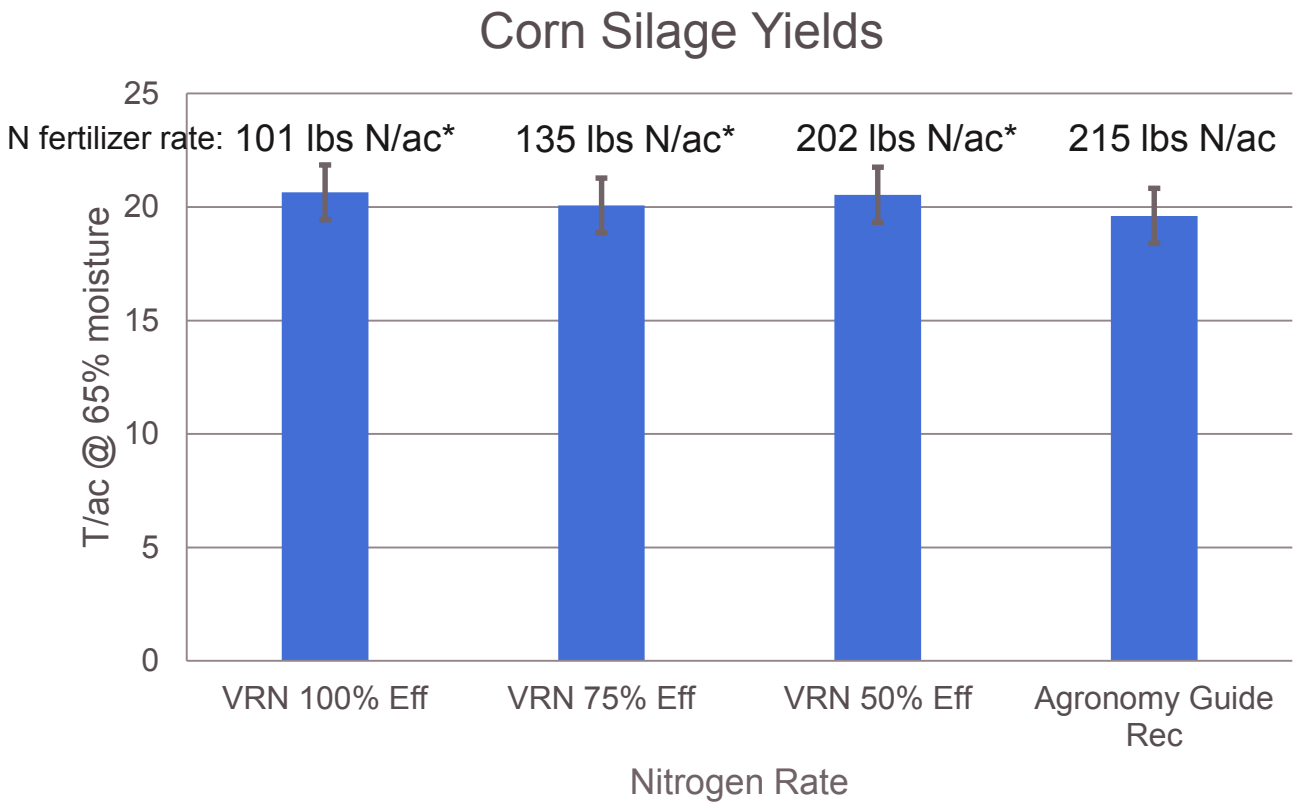
Yield Results from Spruce Creek, PA



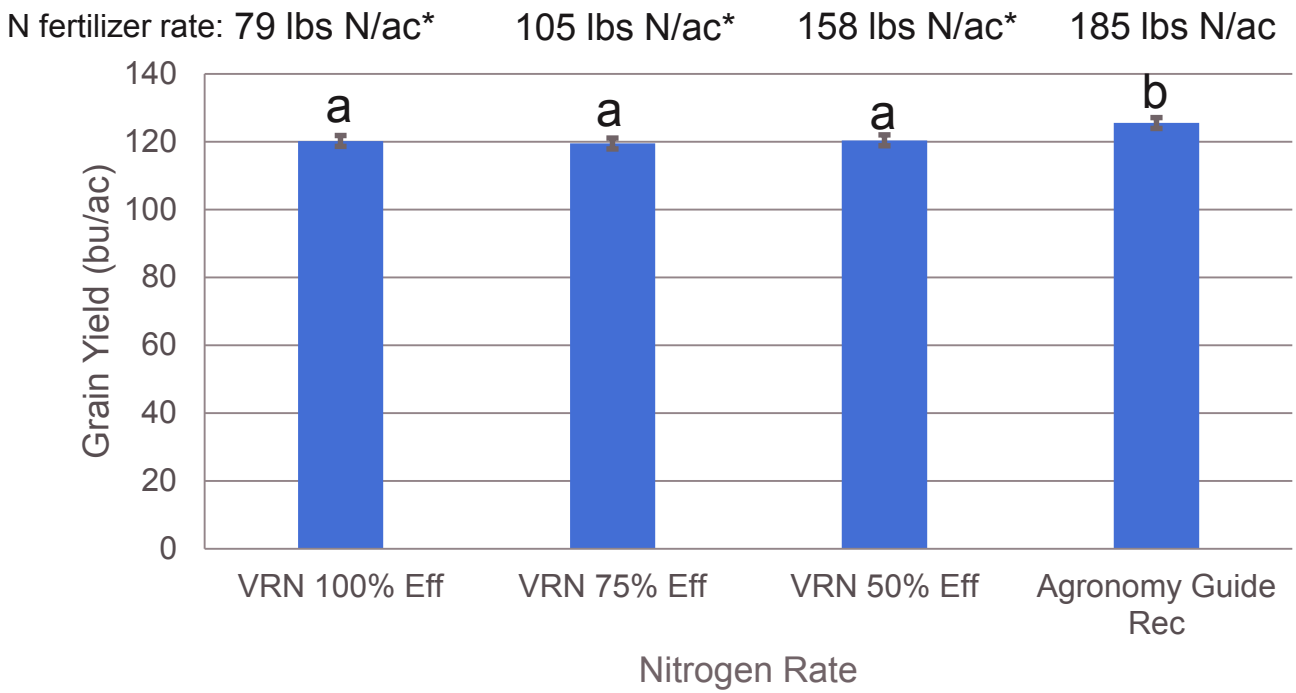
Yield Results from On-Farm Exp. Spruce Creek, PA



*Area weighted average across the fertilizer variable rate zones

No significant difference in yields (F-test, P=0.55)

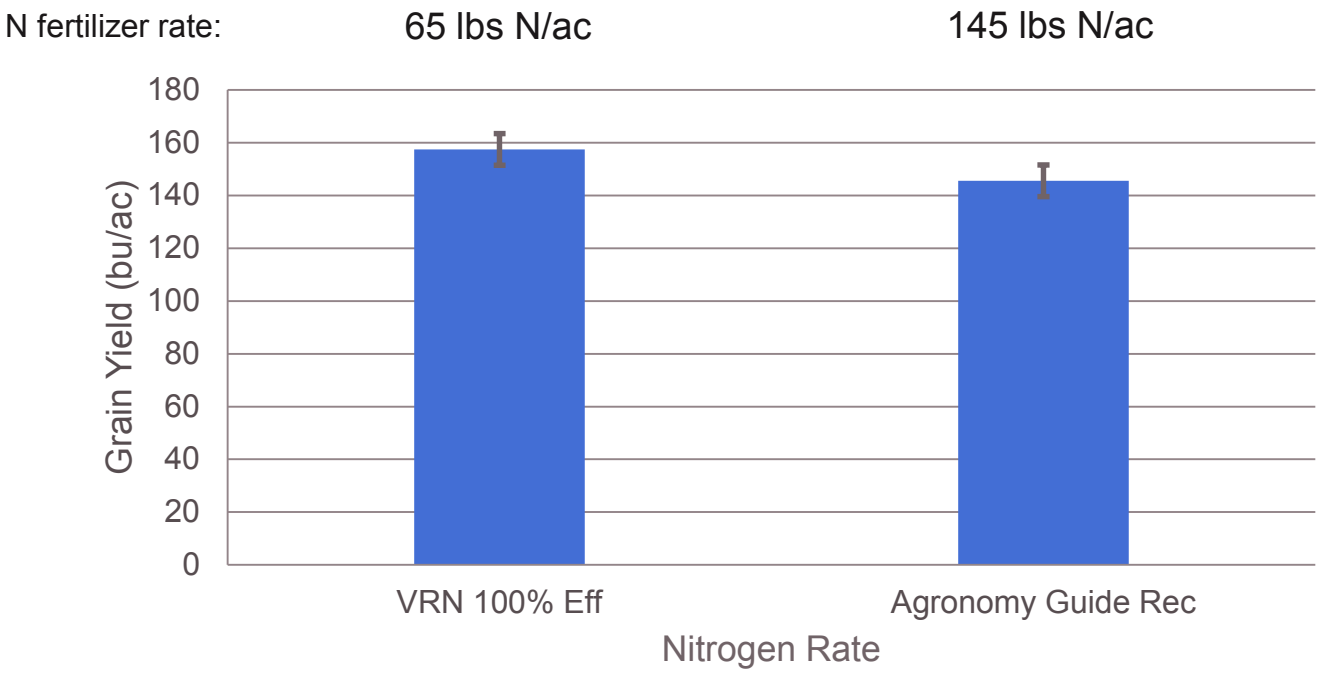
Yield Results from Rock Springs, PA



*Area weighted average across the fertilizer variable rate zones

Yield increase of 5 bushels with ~100 lbs extra N fertilizer is not economical

Yield Results from State College, PA



No significant difference in yields (F-test, P=0.19)

Concluding Thoughts

- Calibrated a biogeochemical equation with agronomic field trials to develop N credits from cover crops and soil organic matter
- Combined commercially available sensor technologies to gather inputs for a variable rate prescription
- Aiming for 100% fertilizer N recovery- how close can we get?
- Further data will help validate and refine the approach

Many Thanks!!

- **Collaborating Farmers**
  - Ed Quigley, Brian Macafee, Don Rill
- **PSU Agronomy Research Farm and Agronomy Extension Team**
  - Hanna Wells, Lucas Stover, Jeff Metz, Scott Harkcom, Ron Hoover
- **Plant Science Dept. Grad Students and Technicians**
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  - Al Cook and Jim Grove
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  - Josh Cawley

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