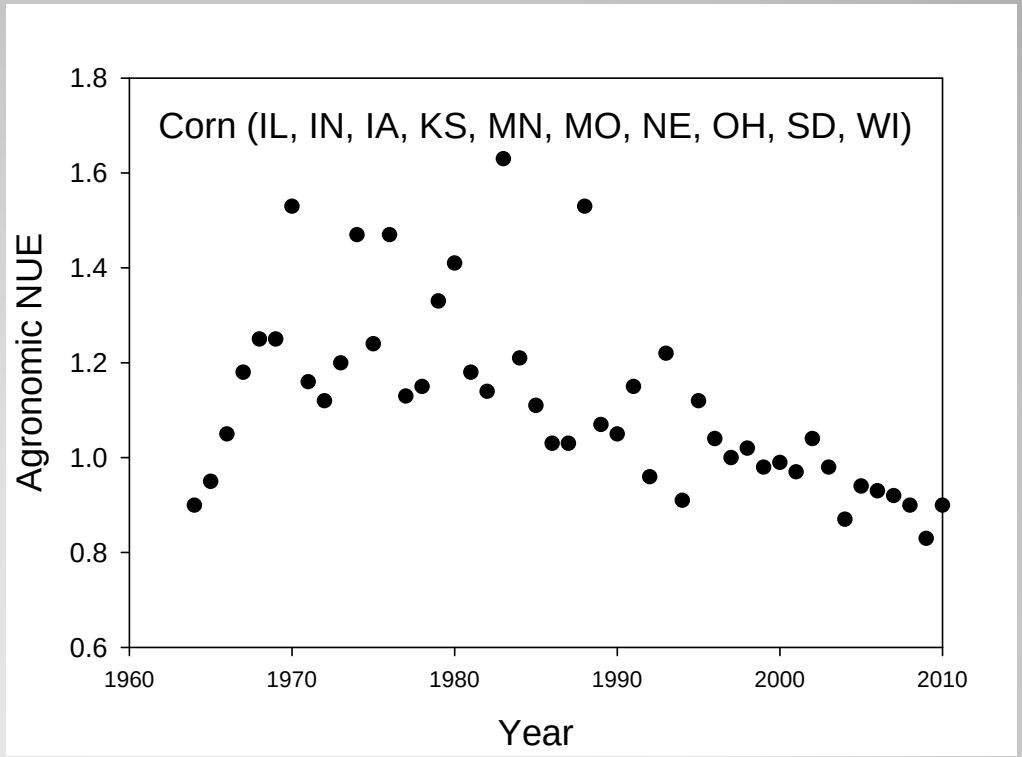
# Improving Nitrogen Use Efficiency

Reflections and Challenges

- Increasing demand for staple food crops
- Marginal lands
- Limited supplies of arable land
- Stagnating yields
- Increasing concerns about environment and climate change

# Megatrends (Cassman)

- Agronomic
- Physiological
- Recovery




# Nitrogen Use Efficiency

# Gaps

- Crop production systems integrate C, N, $H_2O$, and solar radiation
- Water is more important than N in yield response, coupling water management with N management
- Soils vary in OM, mineralization potential, water holding capacity
- G x E x M

# Gaps

- Climate variability will become a more prevalent signal
- Need to treat agriculture in an ecological context
- Understand the dynamics of crop rotations on NUE at the landscape and watershed scale
- Understand the linkage between field, landscape, and watershed dynamics

- Soil erosion
- Organic matter and mineralization potential
- Drainage and water management in soils
- Water holding capacity

# Soil Degradation

# Challenges

- Link agriculture, social, economic aspects, what are the metrics of risk?
- Refine sensor technology for within season monitoring and application management
- New research methods; RCB is not adequate for the questions being asked
- Data legacy, we treat years as single events instead of a series of events

# Sensor Technology

- Can we detect what and when to apply?
- Soil vs plant sensors
- Need to improve canopy level chlorophyll indices for more accurate estimate of N status in canopies
- Multiple scale (temporal and spatial) response across fields

# Sensor Technology

- Sensors need to be sensitive to N requirements (without confounding factors) to allow for time to apply N across fields, especially with handheld instruments or drone/satellite platforms
- Will this information base lead to more precise application of nutrients?

- Would the real factor impacting NUE, please stand up?
  - Rate
  - Placement
  - Form
  - Timing

# 4 R's

# Challenges

- Need to develop performance based metrics which include agronomic efficiency and environmental quality
- What is the time lag between implementation of improved in-field practices and environmental quality signals?
- How do we incorporate researchers, consultants, producers, and industry into development of solutions?
- Do we have the infrastructure which would support a change in management systems?