Improving nutrient management recommendations: the "Zero N" Project

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Reducing Nutrient Loading into the Chesapeake Bay

- Nitrogen decreased `17% from 2009 to 2023
  - Only 57% of the goal by 2025...
  - 43% reduction needed to a year to meet goal
- Phosphorus decreased by 17% from 2009 – 2023
  - 67% of the goal by 2025

- Agricultural sector is responsible for 43% of that reduction.
  - Only West Virginia and Washington DC is on track to meet the 2023 pollution targets for nitrogen and phsophorus
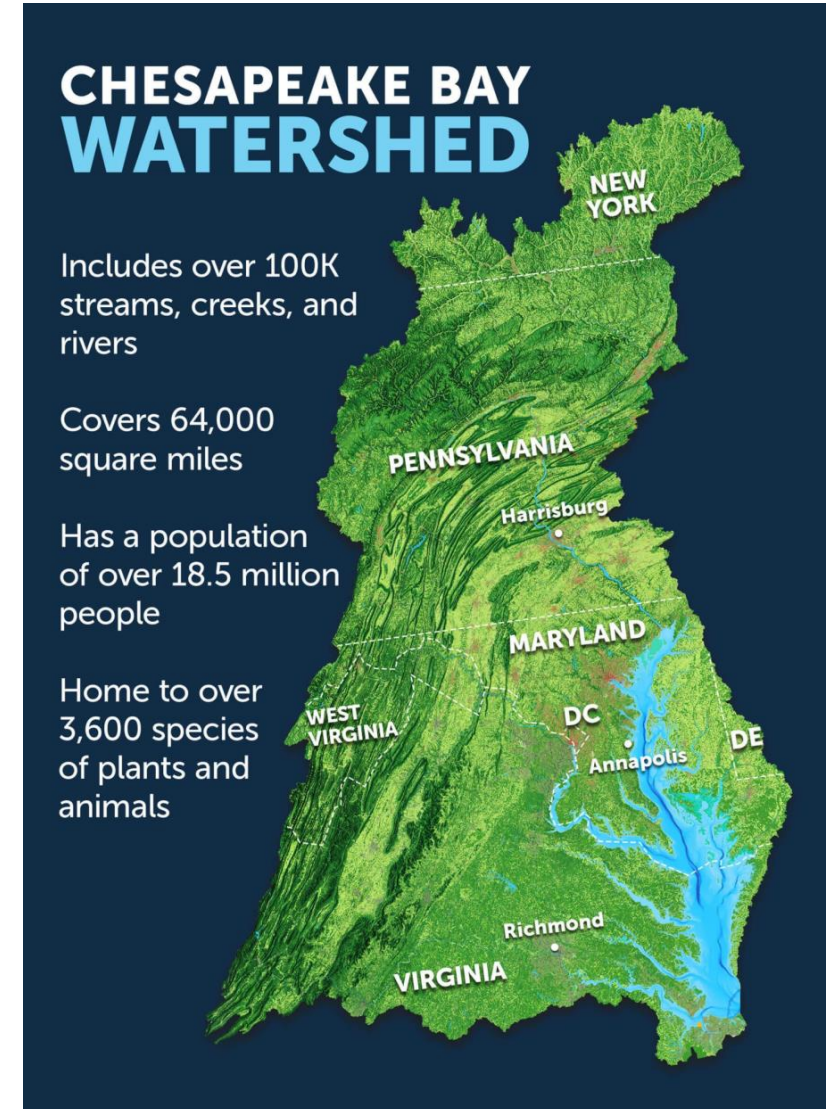
How do we meet the goals for nitrogen loading while maintaining crop yields?

- How do we improve nitrogen management across the Chesapeake Bay Watershed?
  - University nitrogen recommendations are decades old and often use the assumption that nitrogen is mobile and therefore do not credit carryover or residual nitrogen reserves
  - Crop yields are increasing = increased uptake
    - Farmers have to balance profitability and maximizing yields to stay in business
- Can we develop agricultural management tool that accounts for soil nitrogen reserves, contributions from organic nitrogen sources (manure and/or cover crops), higher crop yields while maximizing nitrogen use efficiency?

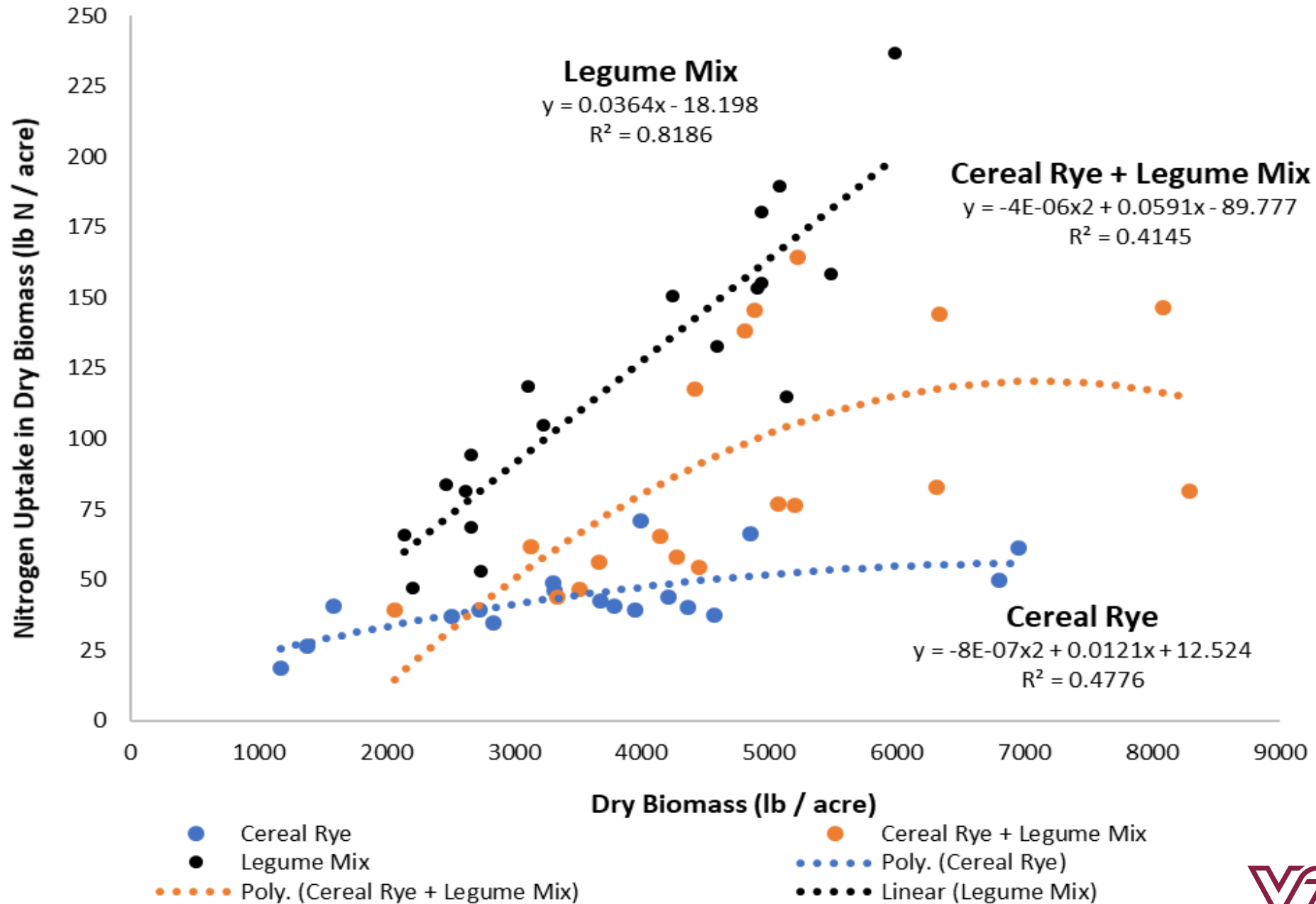Dr. Charlie White at Penn State University has developed a Nitrogen Prediction Tool for corn production

How can we incorporate this in other states to further reduced nitrogen loading in corn production systems
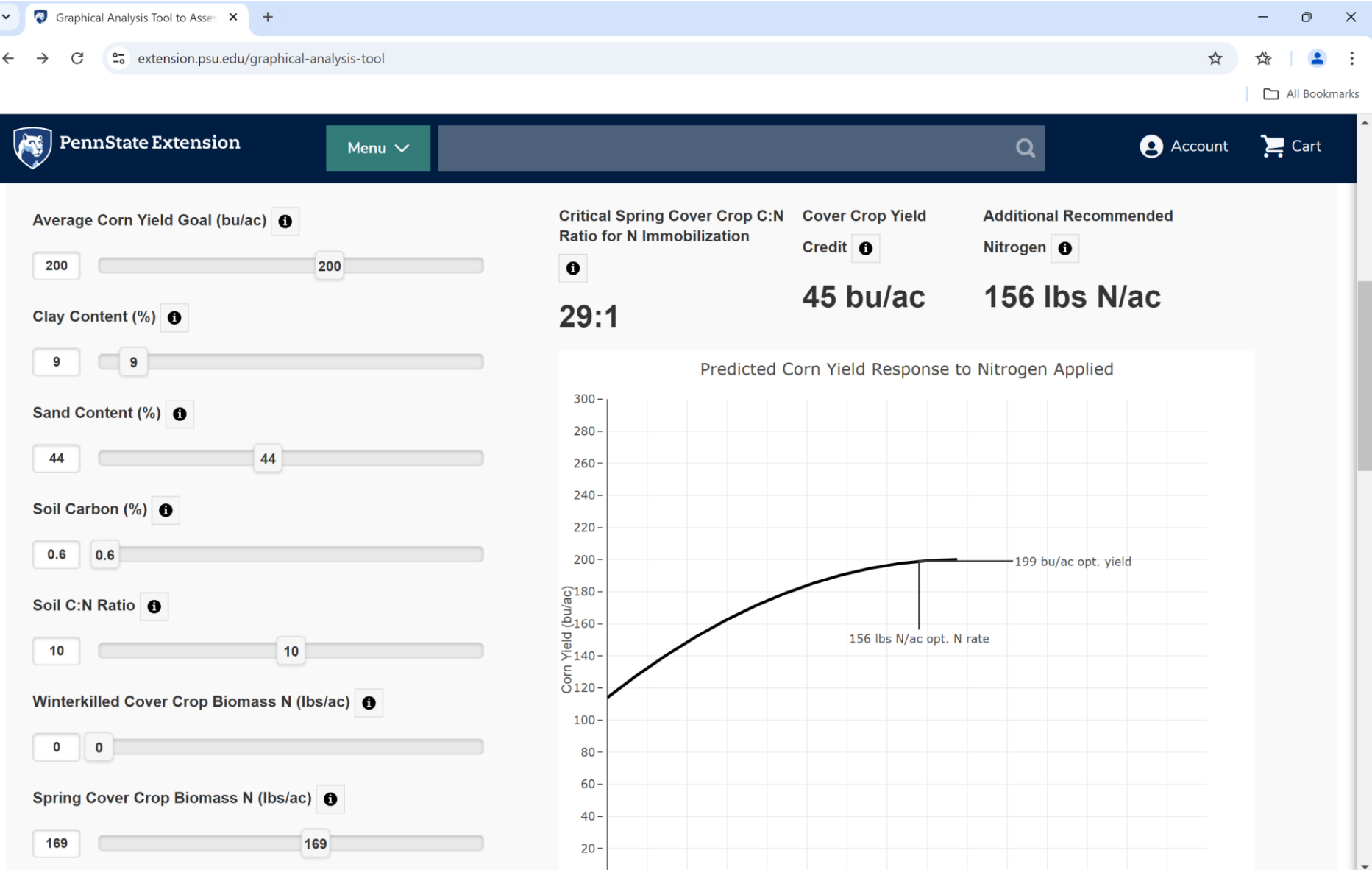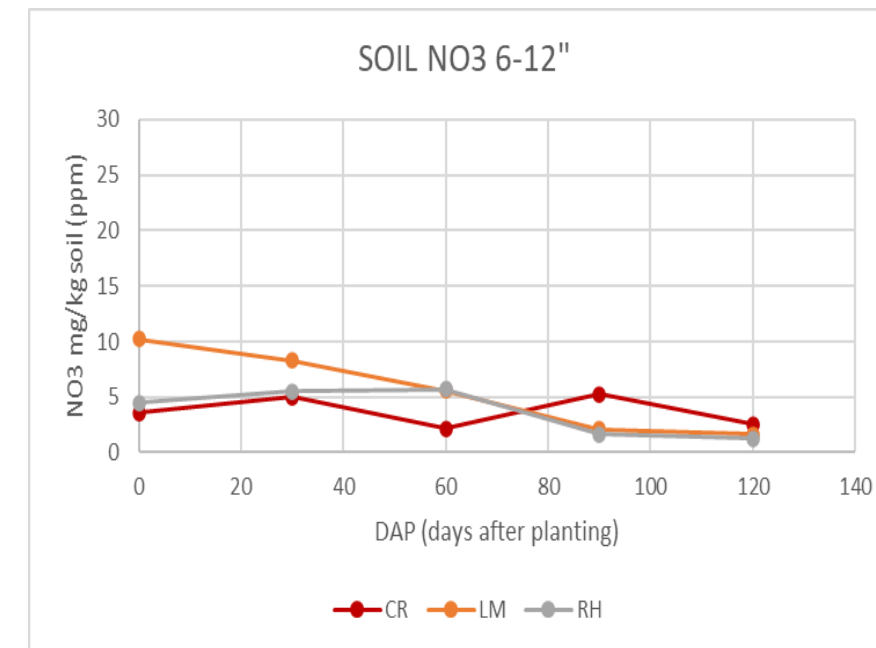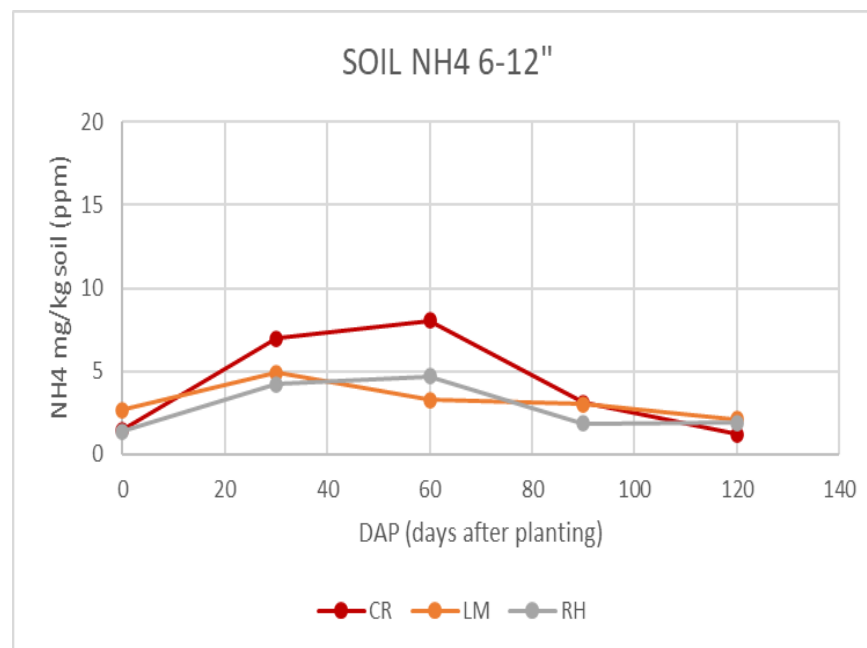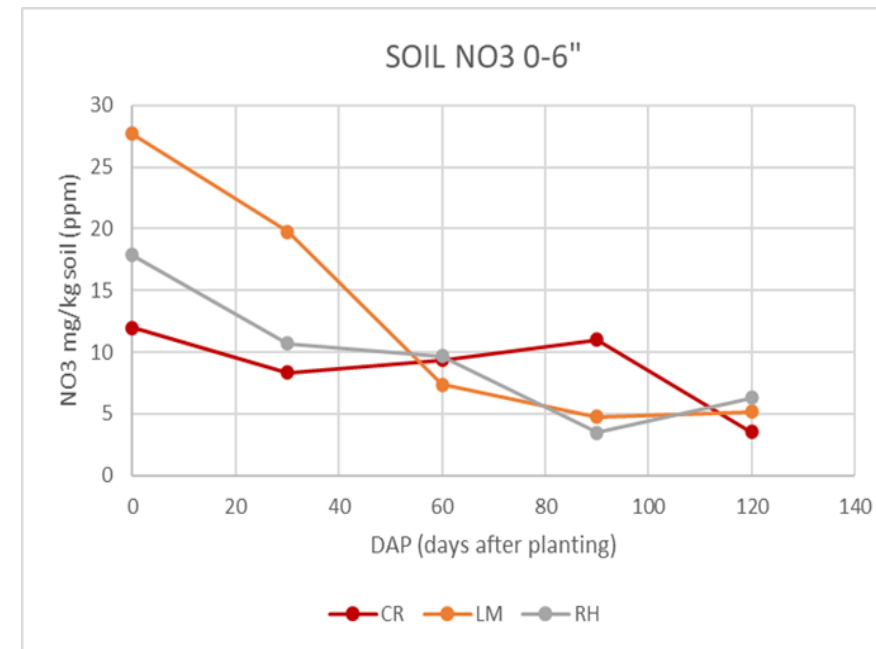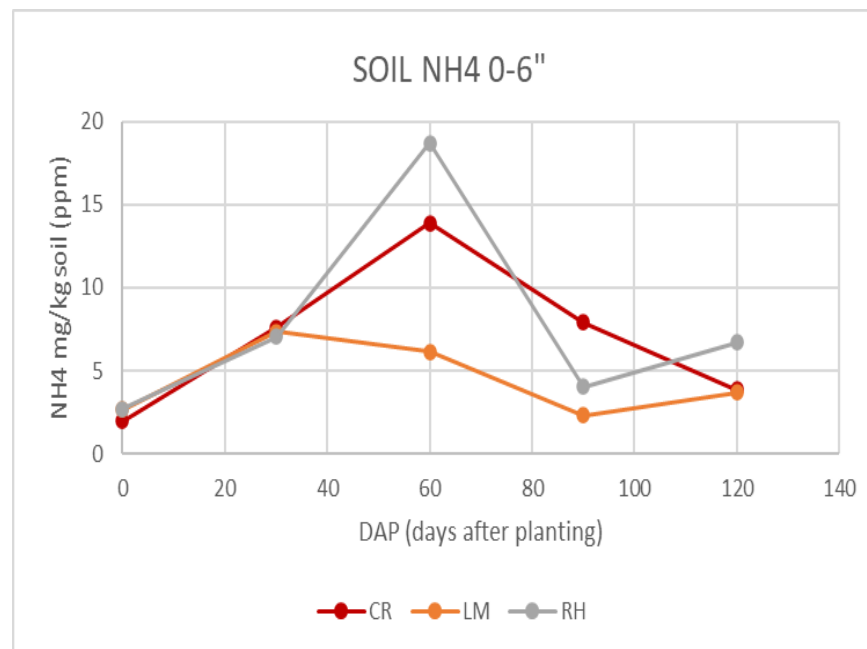
Cover Crop Nitrogen Accumulation

Year	Cover crop	Dry biomass (kg ha⁻¹)	C/N ratio	Cover crop N uptake kg N ha⁻¹
2020	Fallow	780 d*	23:1	11 d*
	Rye	2,512 c	34:1	31 c
	Legume mix	7,510 a	14:1	216 a
	Legume mix + rye	5,386 b	18:1	133 b
2021	Fallow	764 d	23:1	11 d
	Rye	3,191 c	39:1	35 c
	Legume mix	7,337 b	13:1	224 a
	Legume mix + rye	8,550 a	19:1	192 b
2022	Fallow	1,578 d	25:1	23 d
	Rye	4,371 c	51:1	37 c
	Legume mix	8,220 a	17:1	189 a
	Legume mix + rye	7,578 b	18:1	175 b

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Nitrogen Uptake of Cover Crops

Legume Mix
$y = 0.0364x - 18.198$
$R^2 = 0.8186$

Cereal Rye + Legume Mix
$y = -4E{-}06x2 + 0.0591x - 89.777$
$R^2 = 0.4145$

Cereal Rye
$y = -8E{-}07x2 + 0.0121x + 12.524$
$R^2 = 0.4776$

Nitrogen Uptake in Dry Biomass (lb N / acre)

Dry Biomass (lb / acre)

- Cereal Rye
- Legume Mix
- Poly. (Cereal Rye + Legume Mix)
- Cereal Rye + Legume Mix
- Poly. (Cereal Rye)
- Linear (Legume Mix)

SOIL NH4 0-6"

SOIL NO3 0-6"

SOIL NH4 6-12"

SOIL NO3 6-12"

Cotton Lint Yield Following Cover Crops – 2023 Edwards On-Farm Trial

Y-axis: Lint Yield (lb per acre), scale 0 to 1800

Bar groups:
- Legume Mix (AB) — 0 lb N
- Rye + Legume Mix (B) — 60 lb N
- Cereal Rye (A) — 120 lb N

VIRGINIA TECH
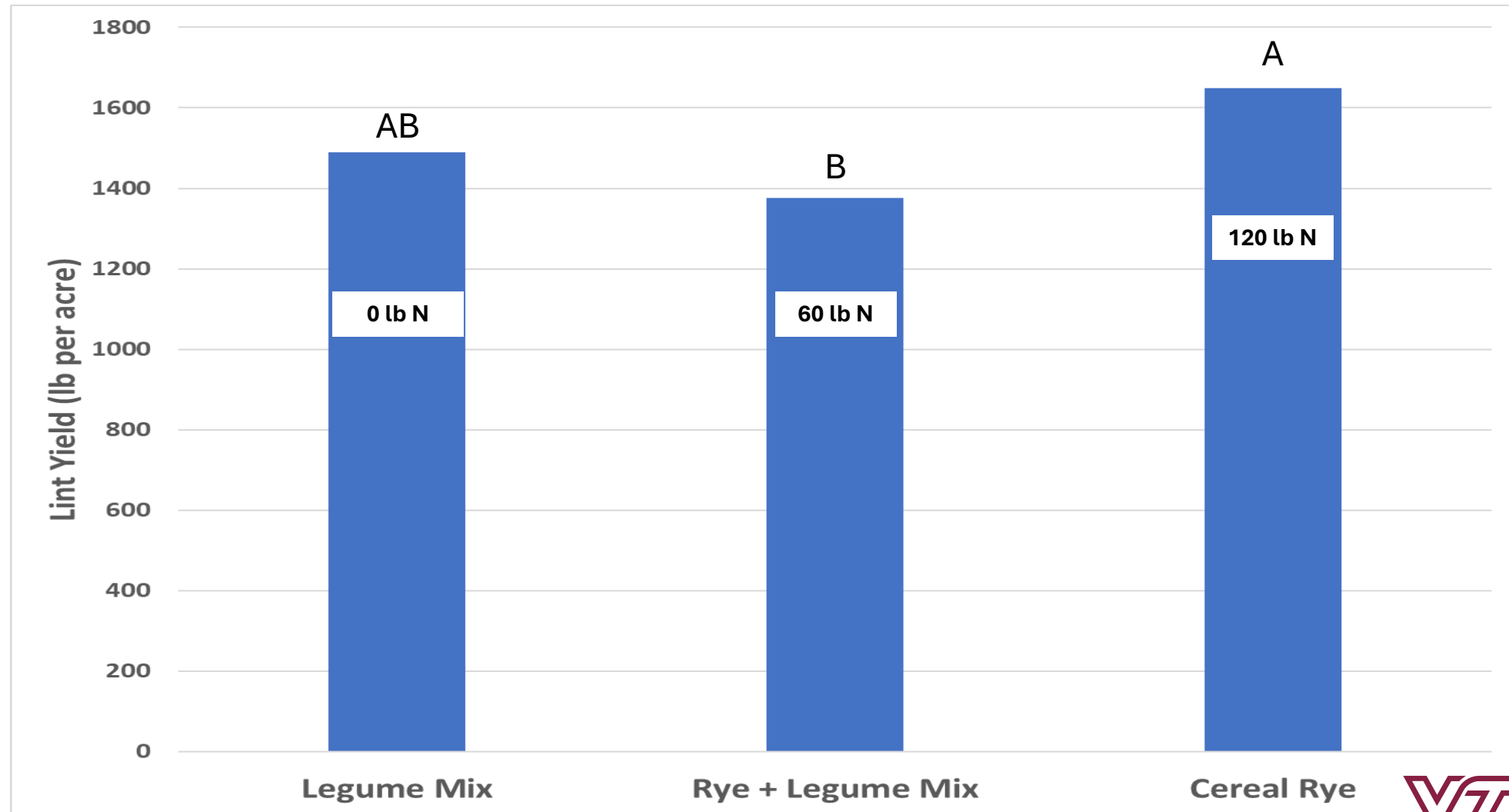
Corn results
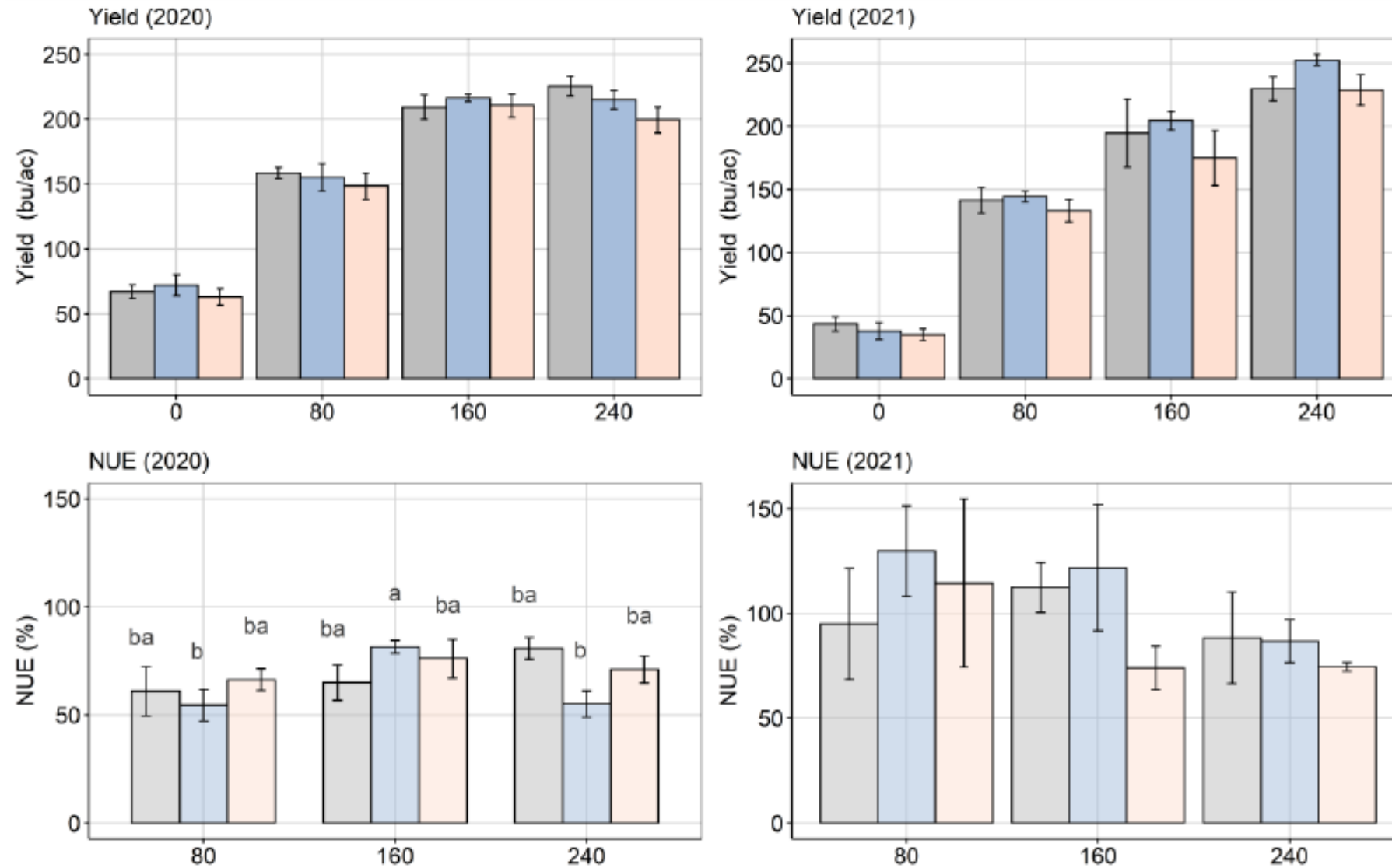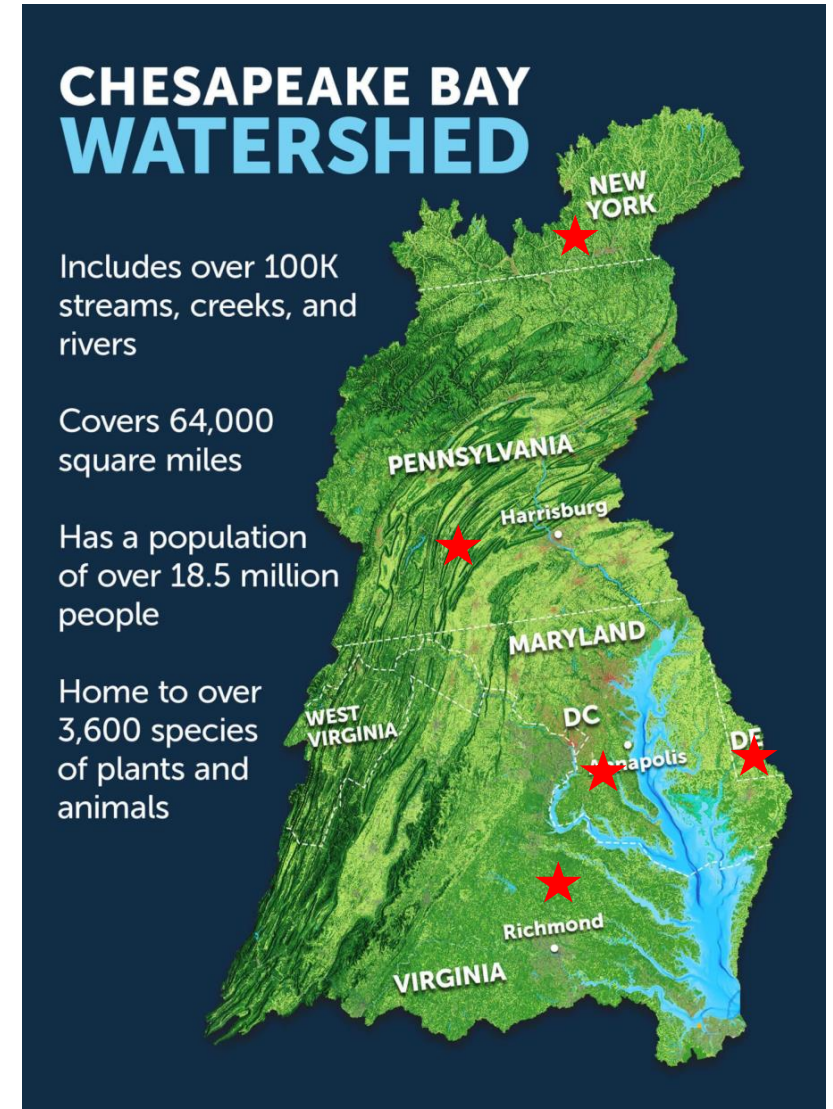
Taken from Sangha et al. (2022)

Proposed Research and Implementation Project

- Validate Dr. White's Nitrogen Prediction Tool across a broader geographic area (Chesapeake Bay Watershed)
  - Virginia, Maryland, Delaware, New York and Pennsylvania
- Measure the impact of using the prediction tool on applied N application rates versus optimal nitrogen application across varying soil type and environmental conditions
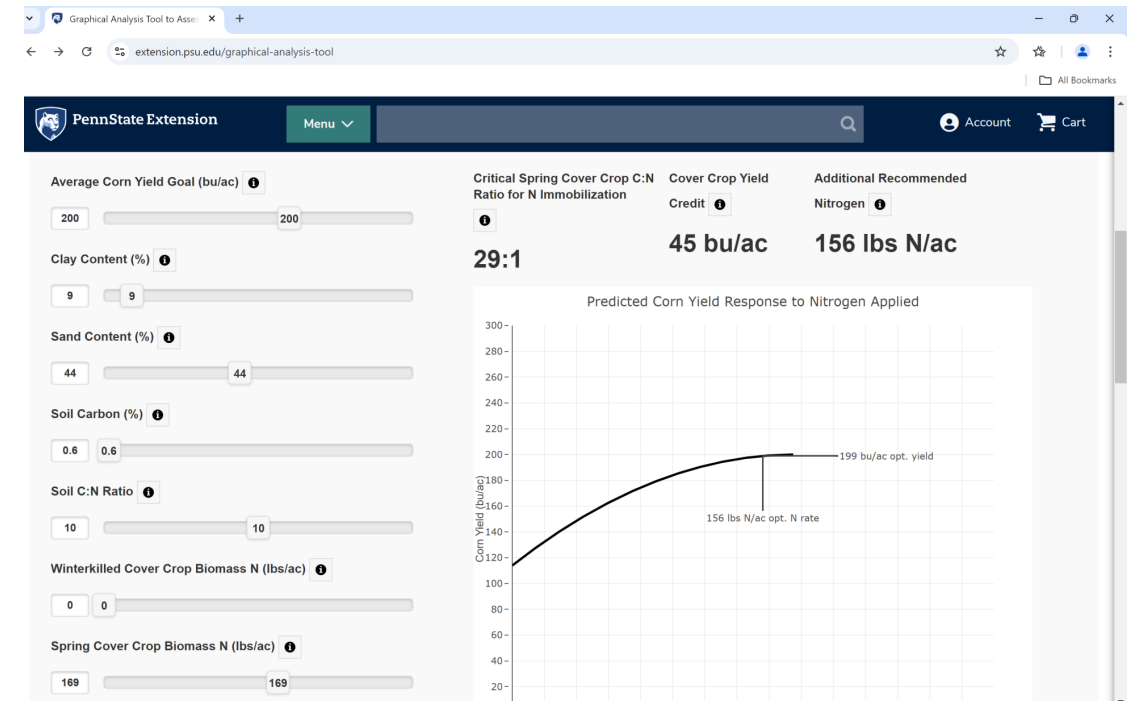
Field Research and Proposed Sites

- Five states encompassing the entire Chesapeake Bay Watershed
  - Three on-farm locations within each state (45 sites over the duration of the study)
  - 3-year study
  - Each location will have replicated N application strips and predictive model application rate
    - Each site will have the soil type characterized and cover crop/manure inputs documented
    - Preplant soil samples will be collected and analyzed for soil nitrate-N availability

- Select locations will further describe the contributions of various cover crops species across environments

- Earth Optics will partner with project to develop a rapid cover crop biomass estimation using remote sensing
  - This will allow for site specific and precision nitrogen management at the field level for producers

CHESAPEAKE BAY WATERSHED

Includes over 100K streams, creeks, and rivers

Covers 64,000 square miles

Has a population of over 18.5 million people

Home to over 3,600 species of plants and animals

Projected Outcomes for the Chesapeake Bay

- Identify soils and production practices that influence residual soil nitrogen levels that can be used to predict fields where fertilizer nitrogen can be reduced or not applied at all.
  - This would significantly reduce fertilizer nitrogen application rates and potentially meet nitrogen reduction goals for the Chesapeake Bay
- Accurately predict the release and availability of nitrogen from legume cover crops to allow producers another option to fertilizer nitrogen sources
- Develop an updated recommendation database for Extension in all states within the Chesapeake Bay Watershed.

Thank You!
Questions?

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