How Can We Improve Nitrogen Use Efficiency?

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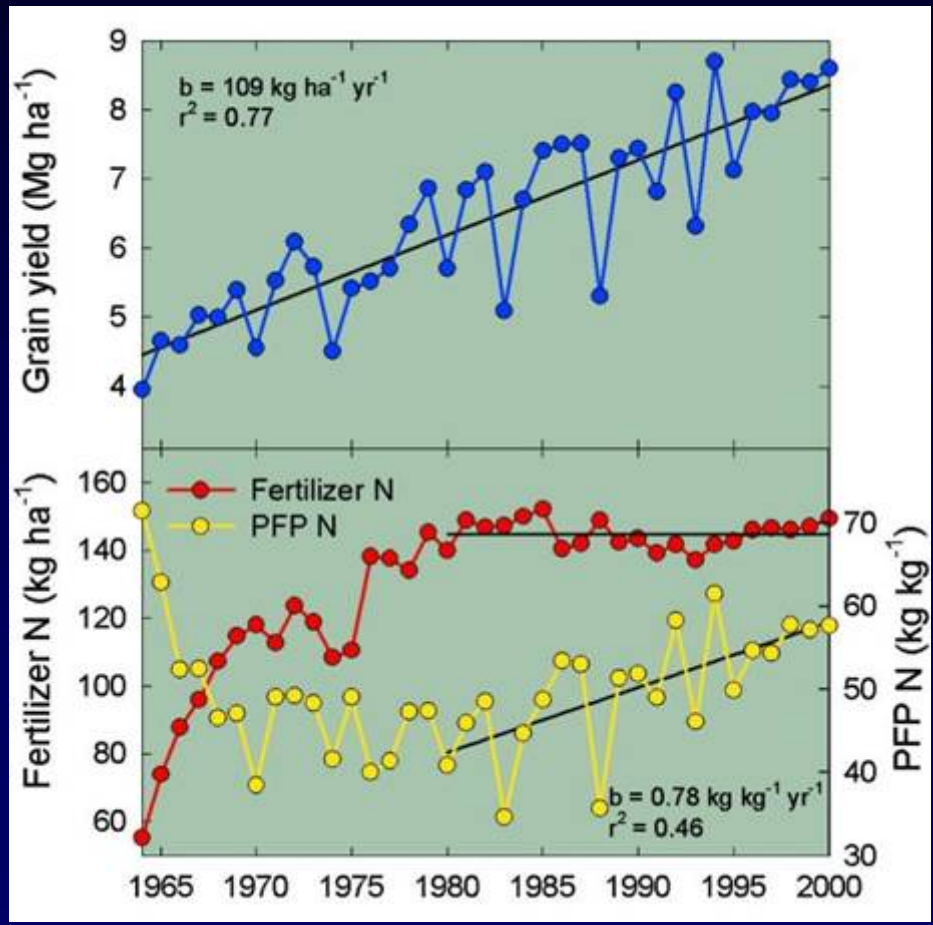
Nitrogen Use Efficiency (NUE)

- The proportion of available or applied nitrogen that is taken up by the crop
- Yield per unit of applied N

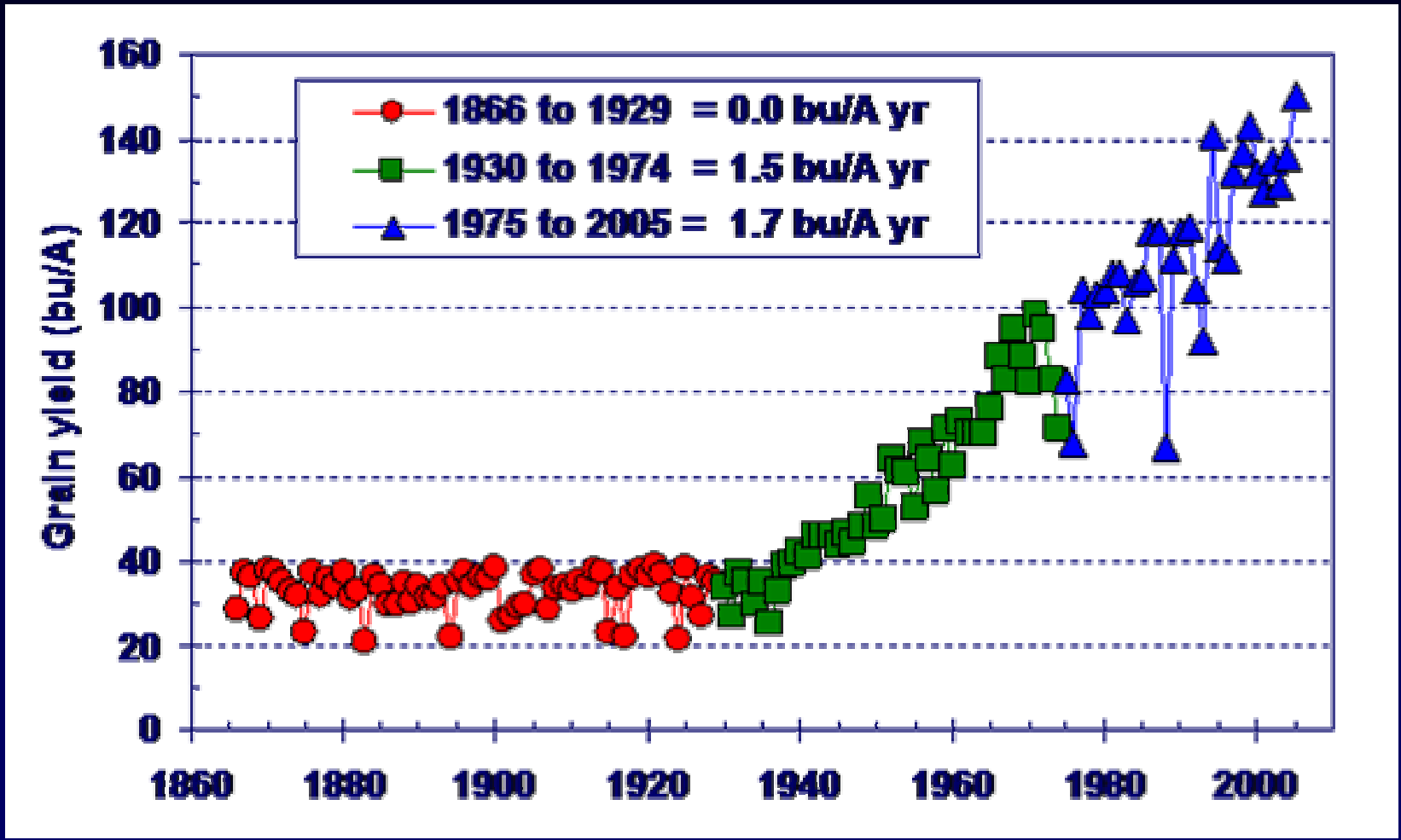
NUE is Increasing

- The amount of corn grain produced in the U.S. has increased steadily
- The amount of fertilizer N used has leveled off since 1980
- This means that the NUE has increased



From Cassman et al., 2002

Wisconsin Corn Grain Yields (1866-2005)

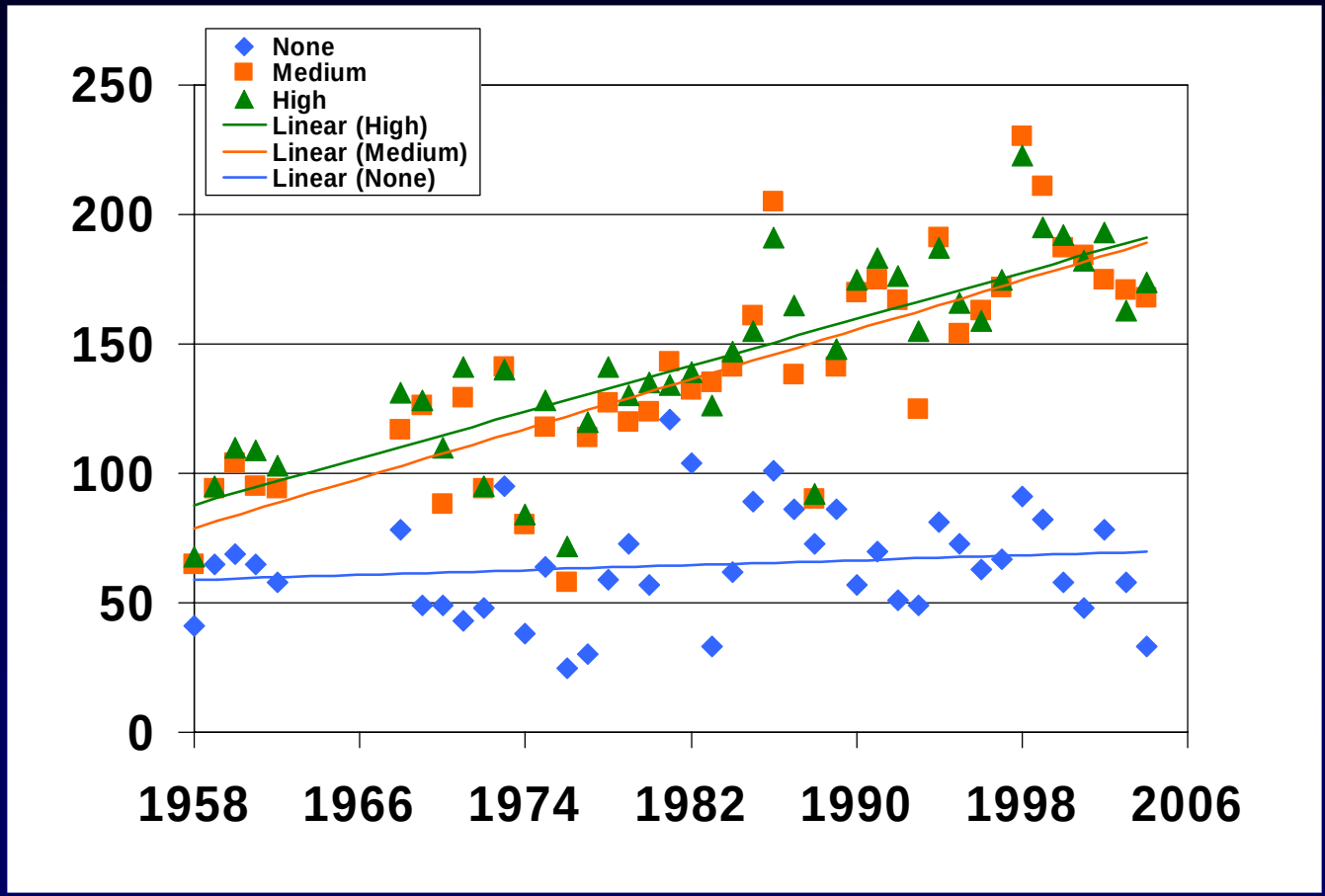


Data from USDA – Statistics Service, Compiled by J. Lauer, UW-Agronomy

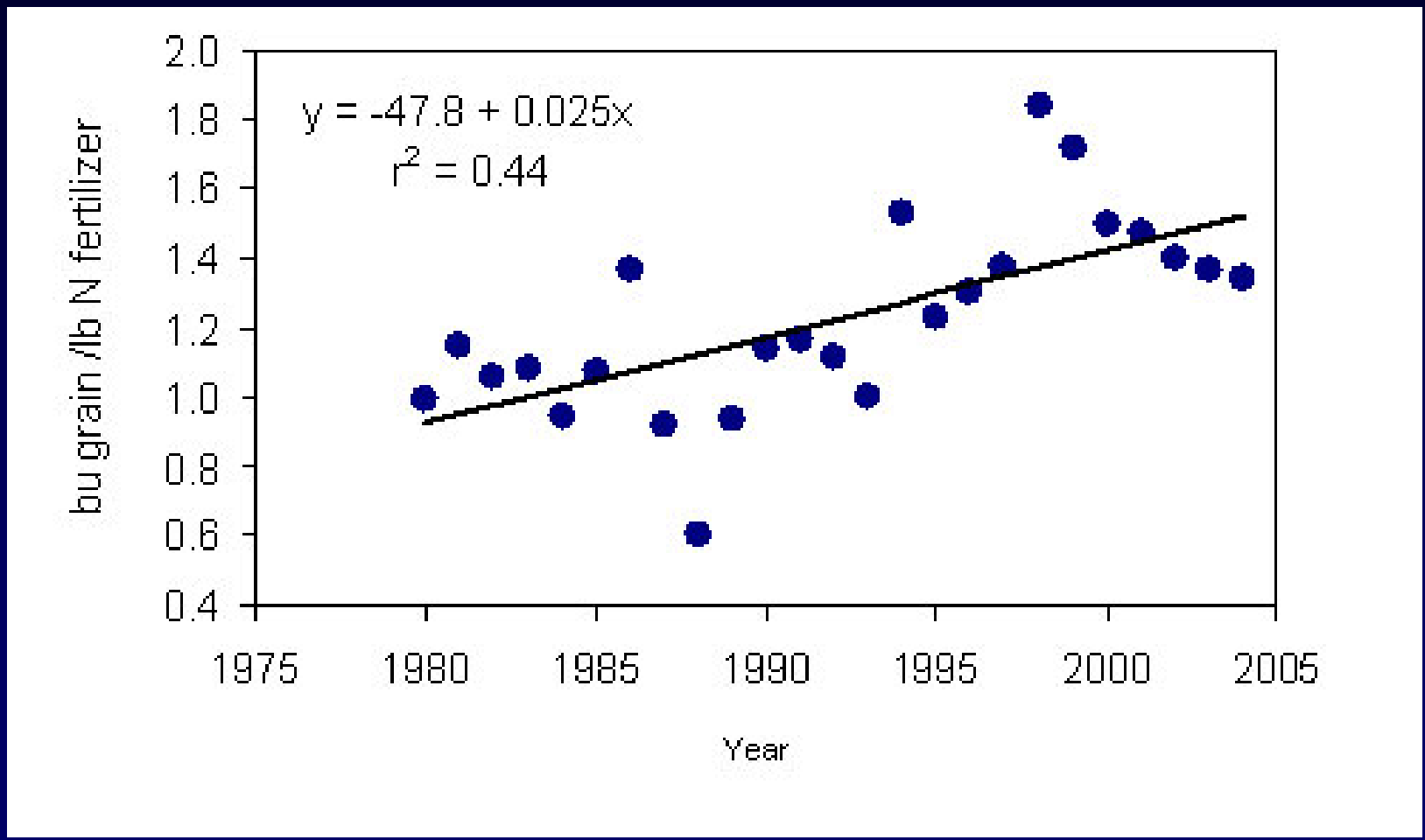
Long-Term N Rate Experiment, Arlington, WI, (1958-2004)

- Continuous corn
- Three N rates as anhydrous ammonia
- Current rates: 0, 125, 250 lb N/acre

Corn yields with three long-term N rates, Arlington, WI, 1958-2004



Nitrogen-use efficiency in long-term continuous corn, Arlington, WI, 1980-2004



Why is NUE Increasing?

- Genetic crop productivity improvements
- Improved cultural practices to match genetics
- Improved N management
  - Substantial potential for improvement
  - Emphasis on BMP's

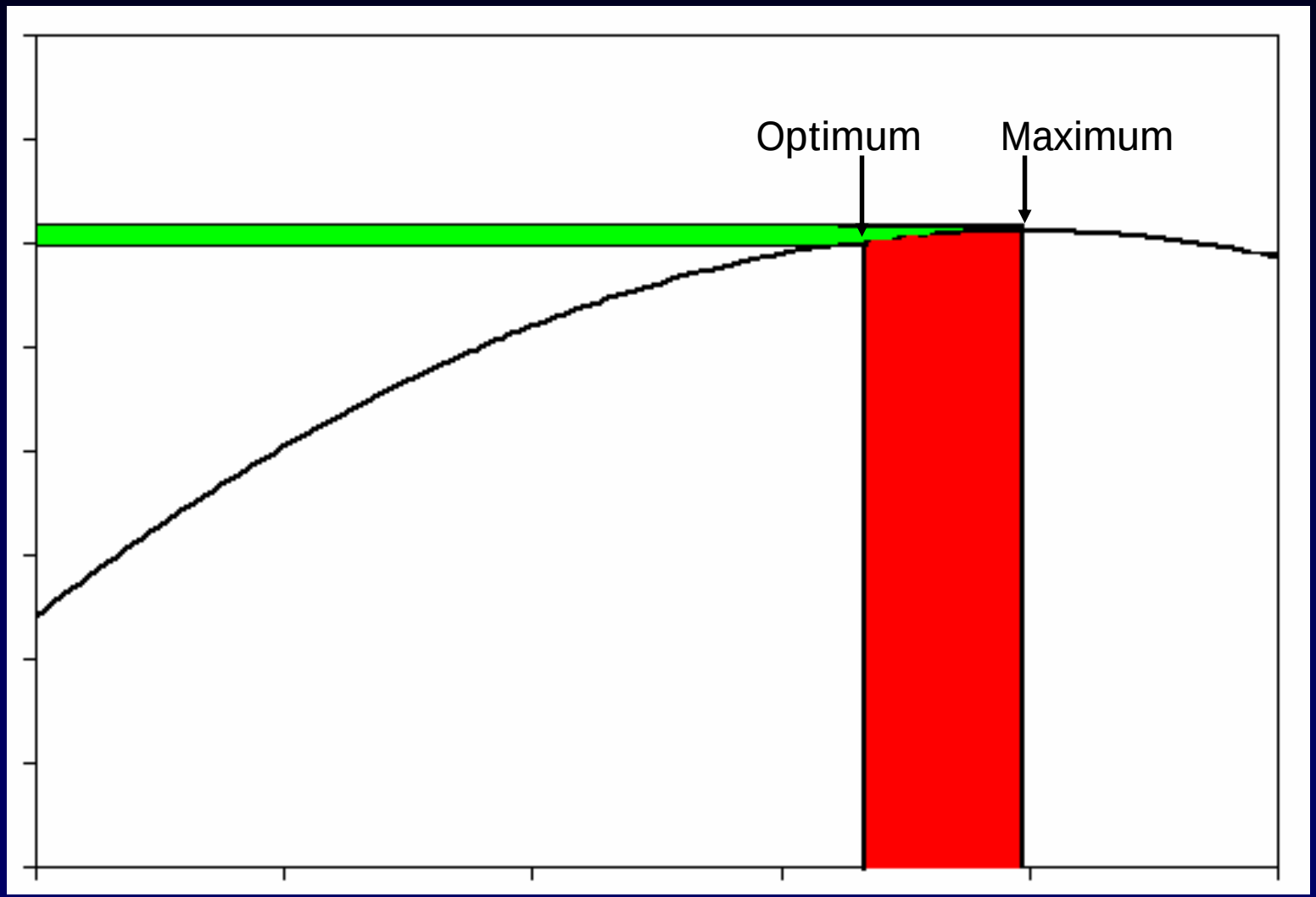
Increasing Nitrogen Use Efficiency

- Determine optimum N rate
- Adjust rate for non-fertilizer N
  - Manure & legume N
  - Soil N contributions
    - Residual nitrate
    - Mineralized N
- Manage N to avoid losses
  - Placement
  - Timing

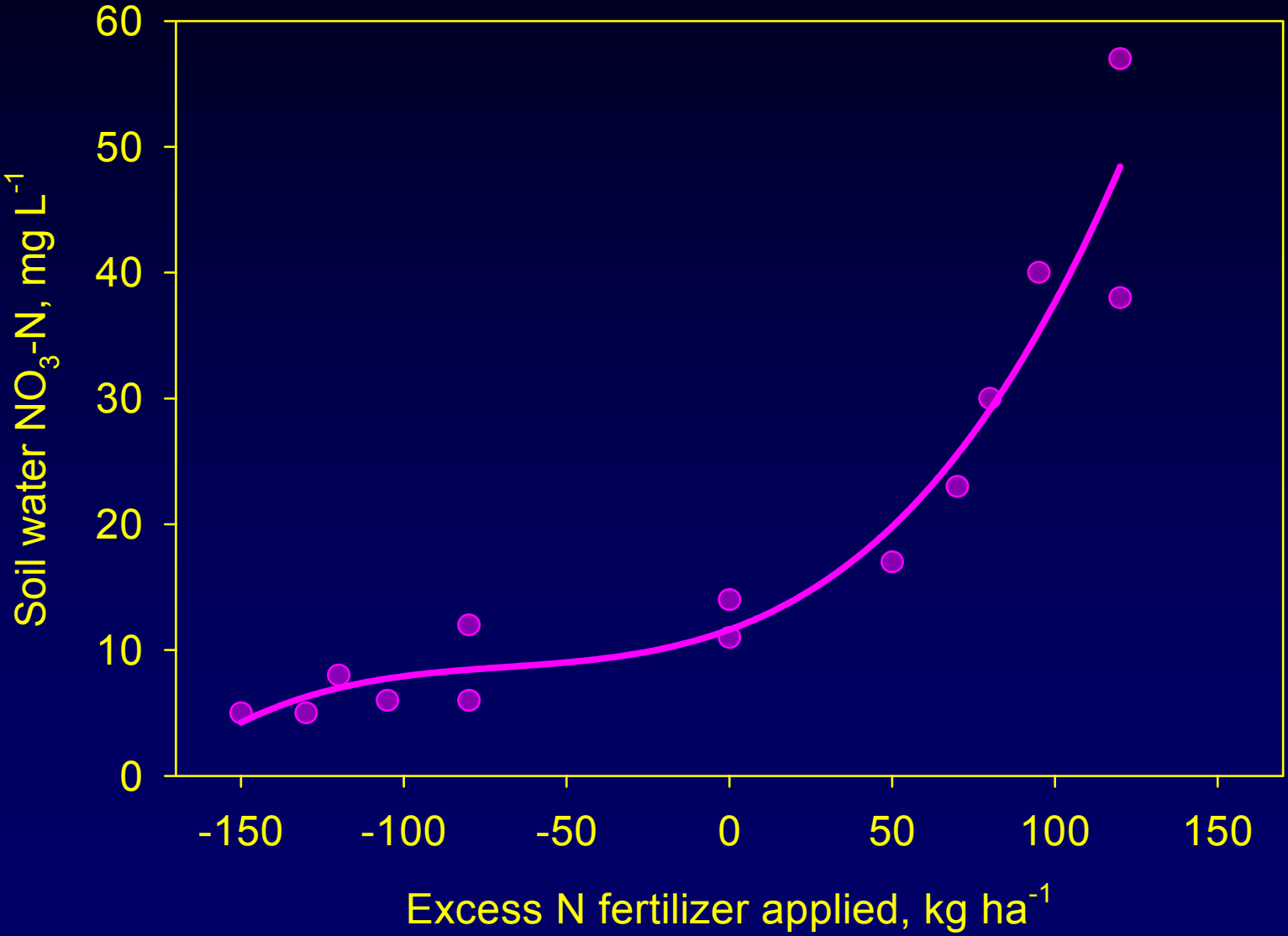
N RATE

- The most important factor for:
  - Agronomic N Efficiency
  - Potential for N Loss to Environment

Maximum and optimum levels for yield response to applied N



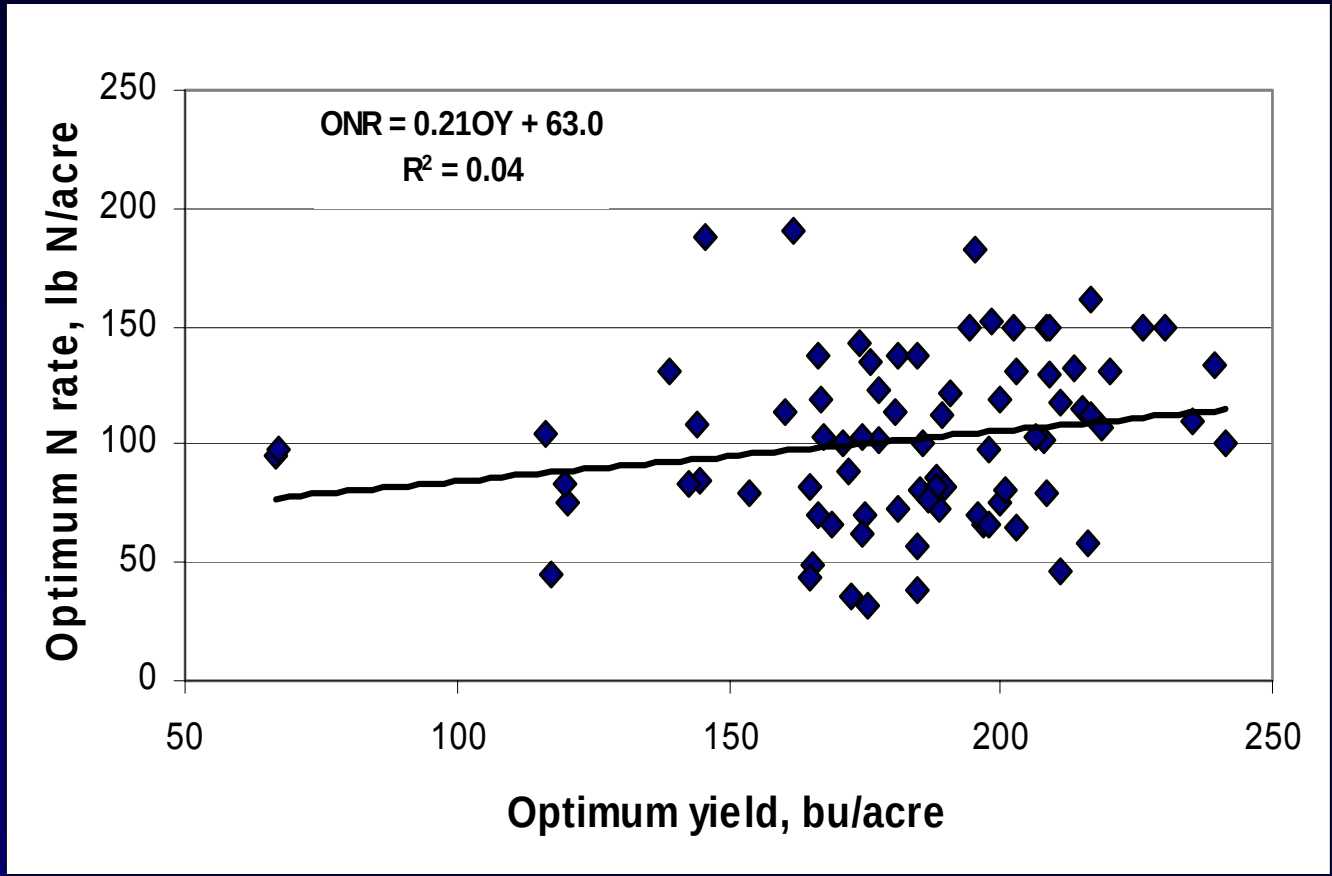
Relationship between excess N applied and soil water NO_3-N concentrations (Andraski, et al., 2000)



Selecting Optimum N Rates

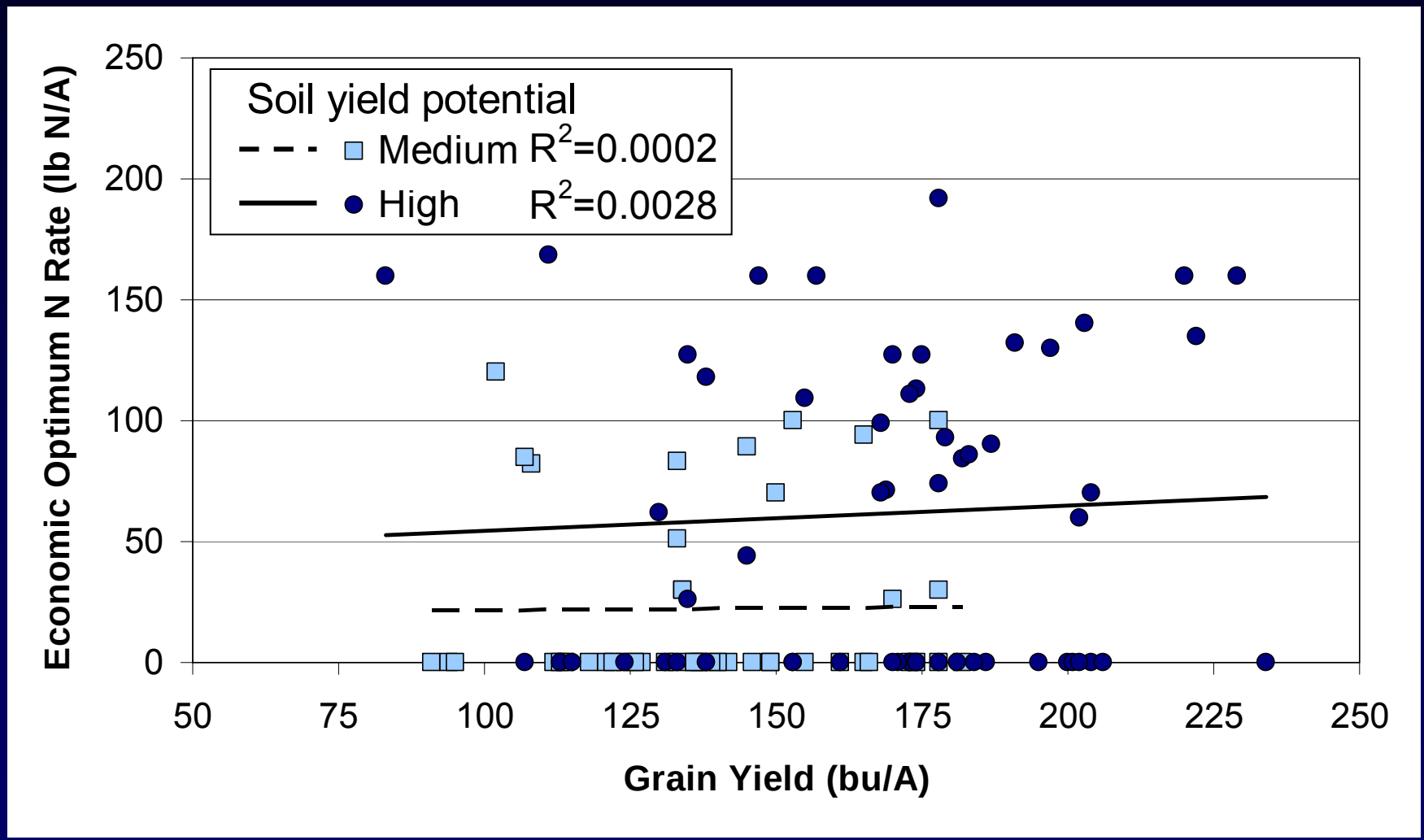
- Yield goal-based
  - Expected yield, not well related to observed N response
- Soil-specific
  - Based on yield response to N
- Maximizing economic return to N
  - Based on economic return functions
- Others

Relationship between optimum N rate and yield in Iowa (81 site years; pc = soybean)

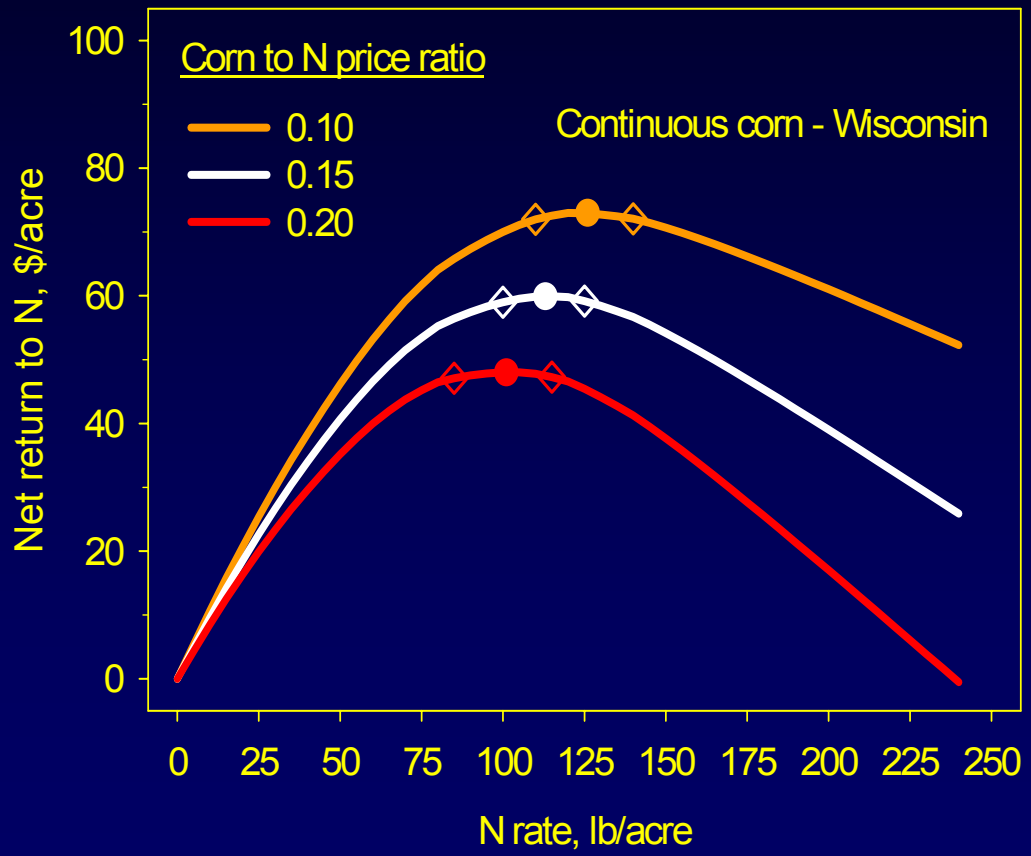


From Nafziger et al., 2004

Relationship between optimum N rate and corn yield (101 WI sites; 1989-1999)



Profitable N Rates - MRTN



- A range of N rates can produce profitable yields
- Economics clearly drives the profitable N rate

Adjust rate for non-fertilizer N

- Corn following alfalfa usually needs little or no additional N

Adjust rate for non-fertilizer N

- Manures can supply all of the N needs of corn or other non-legume crops

Adjust rate for non-fertilizer N

- Corn following soybean usually has a lower N need
  - Crediting vs. cropping system

Adjust rate for non-fertilizer N

- Accounting for soil N contributions
  - Residual nitrate
  - In season tests
    - PSNT
    - Others
  - Soil N mineralization
    - No reliable methods
    - Large N contributions

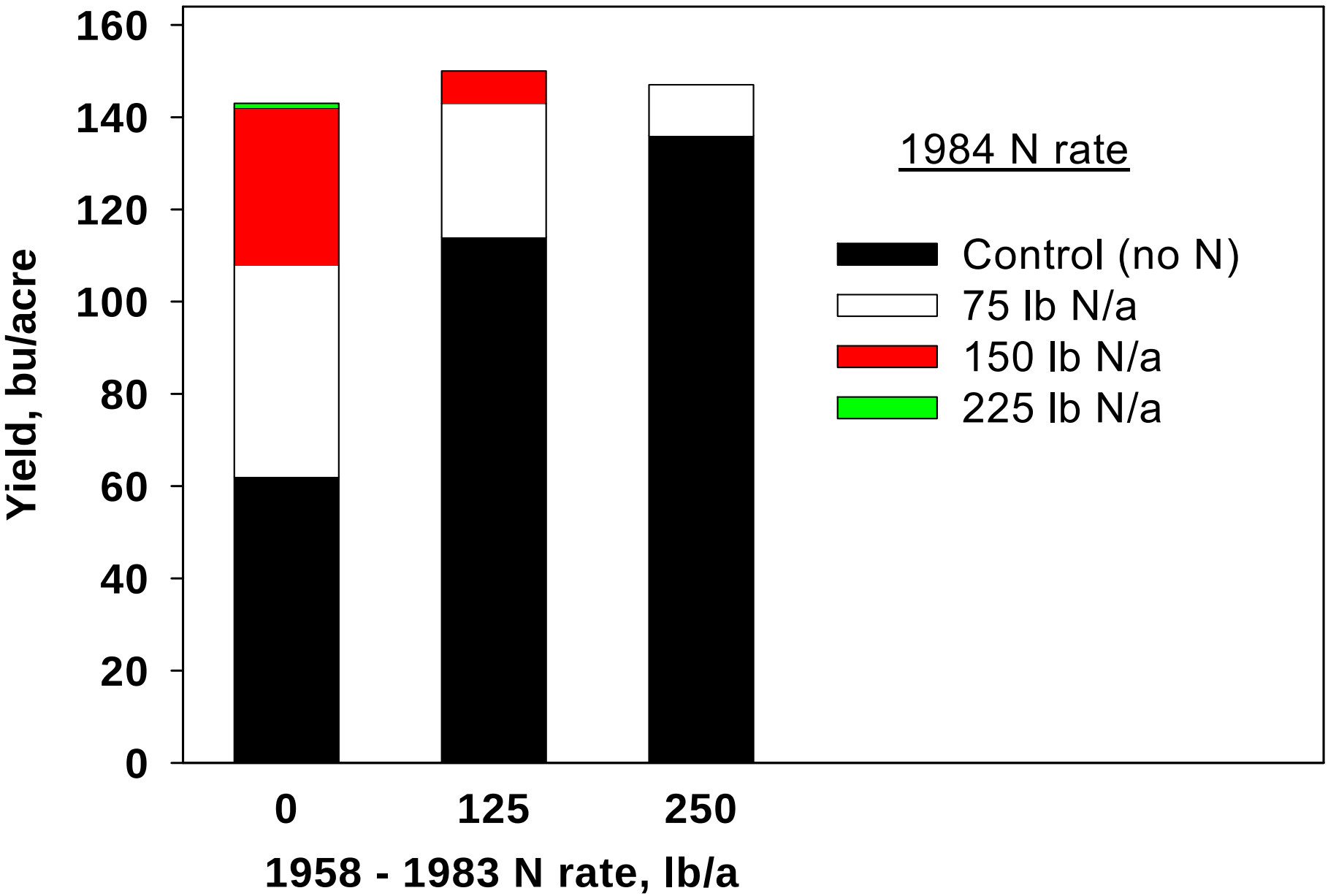
Contribution of Soil N to Yield

State	CC	SC
	-------- % [1/] --------	
Illinois	54	64
Iowa	45	75
Minnesota	60	76
Wisconsin	71	77
Mean[2/]	56	70

[1/] Yield with zero N as % of yield at EONR.

[2/] Mean of 271 CC and 427 SC sites. Sawyer et al., 2005.

Soil and fertilizer N contributions to grain yield at three long-term (26 yr) corn N rates, Arlington, 1984



Managing N to Avoid Losses

- Placement
  - Controlling ammonia volatilization losses
  - Increasing importance of urea as a fertilizer source
  - Increasing use of no-till cropping systems

Controlling Ammonia Volatilization Losses

- Incorporate or inject urea-containing fertilizers
- Use a soil urease inhibitor
- Use alternative N sources

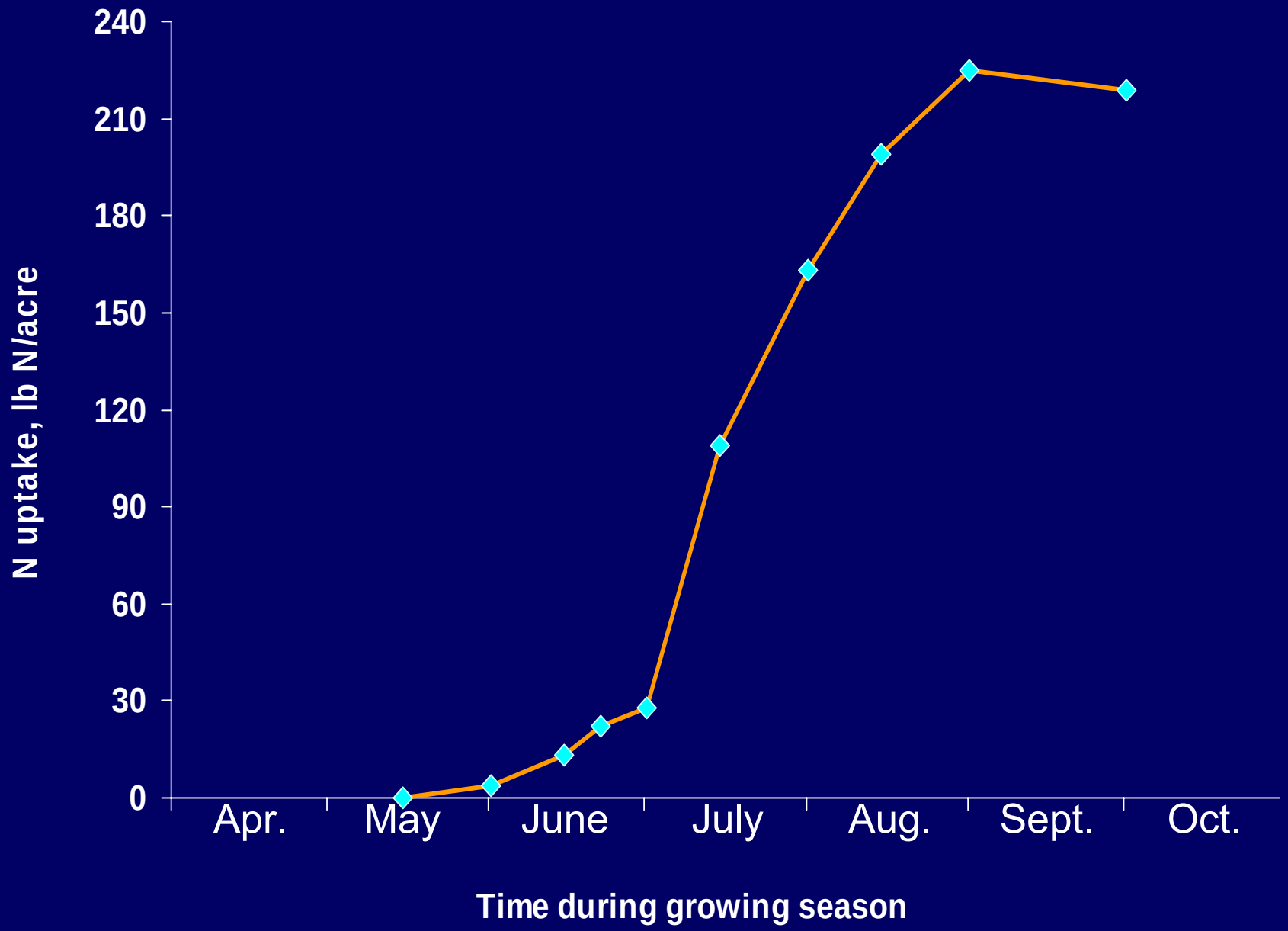
Managing N to Avoid Losses

- Timing of N applications
  - Consider soil characteristics and climate
  - Consider likely loss mechanisms
  - Consider timing of crop N demand

Nitrogen Timing Options

- Fall
- Preplant
- Sidedress
- Post-emergence
- Split

Timing of Nitrogen Uptake by Corn



Suggested Timing of Nitrogen Applications for Corn - Wis.

Soil	Fall	Preplant	Sidedress
Medium/Fine Texture Well-Drained	OK*	Optimum	OK
Medium/Fine Texture Poorly Drained	No	OK	Optimum
Coarse texture	No	No	Optimum

*Includes use of BMPs for fall-applied N.

Fall Applied Nitrogen

- Higher risk of N loss
  - Average 10-15% less effective
  - BMP's needed:
    - Soil temp. below 50° F
    - Anhydrous ammonia as N source
    - Use a nitrification inhibitor

Improving N-Use Efficiency

- Exploit improvements in NUE from genetics and cultural practices
- Improve N rate decision
  - N rate selection process
  - Account for non-fertilizer N with available tools
  - Accounting for non-fertilizer N is critical for avoiding excess N

Improving N-Use Efficiency

- Improve N rate decision
  - Improved assessment of soil N contribution is a key research need
- Manage N to avoid losses
  - Placement – Control NH_3 loss
  - Timing – Use sidedress or delayed applications if leaching risk is high
  - Minimize fall N applications