Implications of Production and Input Technologies on Nitrogen Use

Biobased Industry Center: Project Update

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Nitrogen Fertilizer Use and Outcomes

Profit maximization under uncertainty about nitrogen loss through growing season may cause producers to apply more N than \textit{ex-post} realizations deem optimal

- economic optimal levels determined by equating \textit{marginal yield gain} (MP) from the last unit of nitrogen applied to the N-to-corn price ratio ($\frac{P_N}{P_C}$)

- Given current yield responses, N use reduction will only occur if N costs increase relative to corn prices or if the MP of N is decreased at lower application rates
The Role of Technology

Technological advances

- N fertilizer management strategies
  - availability of N for plant: N stabilizers / N-fixation
  - canopy sensing, mid-to-late season application

- Genetic advances in N Utilization Efficiency (NUE)
  - root system development
  - translocation within plant
Project Objectives

- What are the potential impacts on N use?

- Can a market value be estimated based on expected N use reduction?

- Is there a potential to meet the EPA’s call to reduce N leaching by 40%?

- What can be inferred about effects on land use?
Pathways by which Technologies Matter

NUE: allows plant to move N stores to areas as needed

N-stabilizers: reduce the 35% - 40% typically lost to decomposition, denitrification, leaching, etc.

Application advances allow mid-season application: at 30-75 days N uptake is at fastest rate (9 leaf stage – tassel)
Iowa Yield Data

- Yield response data from field-level experiments in Iowa during 1986-1991 are used to identify the potential that exists for N
  - all inputs except N are non-limiting
  - variables are weather and N
  - continuous corn rotation
  - updated to reflect 2010 yields
Site 9

Economically optimal N rate given 0.2 price ratio
Site 10

Economically optimal N rate given 0.2 price ratio

Nitrogen Rate (lbs/acre)
The **Right Amount, Right Time, Right Place**

- Use yield data to identify the minimum N that achieved the site-specific maximum yield, calculate reductions.
- Average maximum yields are achievable at lower N under various growing conditions.
- One measure of value of technology is reduced N costs.

Ex: 100 lbs/acre achieved avg max yield for site

Potential N savings of $60/acre
Potential savings: $90/acre

Site 10

Economically optimal N rate given 0.2 price ratio
What is the Value?

- The technologies reduce the effect of temporal uncertainty over N availability.
- Simple analysis indicates 30% - 50% reduction in N needed to achieve current yield “targets” given current yield responses.
- Assuming average fertilizer costs of $120 / acre in Iowa, data indicate a potential savings of $36 - $60 / acre depending site-specific characteristics.
- Reduction in N pollution by 40% seems feasible.
Other Considerations

• Mid- and late-season application and canopy sensing result in increased compaction, custom application decreases likelihood of widespread adoption but perhaps most feasible of all technologies
• Value to environment should be considered
• Unknown effects of stabilizers and NUE on soil organic matter and post-season nitrate levels
• Yield response may not be stable under technology, intensive and extensive margin driven by yield response, planting populations
Next Steps

• Simulate yield response curves to estimate sensitivity of optimal N application.

• Estimate effects if corn-soybean rotation is used

• Locate longer series of yield data
Questions, Comments?

Thank you for your time.