Fine Tuning Nitrogen Recommendations across the U.S. Cotton Belt: A Multi-Faceted Approach

DR. HUNTER FRAME, VA TECH

DR. RYAN STEWART, VA TECH

DR. KATIE LEWIS, TEXAS A&M

DR. GLENN HARRIS, UNIVERSITY OF GEORGIA

D.R TYSON RAPER, UNIVERSITY OF TENNESSEE

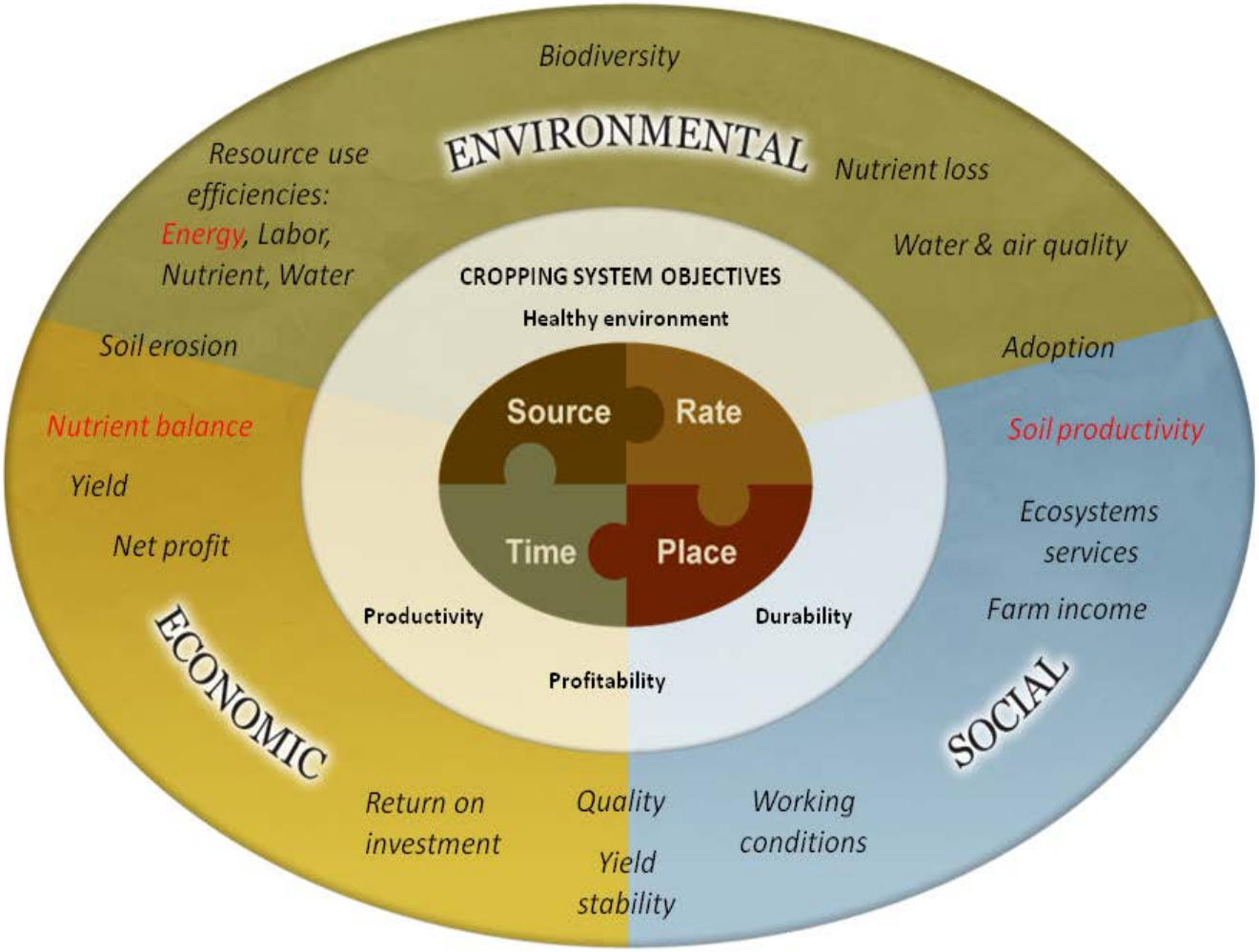
10/22/2020

Why do we need to RE-evaluate cotton nitrogen use?

- 2017- 373,409 metric tons of nitrogen (N) were applied to cotton
- 43% nitrogen use efficiency (NUE) in cotton (Bronson, 2008)
  - >200,000 metric tons of N were lost to the environment that year
- How do we use the 4R's of nutrient management to increase NUE in cotton production
- Do the N recommendations for each cotton growing state change and are they up to date?

Current State Recommendations for Nitrogen in Cotton

State	Extension Nitrogen Recommendations
Alabama	101 ± 34 kg N ha^{-1} in split application for all soils
Florida	67 kg N ha^{-1} in split applications
Georgia	67 to 118 kg N ha^{-1} in split applications based on realistic yield goals of 842 to 1,684 kg lint ha^{-1}.
Mississippi:	56 to 67 kg N $bale^{-1}$ on "light-textured soils"; 67-78 kg N $bale^{-1}$ on "medium textured soils"; split applications if over 112 kg N ha^{-1} applied.
North Carolina	56 to 78 kg N ha^{-1} in split applications
South Carolina	78 ± 34 kg N ha^{-1} in split applications
Virginia	Yield goal based: 56 kg N per bale of expected yield (Available soil N will contribute 22-34 kg N ha^{-1})
Tennessee	34 to 67 kg N ha^{-1} on bottom soils; 67 to 90 kg N ha^{-1} on upland soils
Texas	50 kg N $bale^{-1}$



IPNI. 4R Diagram. 4R Nutrient Stewardship Portal. International Plant Nutrition Institute. June 2009. http://www.ipni.net/4r

2019 Proposal to 4R Fund for Updating Cotton N Requirements

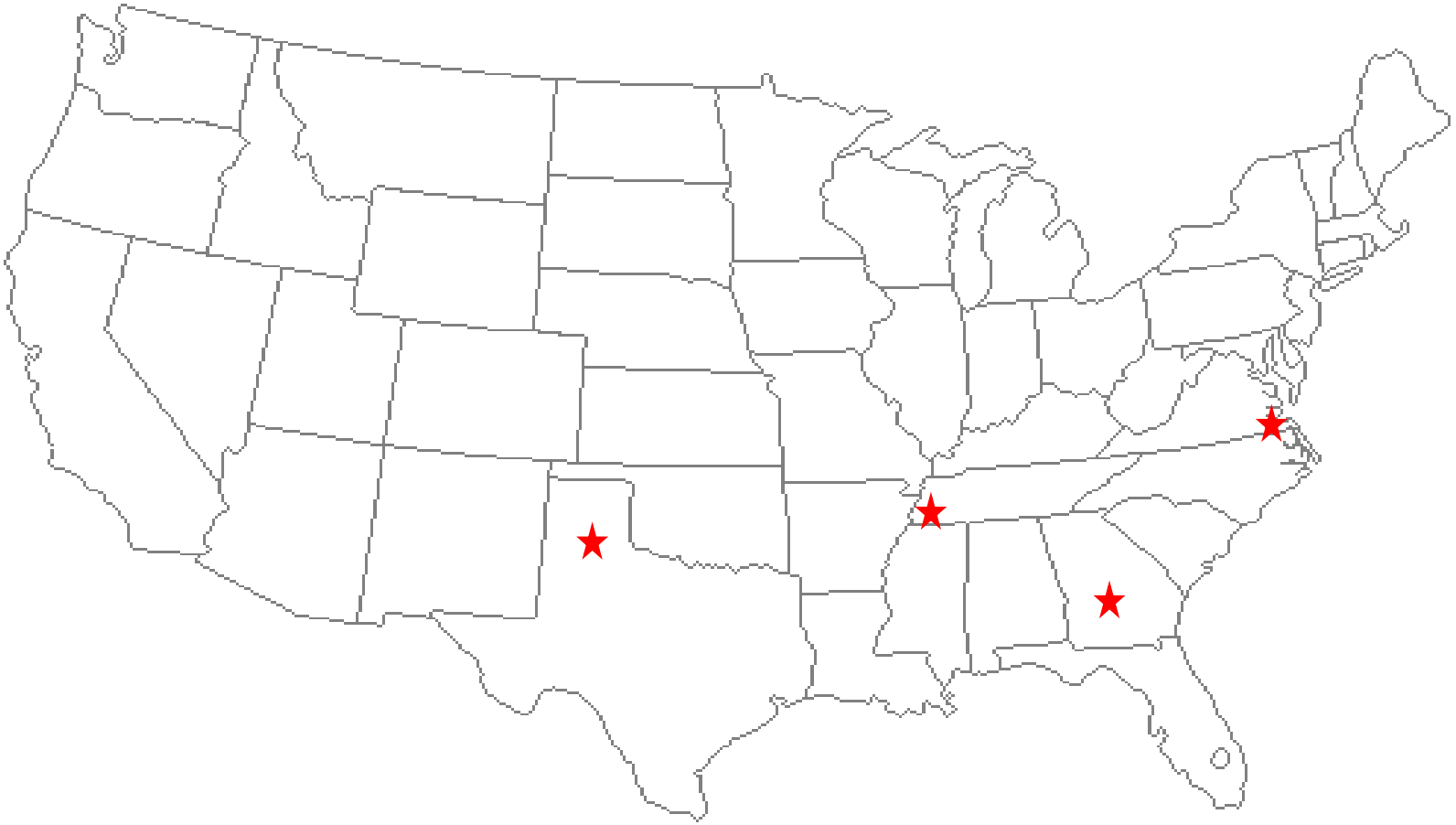
1. Quantify the agronomic response to varying N rates and placement strategies of contemporary cotton varieties adapted to major production regions.
   - 4 locations from 2019 - 2021

2. Determine the impact of EEF's on N transformations and NUE in cotton production systems. More specifically:
   a. Measure gaseous losses of N species and other greenhouse gases from common N fertilizers, and leaching losses of N applied at varying N application rates and placements with and without enhanced efficiency N fertilizer additives or products
      - VA and TX using Gasmet 4040 to monitor gas flux from 2019-2022
   b. Quantify the effectiveness of current N stabilizers and slow/controlled release N products on N transformations/species in representative soil types from the U.S. Cotton Belt using controlled laboratory environments.
      - A horizon soils from each N placement x application rate trials are sent to Dr. Frame's laboratory for ammonia volatilization

3. Measure the impact of various cover crops and cropping rotations on N cycling and availability in different regional production systems, and evaluate the responsiveness of cotton to applied N at those locations.
   - 4 locations from 2019 - 2022

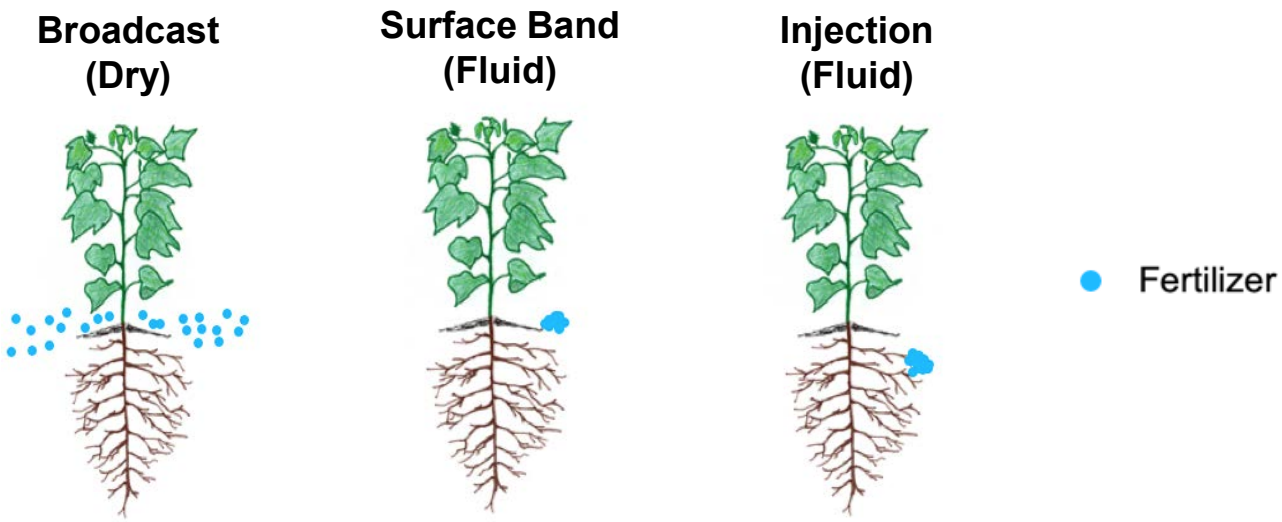
4. Develop a comprehensive management guide that informs regional management practices, thus reducing off target movement of N and maximizing the NUE of cotton systems.

Trial Locations from 2019-2023



Nitrogen Placement and Application Rate Trials

Nitrogen placement determines nutrient acquisition by roots and potential losses to the environment

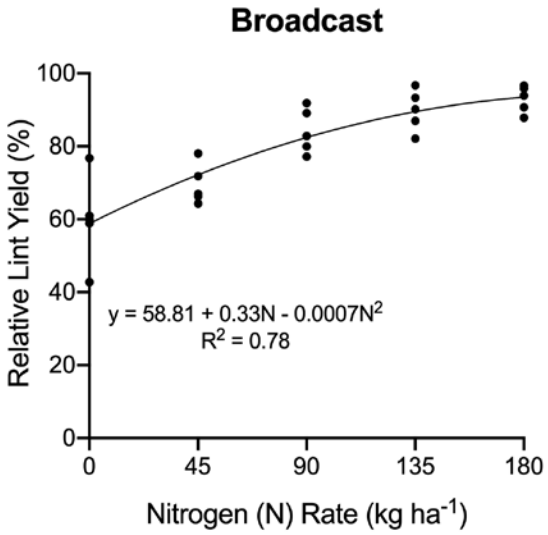


Applied at six rates: 0, 45, 90, 135, 180, and 225 kg N ha^{-1}

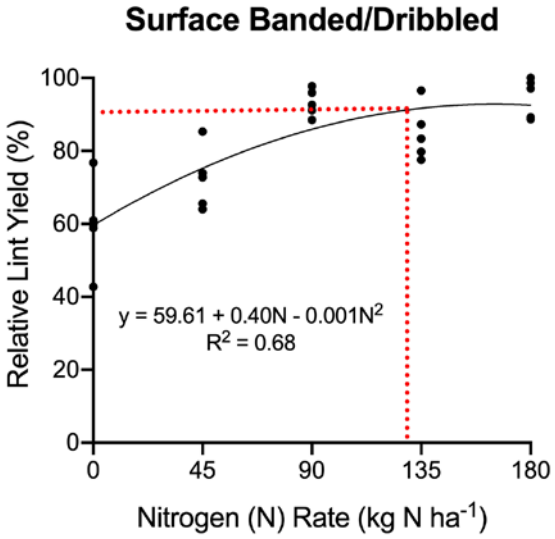
How does cotton respond to different placement methods across US Cotton Belt?

How does the optimal N rate change based on placement method?

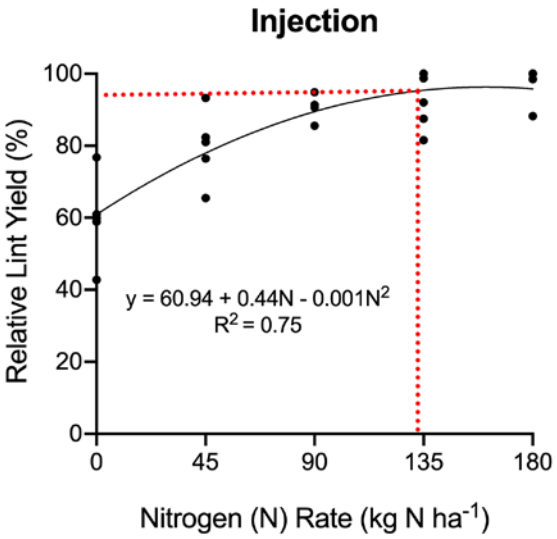
Three Year Nitrogen Rate/Placement Study in Virginia/North Carolina (2016 – 2018)



Join point not shown
Optimal N Rate: >180 kg N ha^{-1}
Max Relative Yield: 94%
≈1,600 kg ha^{-1}

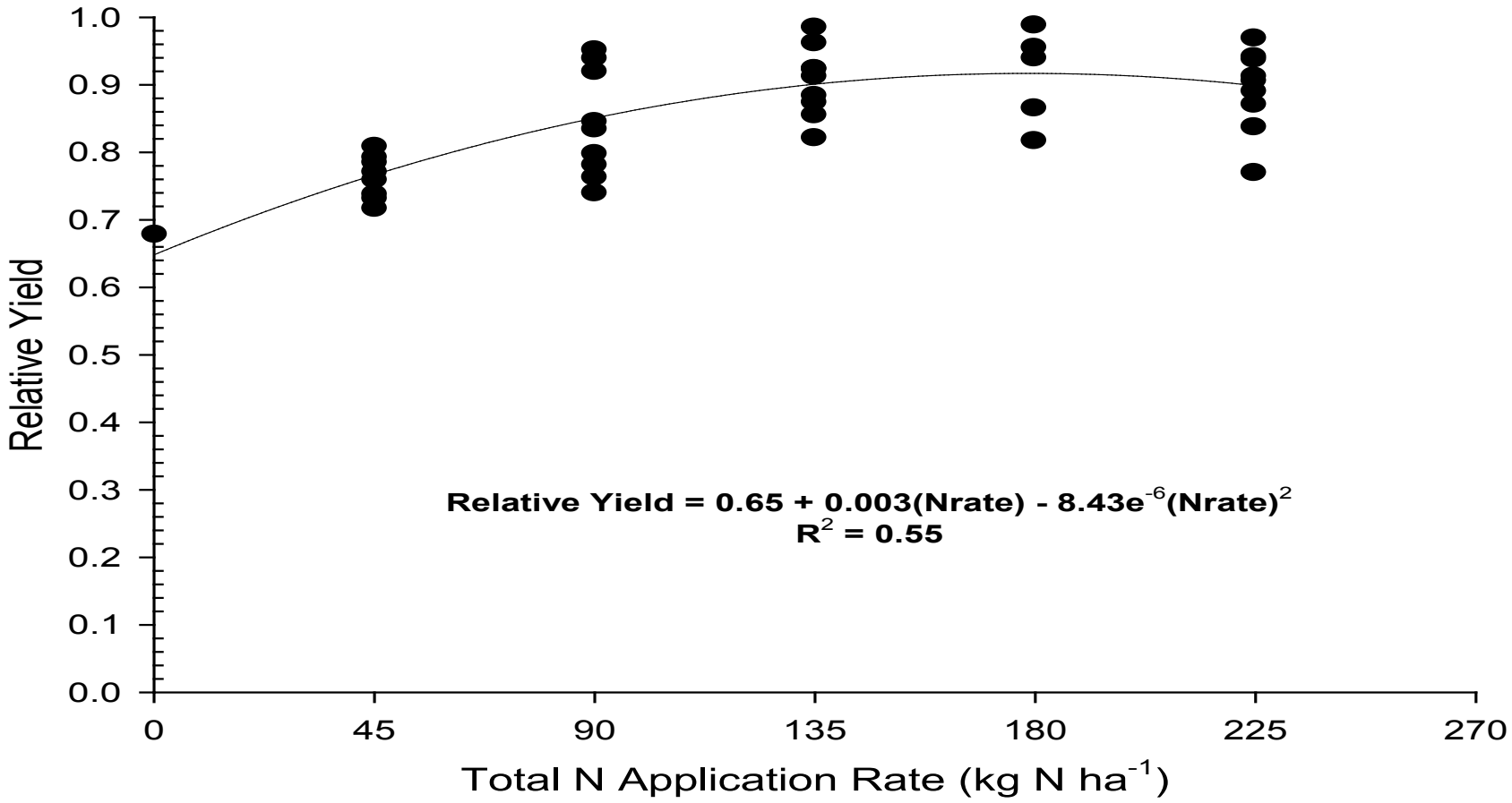


Optimal N Rate: 128 kg N ha^{-1}
Max Relative Yield: 90%
≈1,550 kg ha^{-1}



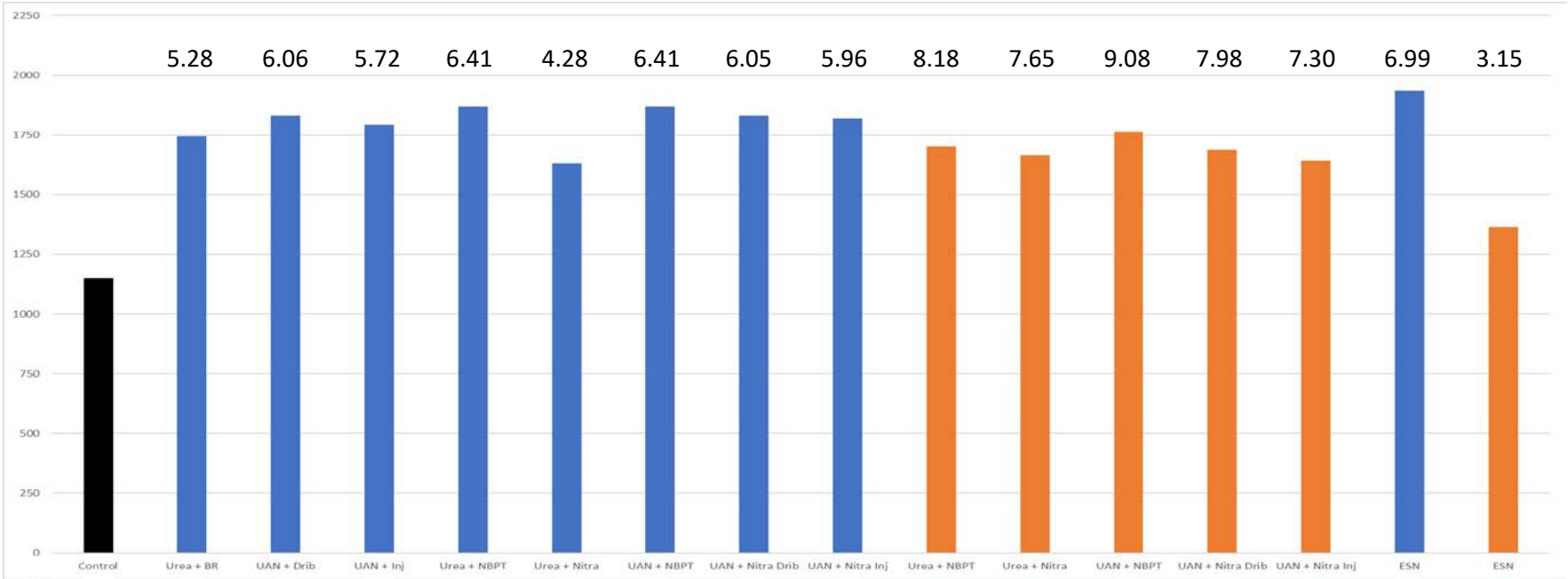
Optimal N Rate: 133 kg N ha^{-1}
Max Relative Yield: 95%
≈1,610 kg ha^{-1}

2019 Nitrogen Application and Placement Study Virginia Location



Enhanced Efficiency Fertilizer Studies

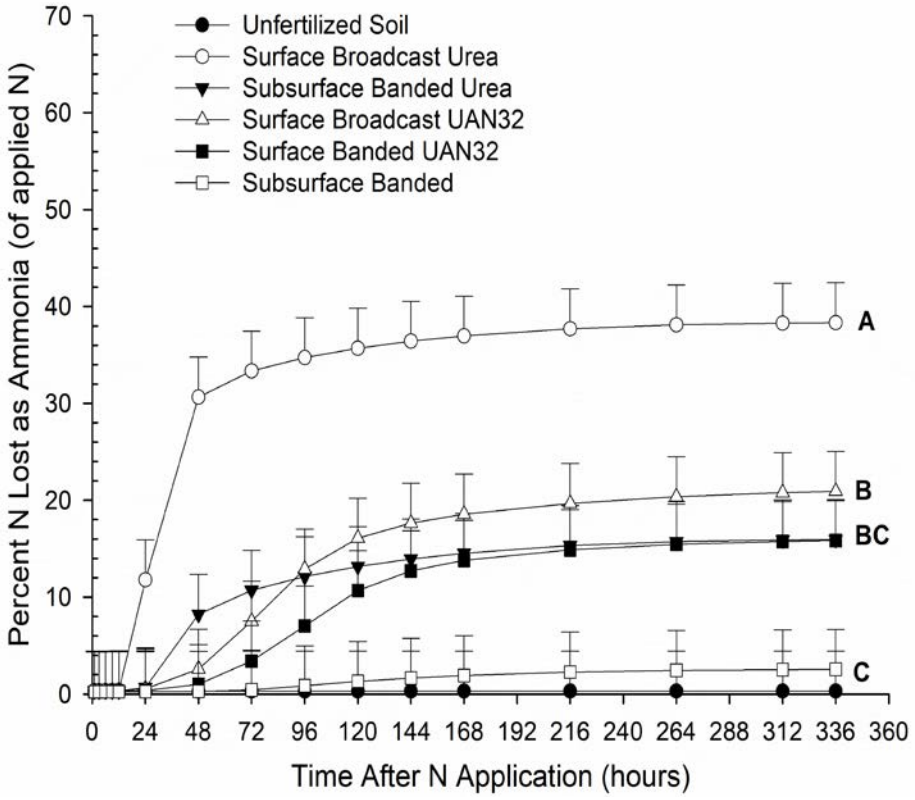
- Virginia was the only location in 2019 in order to solidify sampling protocols for future years of the study
  - Static green house gas chambers did not work
    - No consistent flux due to time from sampling to analysis and variability in crimping of vials
    - Gasmet provided a quick, consistent sampling of GHG emissions
      - Methane, nitrous oxide, ammonia, carbon dioxide simultaneously measured



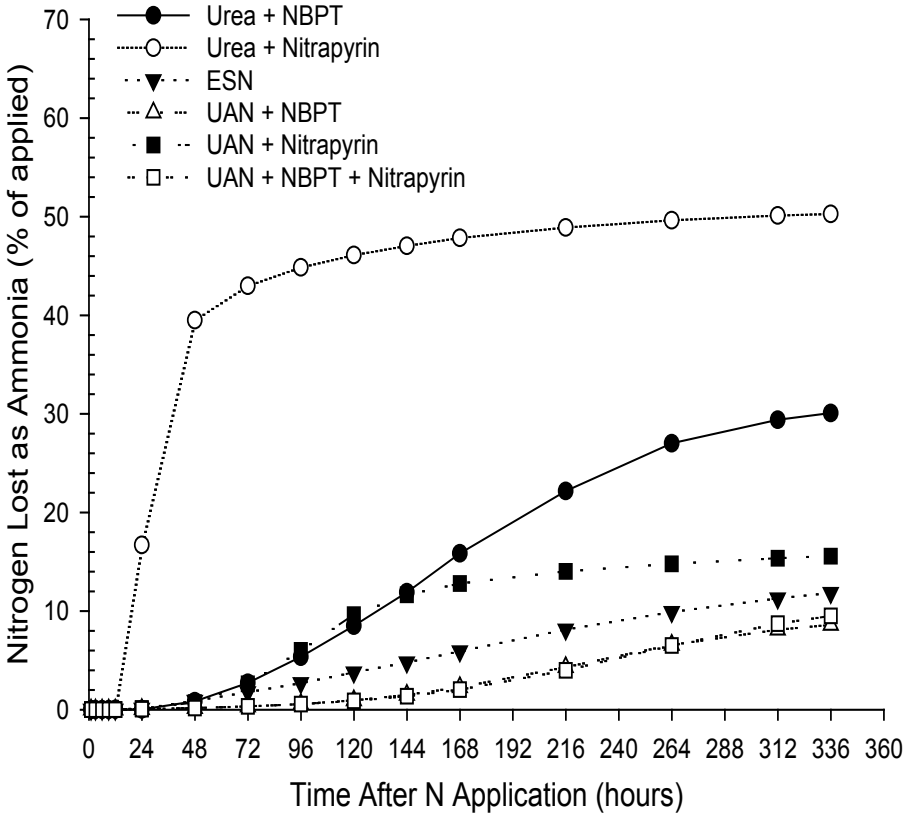
Agronomic Efficiency = kg lint / kg N applied

Ammonia Volatilization in Laboratory Trials
(Fine Sandy Loam from Virginia)

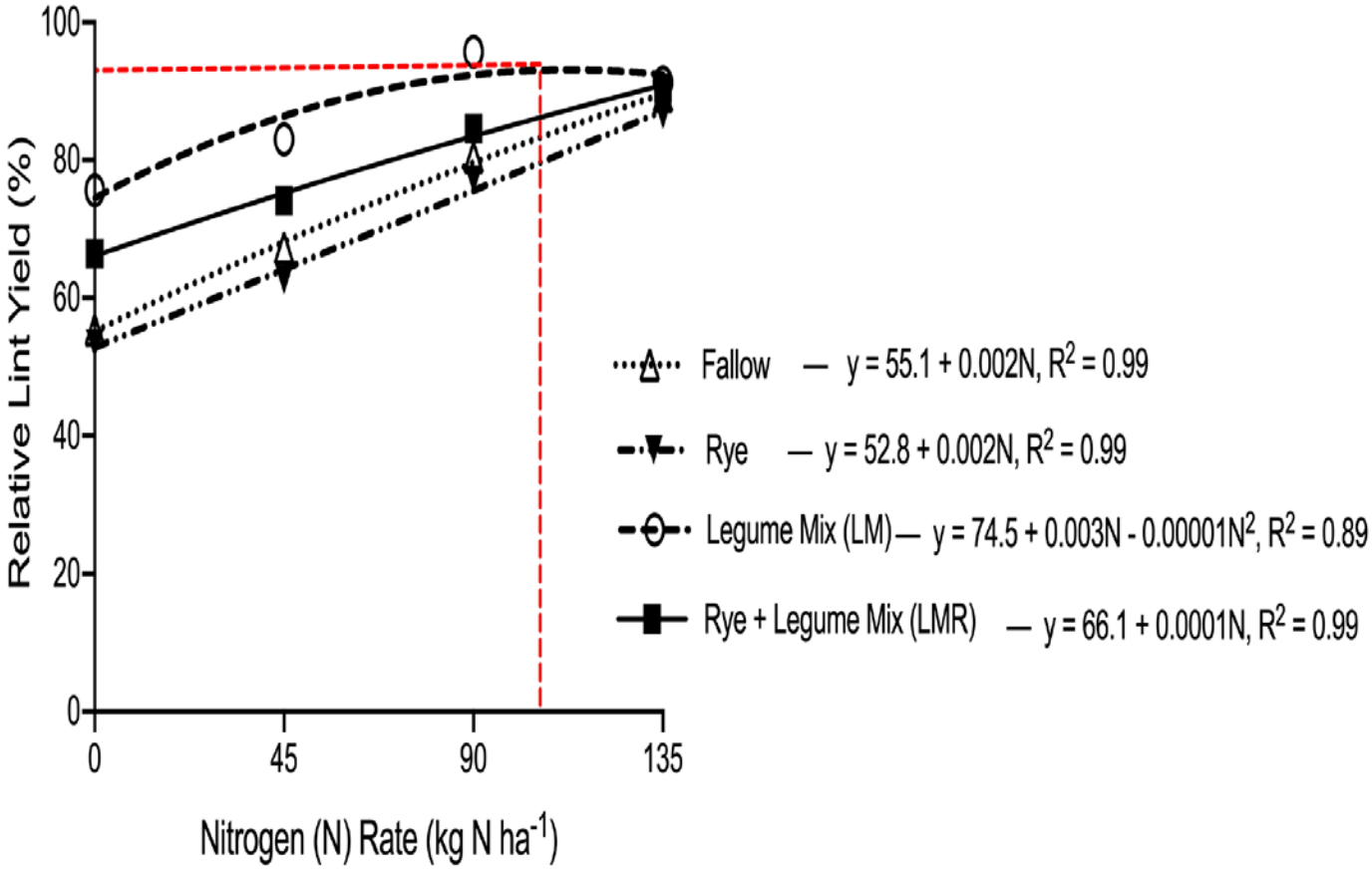
Nitrogen Placement



Enhanced Efficiency Formulations



Two Year Average Cotton Yields Following Different Cover Crops 2017-2018



→ Quadratic Plateau: 110 kg N ha^{-1} to reach 93% relative yield

Expected Outcomes for N Management in Cotton

- Optimize the N application rates in each production region of the US Cotton Belt.
  - 134 kg N ha^{-1} in Southeast?
  - 67 kg N ha^{-1} in Mid-South?
  - Do early, mid-, and late maturing varieties respond differently to N placement and rate?
- Develop N management strategies that maximize NUE across the different regions of the US Cotton Belt
  - Using EEF's versus placement in VA or TN??
- How can we incorporate legume cover crops in the different regions to reduce the need for inorganic cotton fertilizers?
  - In Virginia there is promising evidence that 0 kg N ha^{-1} behind crimson clover and hairy vetch can achieve the same lint yields as 134 kg N ha^{-1} following cereal rye.
- Development of a comprehensive guide to N management in cotton for the US Cotton Belt.

Thank You!
Questions?

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FOUNDATION FOR AGRONOMIC RESEARCH

Dr. Hunter Frame
6321 Holland Rd, Suffolk, VA 23437
Office: (757) 807-6539
Cell: (757) 653-8292
Email: whframe@vt.edu