The Future of Controlled-Release Fertilizers

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The Future of Controlled-Release Fertilizers

- Overview of products and modes of action
- Reducing N losses
- Improving N-use efficiency
- Maintaining/increasing productivity
- Managing risk
- The future

Controlled-Release and Enhanced-Efficiency Fertilizers

- “Controlled-release” is a subset of a larger group of fertilizers being called “enhanced-efficiency” fertilizers
- Old and new products being viewed with new interest

Many Products – Different Modes of Action

- Inhibitors and stabilizers
- Uncoated, slowly available compounds; synthetic organic compounds
- Coated water-soluble fertilizers

- www.fertilizer.org/ifa/news/2005_17.asp
  Jim Robbins, Univ of Arkansas

Inhibitors and Stabilizers

- Reduce loss by slowing conversion of N sources to forms that can be lost
- Protection time days to a few weeks
- Not true slow release
- Examples: Agrotain (NBPT), N-Serve (nitrapyrin), DCD, Super U, Super N (Agrotain Plus), Nutrisphere N.
- Provide a specific benefit for a specific amount of time
  - If you have conditions for the loss addressed by the product for the effective period of the product, the benefit is realized.

Uncoated, Slowly Available Compounds

- Protect N by delaying N availability
- Generally rely on biochemical decomposition
- Protection time typically weeks to months
- Release rate determined by
  - Chemical structure (resistance to breakdown)
  - Molecular weight/degree of polymerization
  - Environmental conditions
- Release slow but generally uncontrolled

Uncoated Slow Release Fertilizers

- Urea formaldehyde (UF) & methylene urea (MU)
- Isobutylidene diurea (IBDU)
- Natural organics
- Still largely horticultural products – professional turf, etc.
- Some new products on the market for ag – Nitamin, Nfusion,

Coated Water-Soluble Fertilizers

- Coatings applied to conventional fertilizers
- Physical barrier against nutrient exposure
- Sulfur- and polymer-coated urea

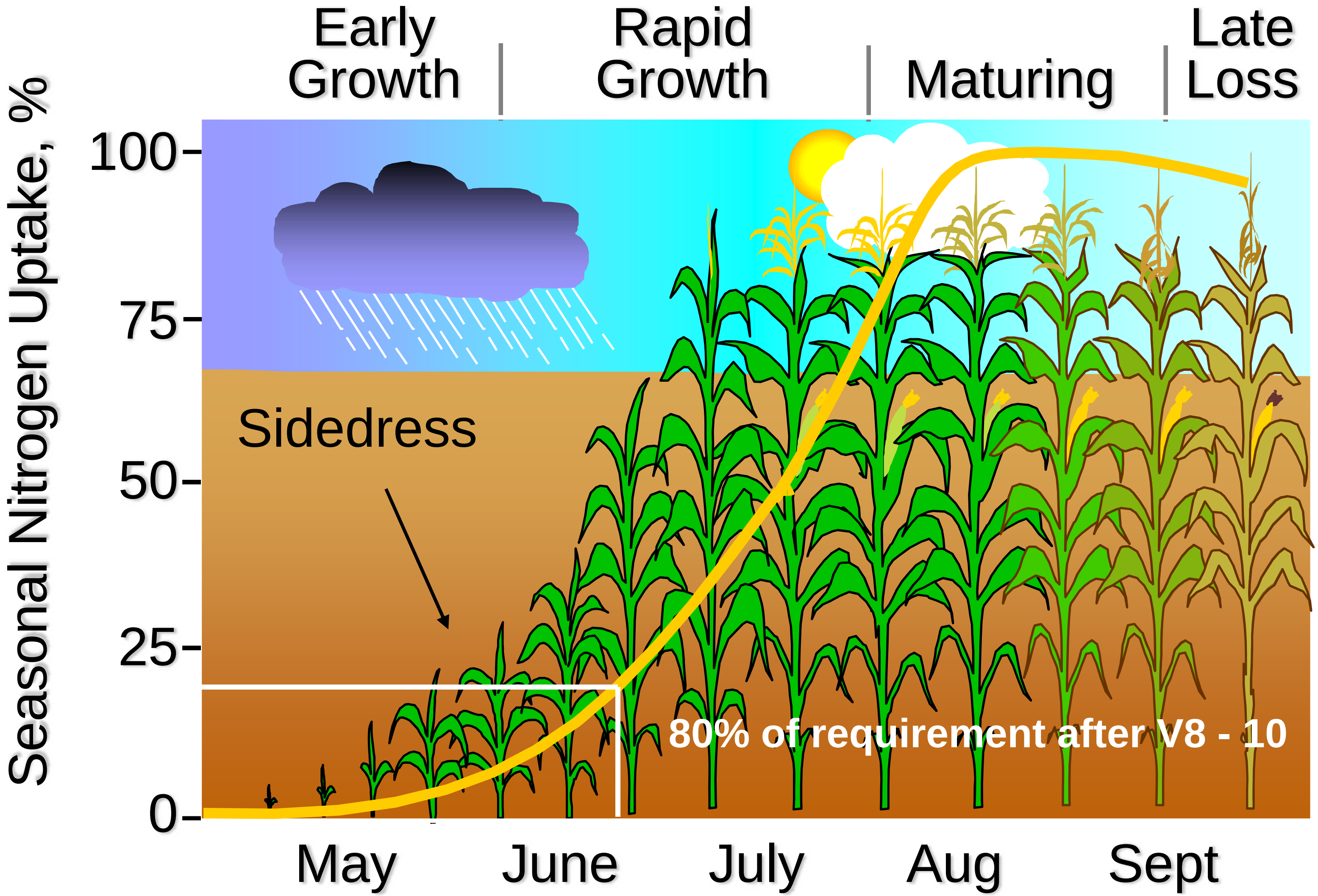
Sulfur-Coated Urea

- Insoluble sulfur coating + protective overcoat applied to urea
- N availability depends primarily on destruction of coating
  - Physical breakage
  - Biological oxidation
  - Diffusion
- Release rate determined by
  - Thickness of coating
  - Environmental conditions
- Release slow but uncontrolled

Polymer-Coated Fertilizers

- Polymer coatings applied to soluble fertilizer
  - Polyurethane, polyolefin
- Release by diffusion through coating
- Release rate determined by
  - Polymer chemistry, thickness, coating process
  - Temperature
- Release can be highly controlled and can be designed to match plant uptake.
- Examples: Osmocote, Polyon, Duration, ESN

Corn Growth and N-Uptake

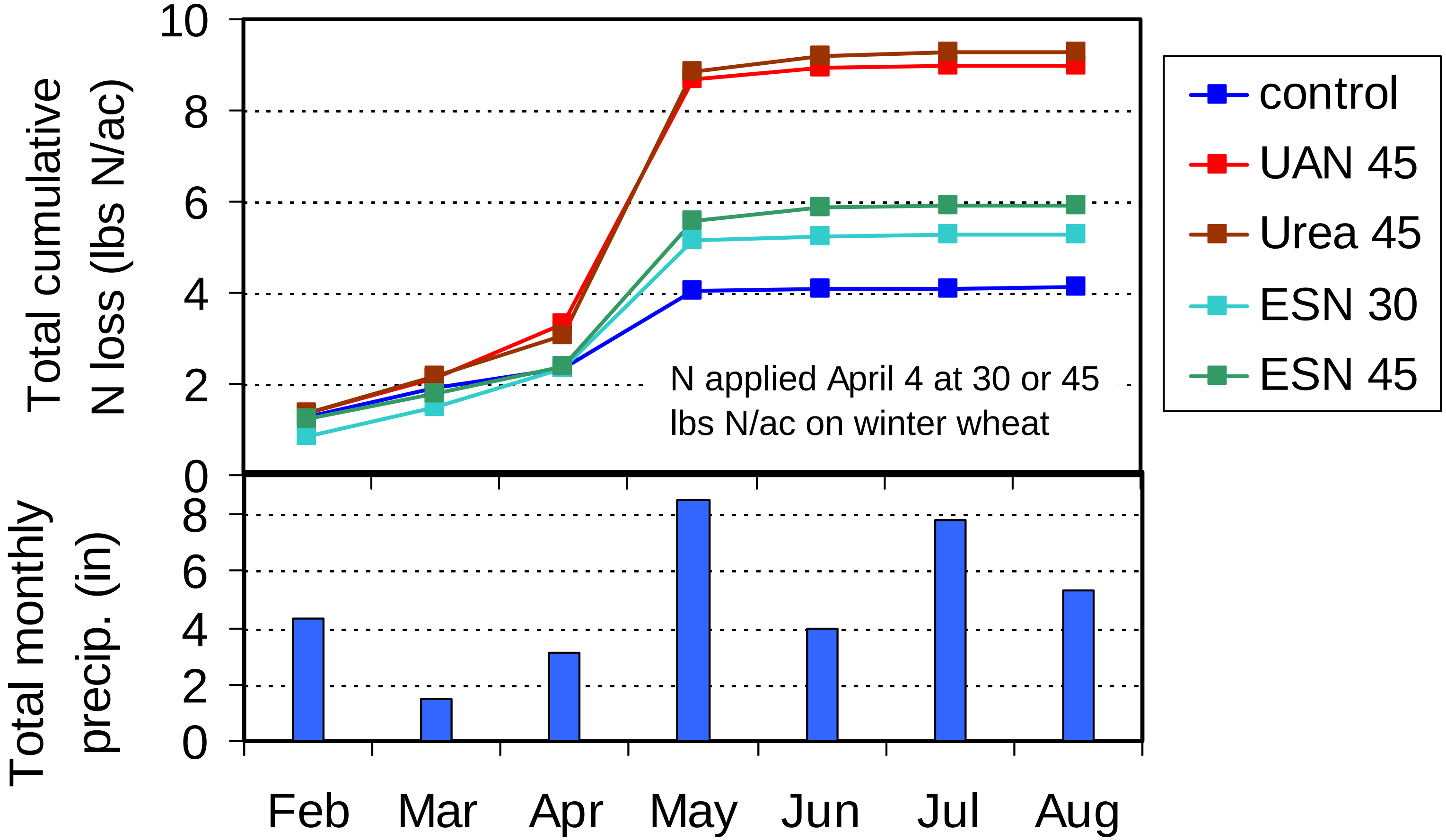


Reducing N Losses

- Controlling N transformations to slow conversion to a susceptible form
- Reducing loss by physically protecting soluble N forms from exposure to N-loss mechanisms

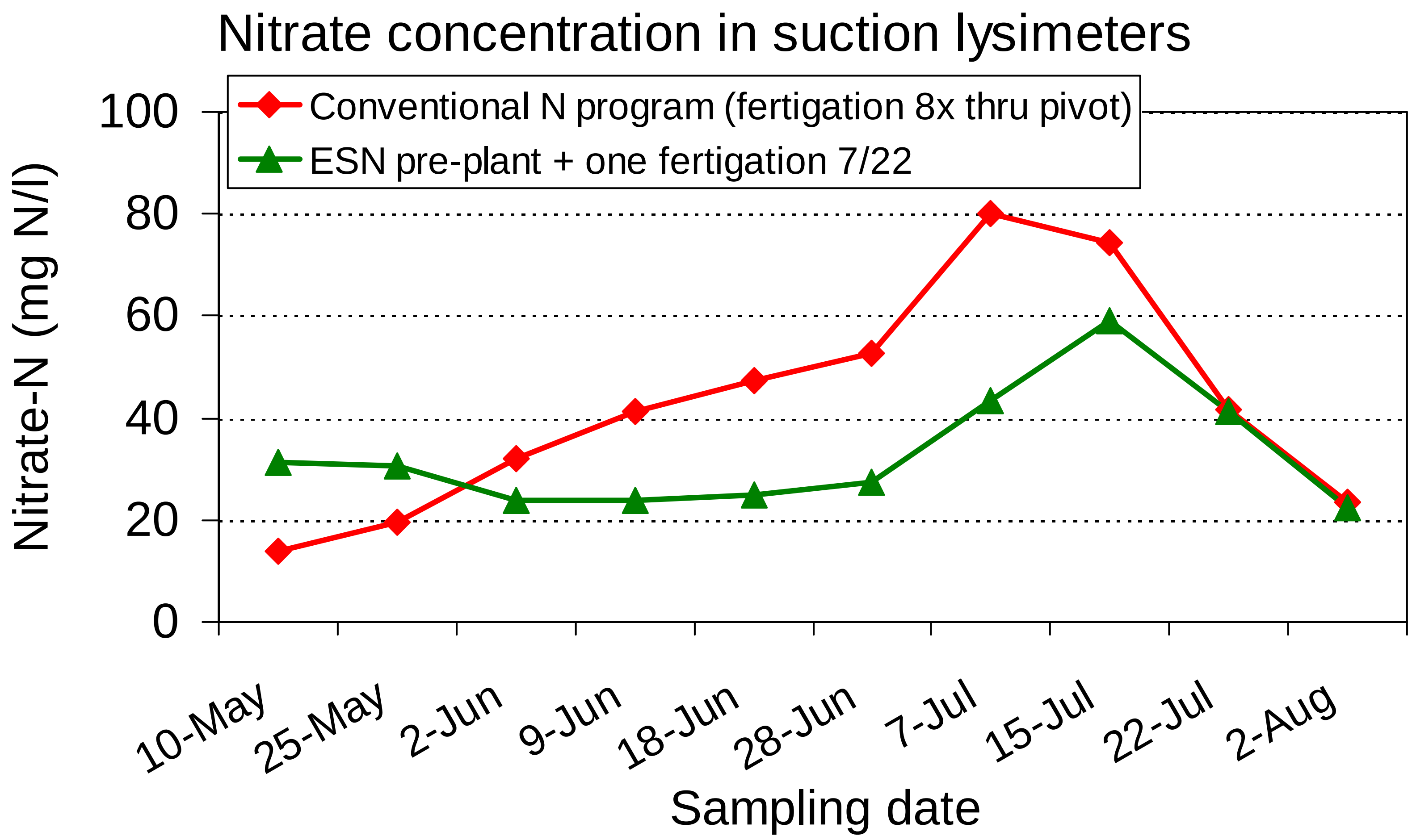
- Nitrate leaching
- N_2O emissions
- Ammonia volatilization

N Source and N Leaching Losses
Winter Wheat, Ohio, 2003



Source: Dr. R. Islam, The Ohio State Univ, 2003.
Inorganic N in leachate from 100- x 30-foot lysimeters.
Calculated from total water volume and N concentration.

Nitrate Leaching in Potato Production, Minnesota, 2004



Source: Dr. Carl Rosen, Univ of Minnesota.

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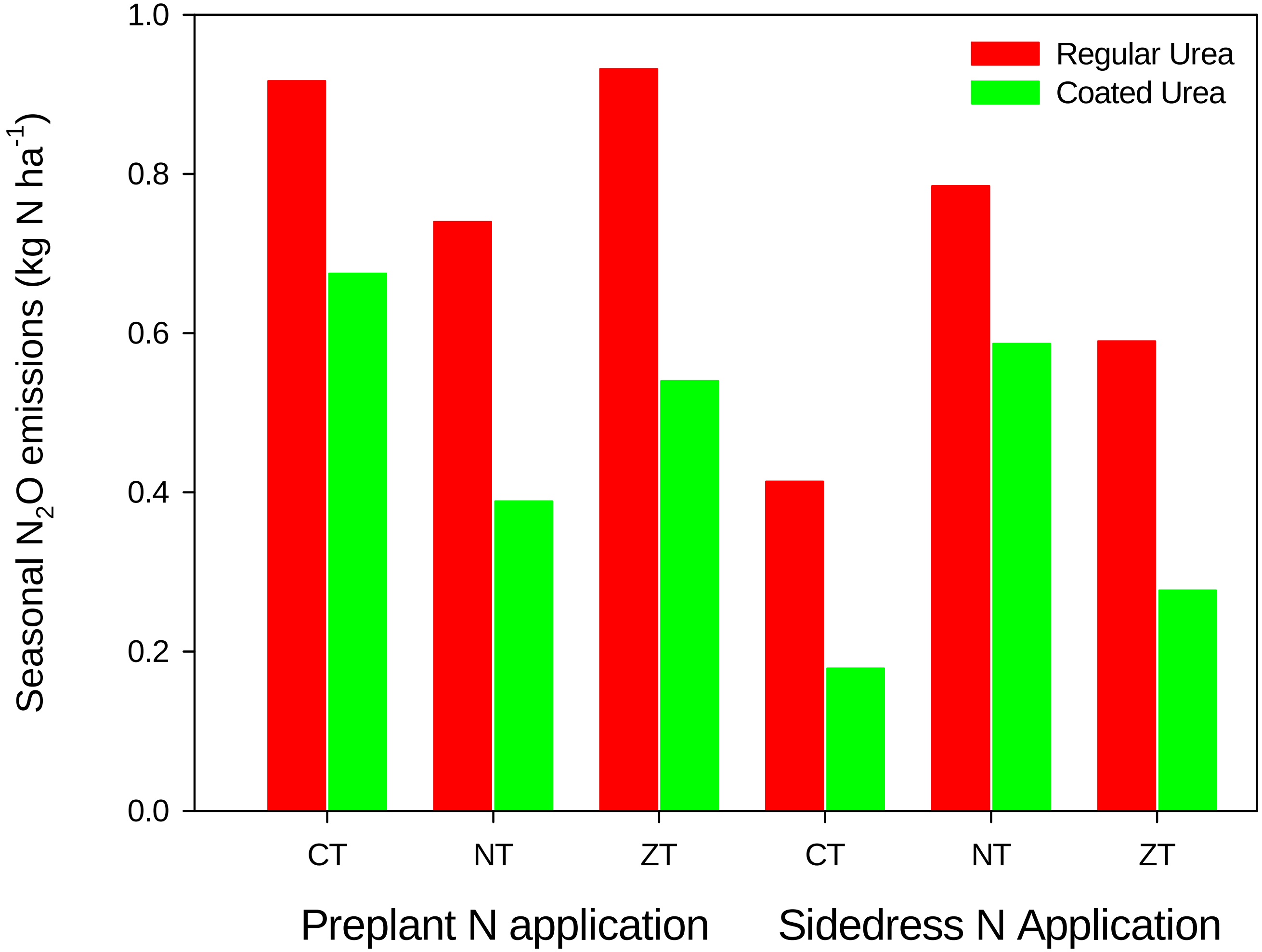
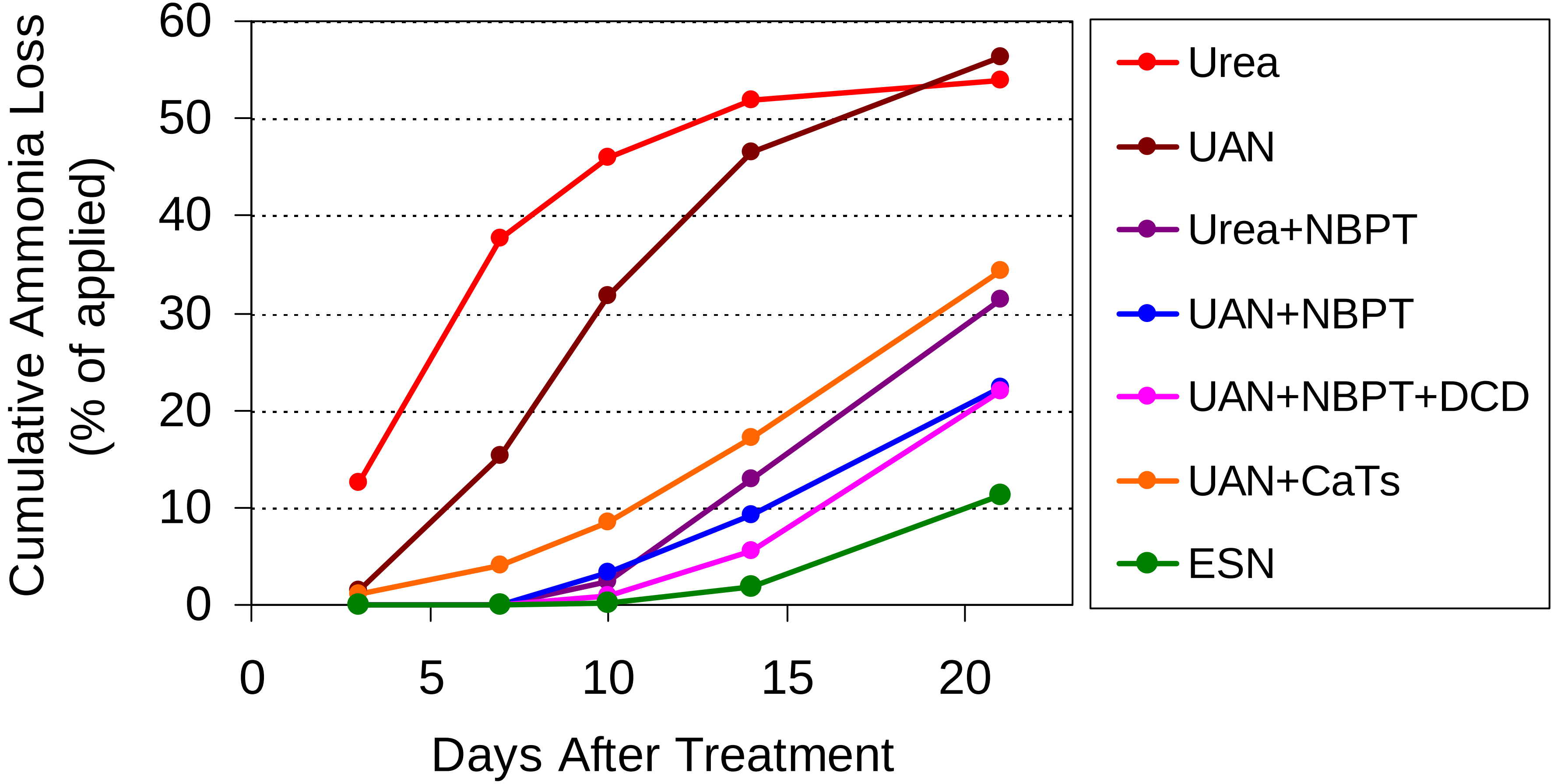
N_2O Emissions (May 1 to June 30, 2006) Corn - Woodslee, ON, 2006



Corn following wheat

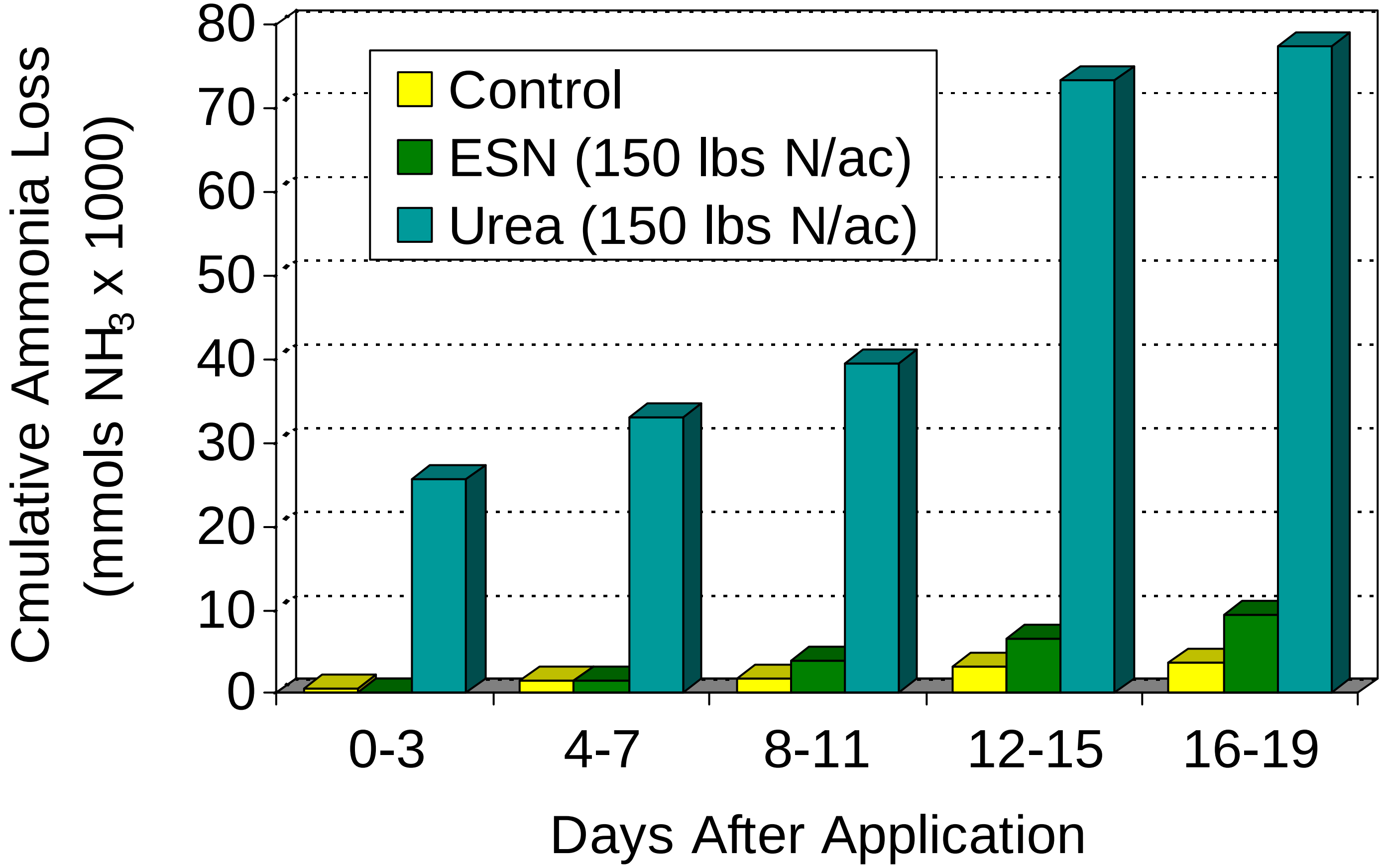
Source: C Drury, AAFC, Harrow, ON

N Source and Ammonia Loss
Laboratory Incubation



Source: Dr. W. Thornberry, Sturgis, KY; Dr. S. Ebelhar, Univ of Illinois
Laboratory incubation

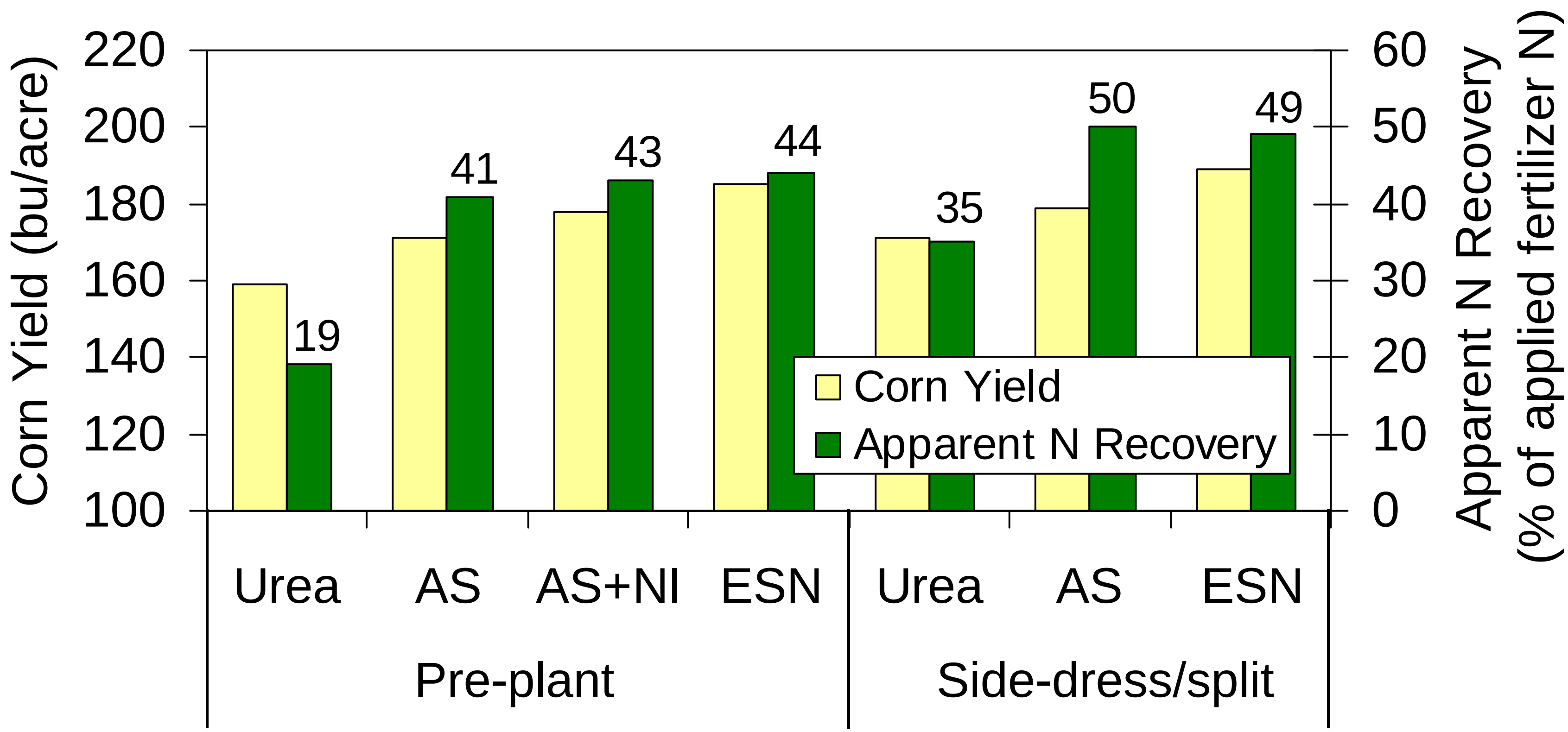
N Source and Ammonia Volatilization Washington, 2007



Field study; spring top-dress application on winter wheat

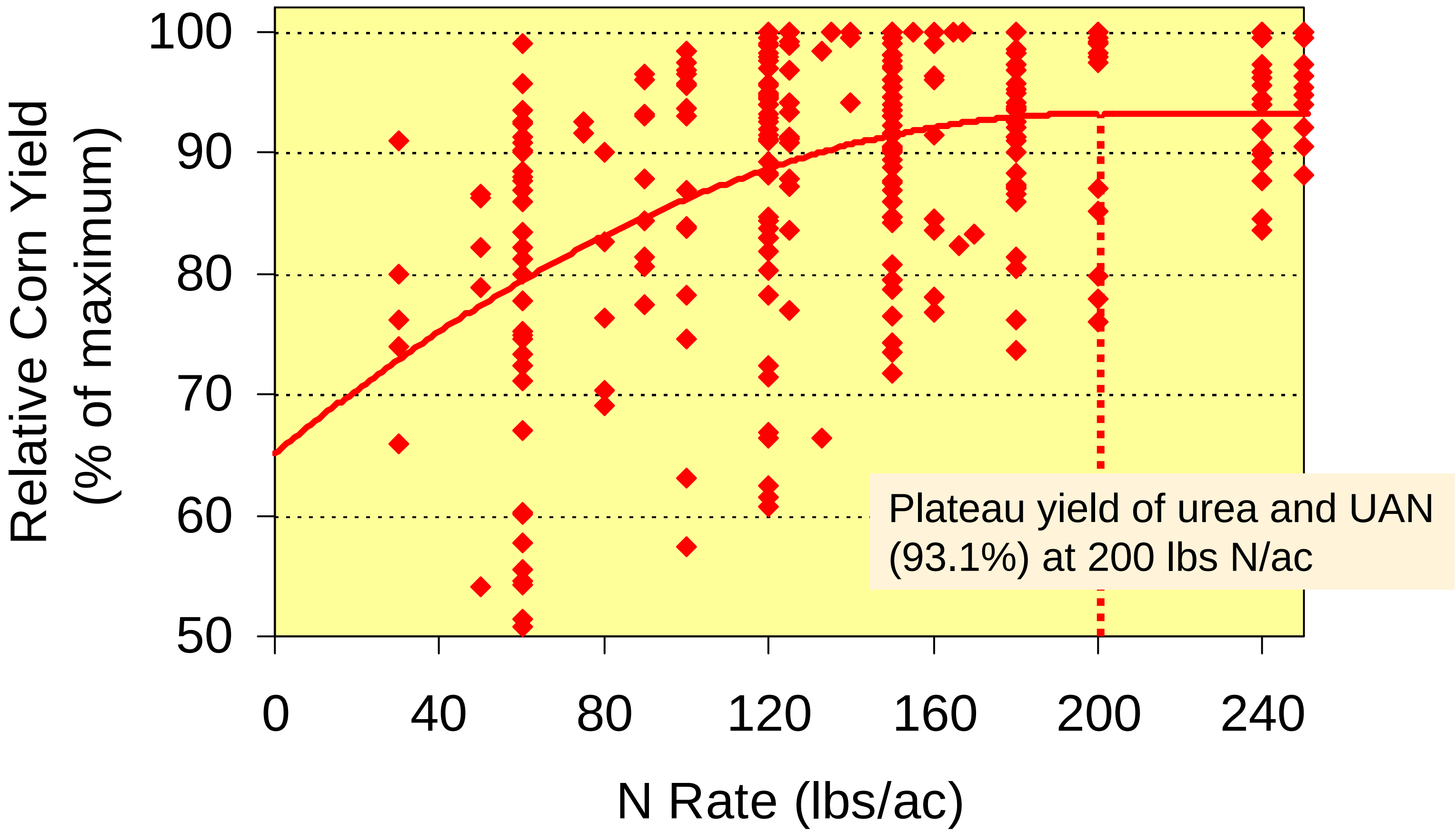
Source: R Koenig, Washington State Univ

Irrigated Corn Yield and N Recovery



Apparent N recovery = N uptake in control (no N) - N uptake in treatment ÷ fertilizer N rate x 100.
Average control yield = 103 bu/acre, control N uptake = 67 lb N/acre.
NI=Nitrification inhibitor, DCD
Source: L Bundy, Univ of Wisconsin

Corn Response to Pre-plant Urea and UAN Compiled Data from US Corn Belt Studies



Data compiled from studies in US Corn Belt studies comparing pre-plant urea and UAN with pre-plant ESN.

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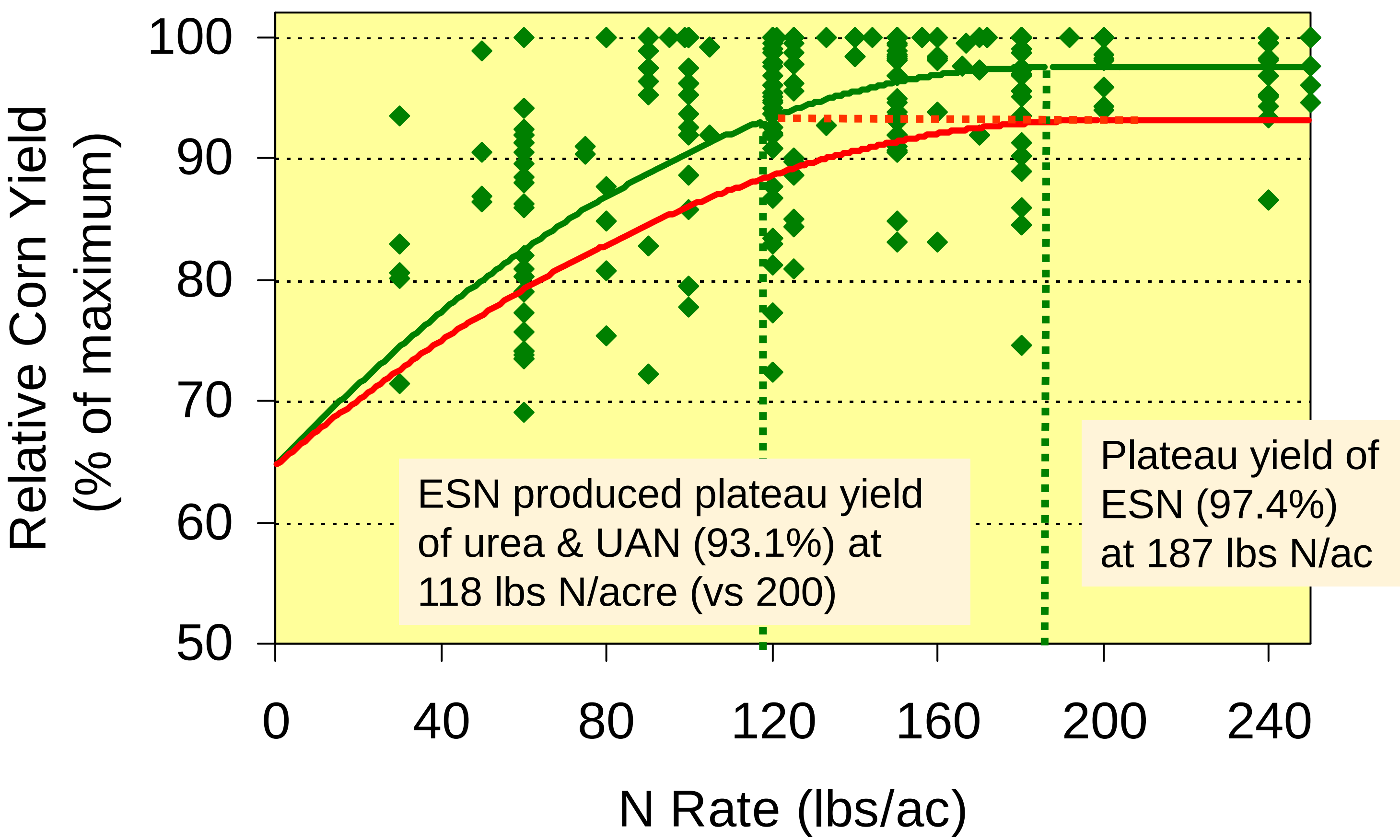
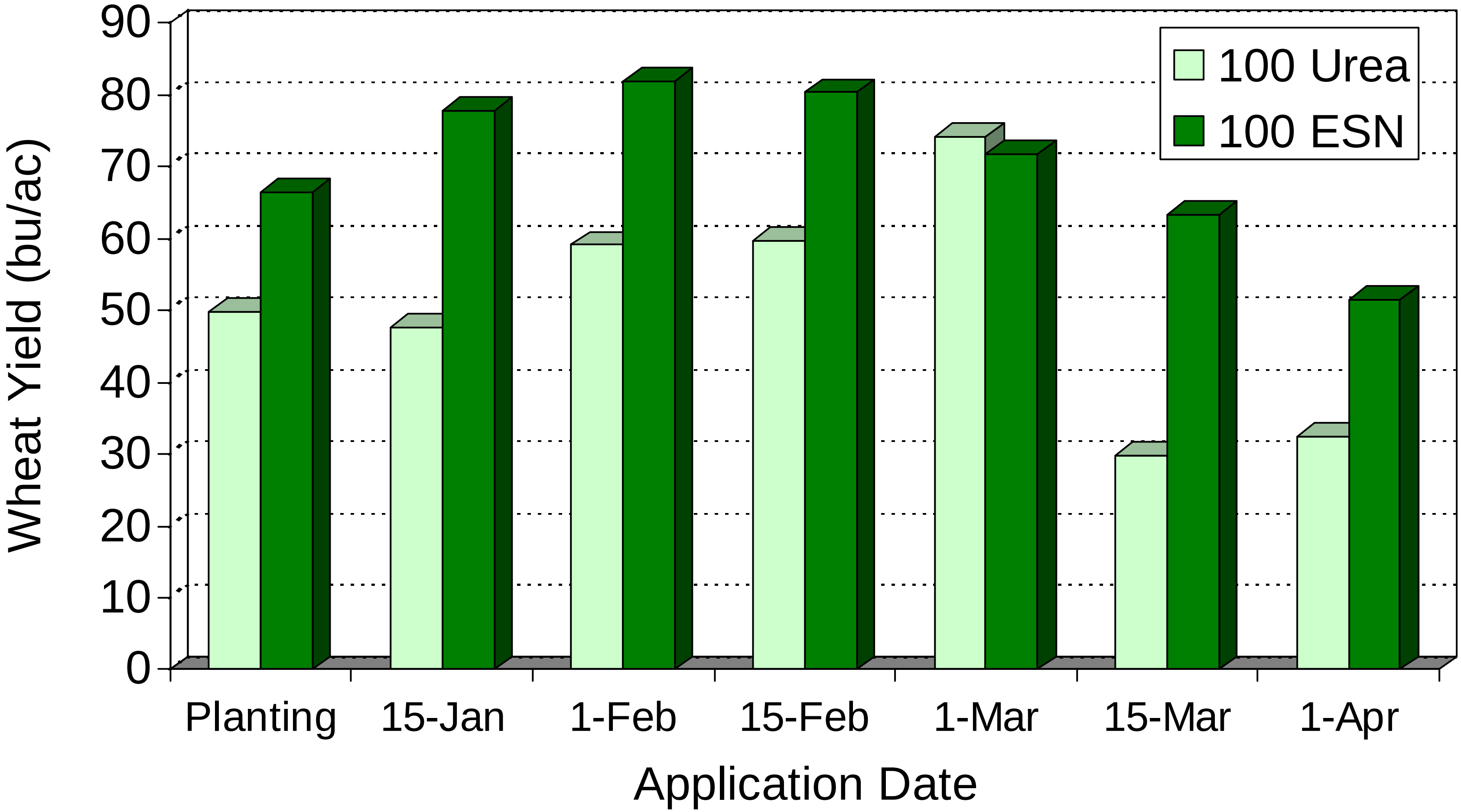
Corn Response to Pre-plant ESN Combined Data from US Corn Belt Studies



Data compiled from studies in US Corn Belt studies comparing pre-plant urea and UAN with pre-plant ESN.

Managing Risk – N Source & Timing Winter Wheat, Princeton, KY, 2006



Source: Dr. G. Schwab, Univ of Kentucky

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The Past and Present

- If enhanced-efficiency fertilizers can do all this, why are the not used more frequently?
- The past:
  - Wide-spread use has largely been limited by cost: expensive products not viable for low value commodity crops.
  - Recognition of traditional BMPs while new technologies that may be as good as or better not yet recognized in policy or practice.

The Future (the Present?)

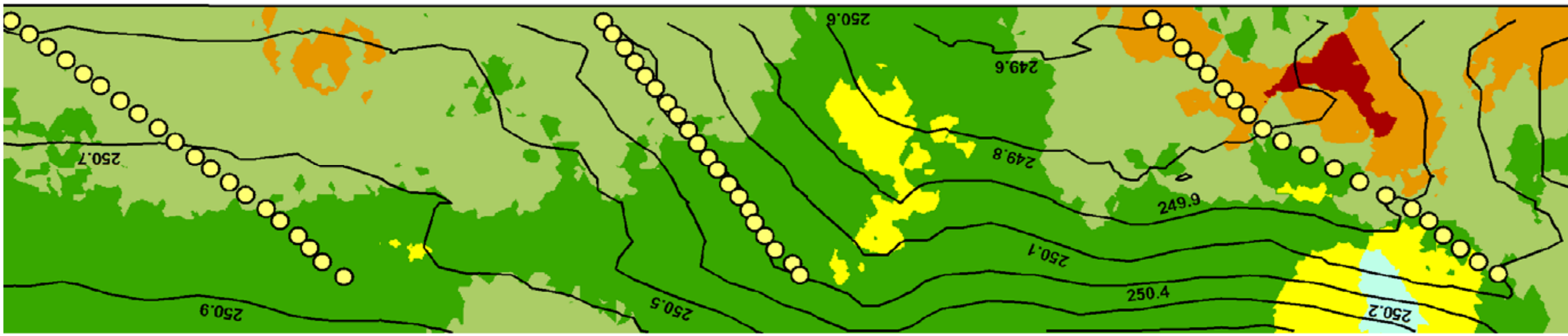
- New, lower cost products
- Higher N prices put premium on efficiency
- Greater awareness of environmental impact
- Higher crop prices improve economic viable
- Government incentive programs

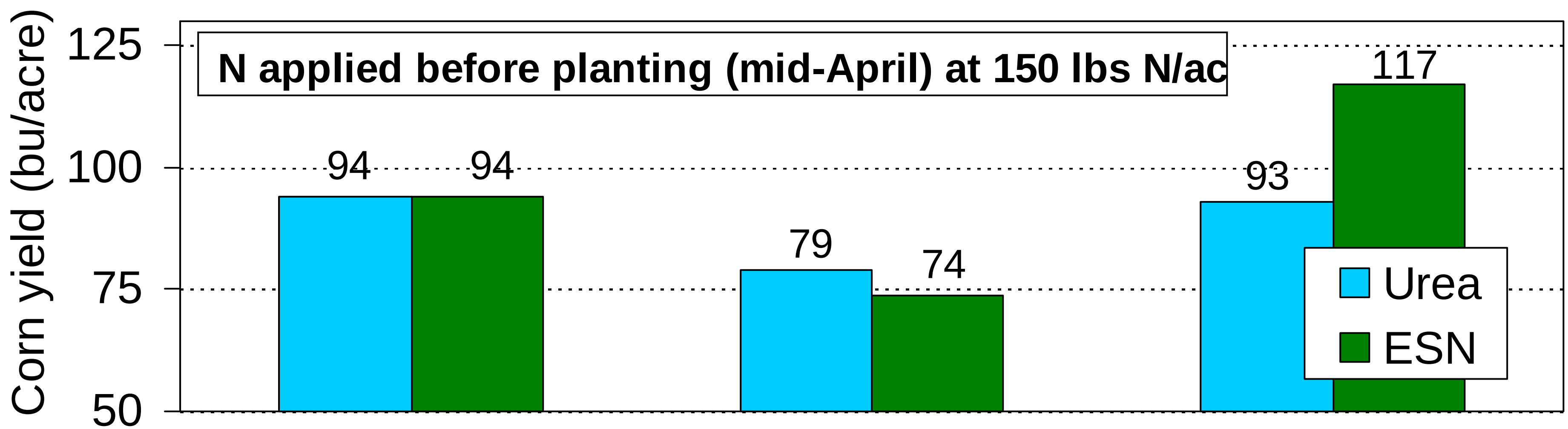
The Future – What Will Aid Adoption

- Research and education
  - Understanding how different modes of action with loss mechanisms
  - Understanding where and when benefits are observed
- Emphasize need to match mode of action to N-loss mechanism and cropping system
- Target right product to specific N loss mechanism with consideration of soil & weather conditions, cropping system, equipment, infrastructure, etc
- Integrate with other technologies

Variable-Source N Fertilization
Greenley, MO, 2005

Summit Sideslope Low-lying





Source: Drs. P. Motavalli, K. Nelson, Missouri, 2005.

What Drives the Grower's Decision

- Drivers are economics, convenience, simplicity, risk
  - Economics are usually foremost
  - Nitrogen BMPs compete with other practices for time, labor, equipment, fuel, etc.
  - Controlled-release fertilizer technologies can substitute for time, labor, equipment - making multiple applications - and achieve the same result with less risk.
- Cost and benefit
  - There must be a benefit, real or perceived, the grower wants that justifies the cost.
  - Growers will pay a higher price if the benefits are sufficient and sufficiently consistent.

Enhanced-Efficiency Fertilizers CAN Enhance Efficiency

- Reduced losses to water and air, increased plant uptake, improved productivity and profitability when matched with appropriate environment
- Simplified N management with less risk for producers
- Enhanced efficiency fertilizer technologies will become – and are now becoming – a larger part of nitrogen management tactics.
- The future is indeed bright for these technologies.

Thank you for your time

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