Nitrogen Management Tools for Reducing Nitrogen losses in the Chesapeake Bay Watershed

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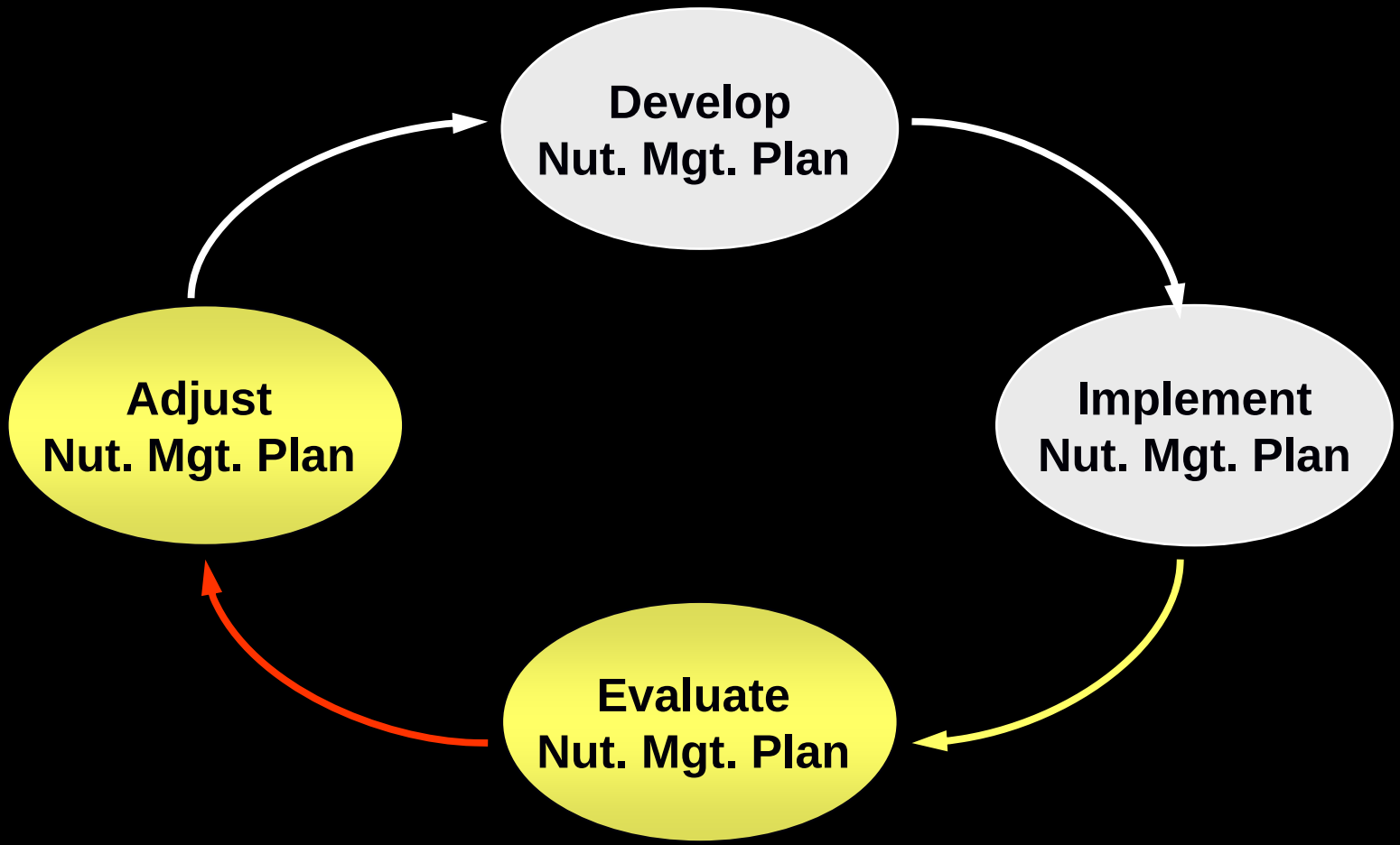
Principles for Managing Nitrogen

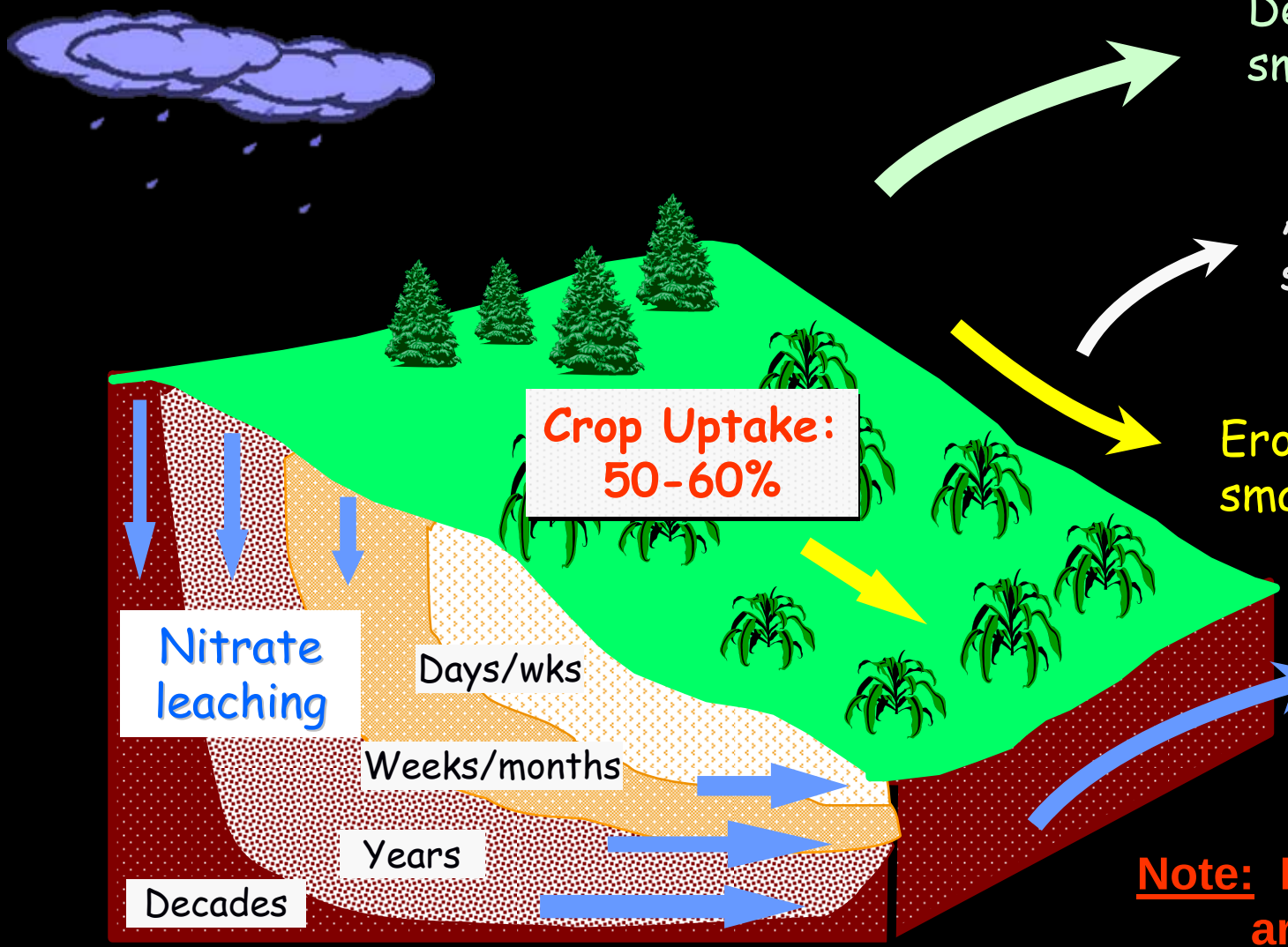
(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - Know the soil-crop-**hydrologic cycle**
  - Apply proper ***rate*** of N - avoid excess N
  - Apply N ***timed*** to crop demand
  - Apply N with proper ***placement*** - incorporate
  - Adaptive management – mgt. w/ evaluation
- **Cropping System Tools :**
  - Use rotations, add cover crop or forage crop
  - Use: riparian buffers, CRP acres, wetlands

Basics of Adaptive Nutrient Management



Nitrogen Cycle "Leaks"



Denitrification losses:
small-moderate 10-20%

Ammonia losses:
small-moderate 5-20%

Eroded organic & mineral N:
small losses 1-5%

Leaching losses:
Large 10-40%

Note: Major N Cycle Losses are Driven by Hydrology

Principles for Managing Nitrogen

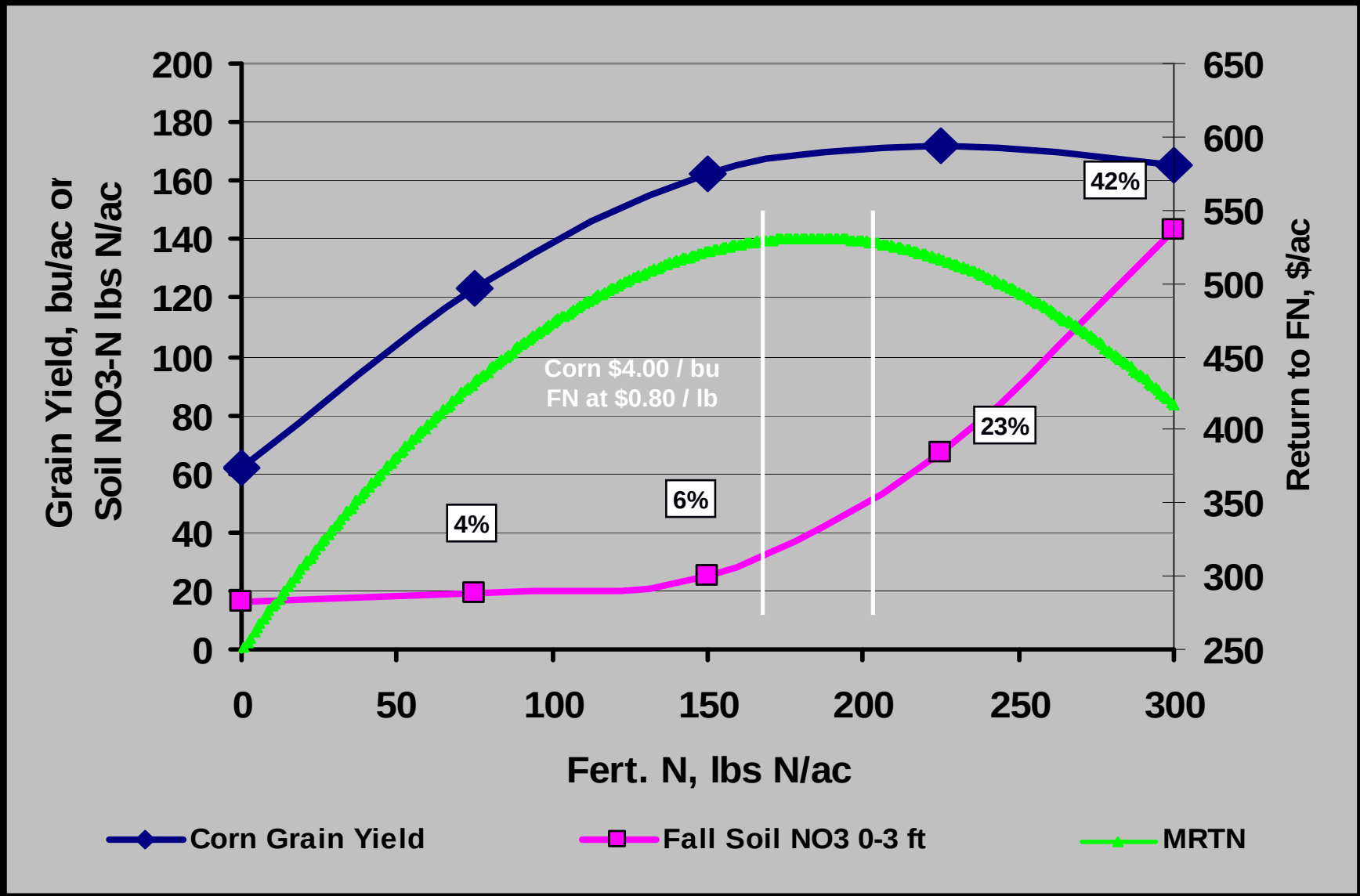
(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - **Apply proper *rate* of N - avoid excess N**
    - ✓ **Use realistic yield estimates, e.g. yield history or yield monitor data for soil types within the field**
    - ✓ **Include other N sources, e.g. manure analysis, manure spreader calibration, legume credits**
    - ✓ **Use in-season monitoring tools, e.g. pre-sidedress soil nitrate test (PSNT), LCM, Sensors**

Connection Between Optimum N Management & the Environment

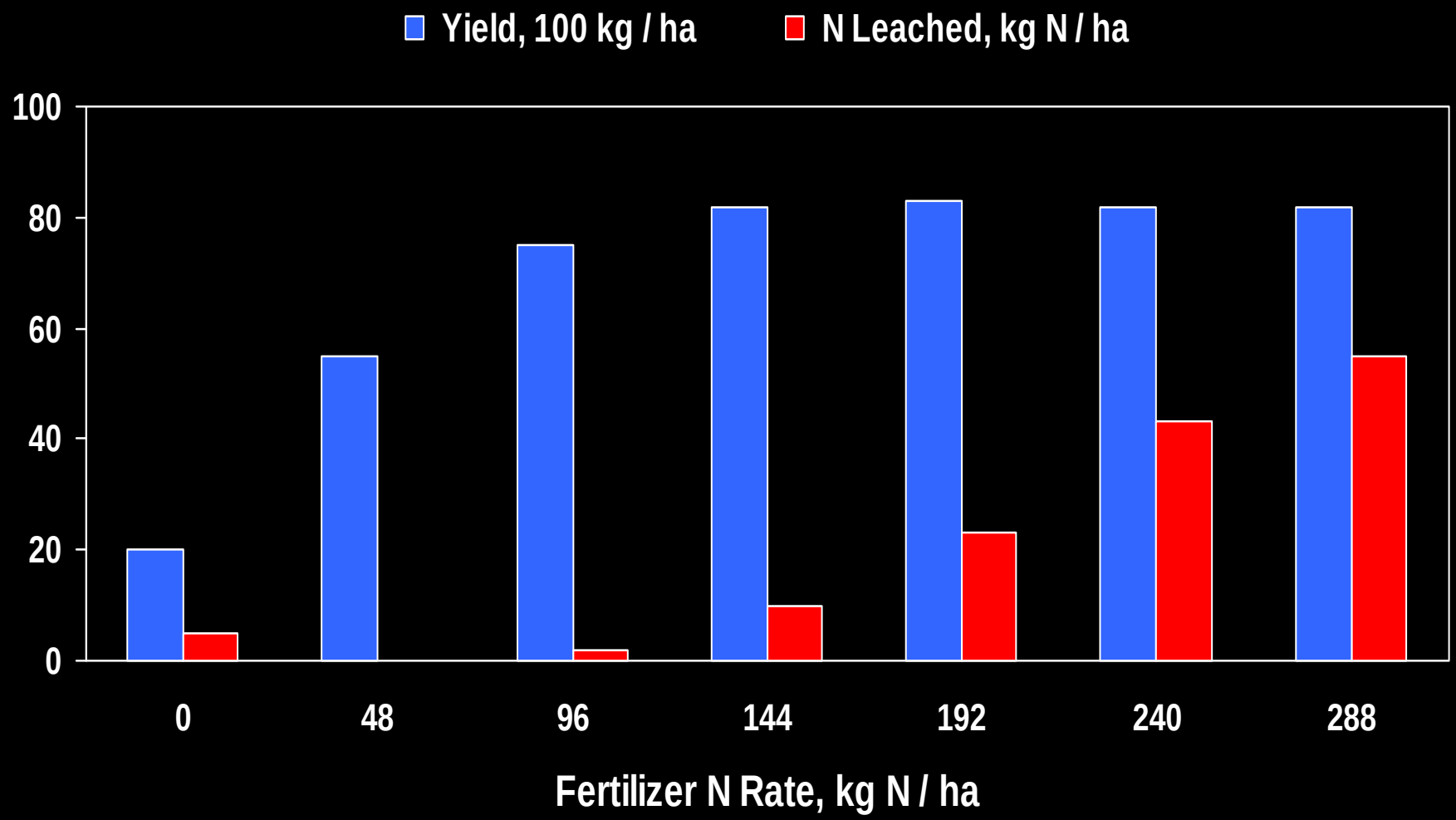
(Adapted from Coale et al., 2000)

Cont. Corn, no CC, 3-yr study, Mattepex silt loam, Lower eastern shore



Managing Nitrogen: Application Rate
Yield & N Leached, UK Winter Wheat

(K. Goulding, 2000)



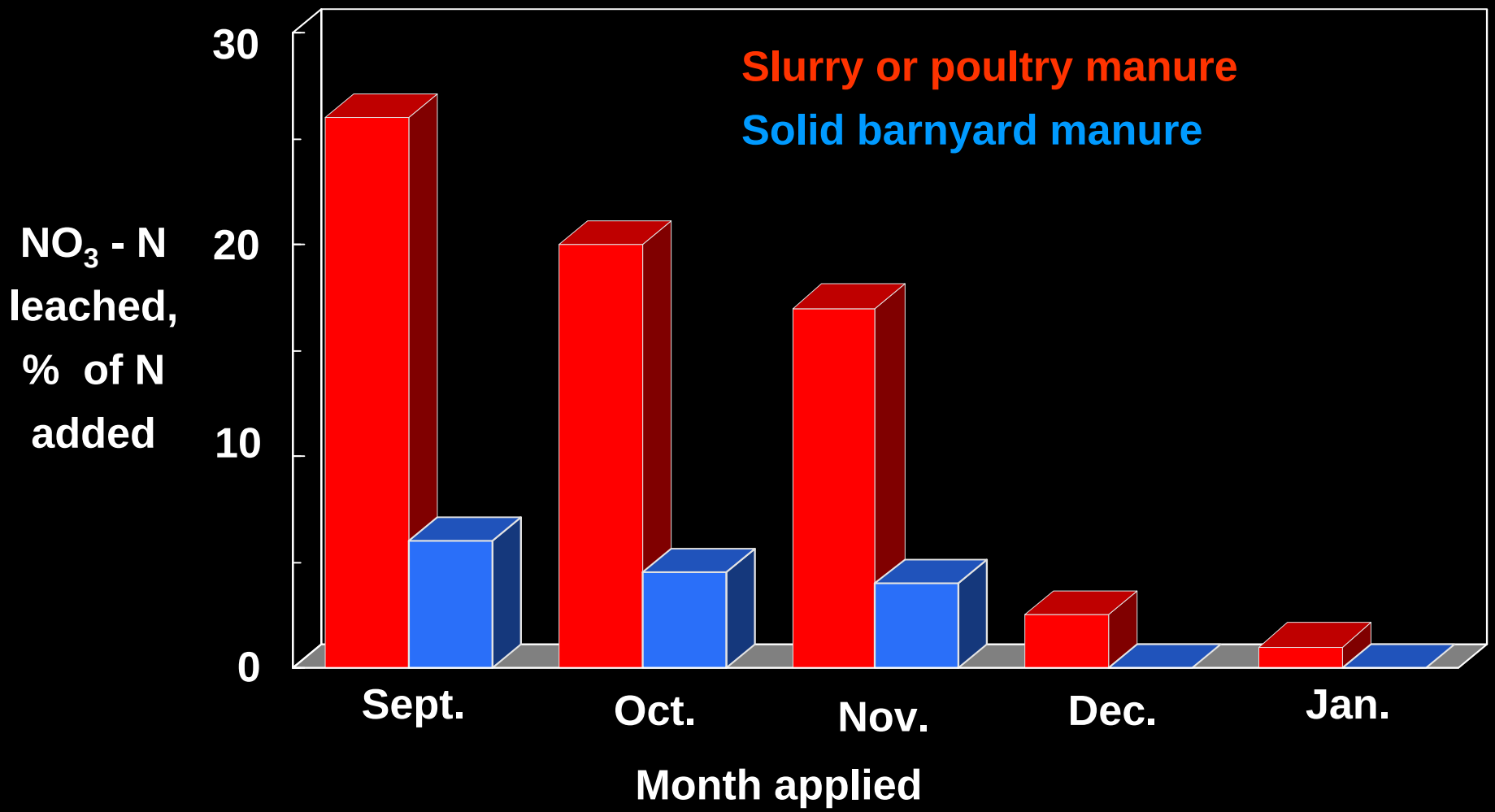
Principles for Managing Nitrogen

(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - Apply N ***timed*** to crop demand
    - ✓ Apply N to avoid periods of potential loss, e.g. avoid the winter “leaching season”
    - ✓ Use split N applications whenever possible, e.g. split N for winter wheat, sidedress N for corn

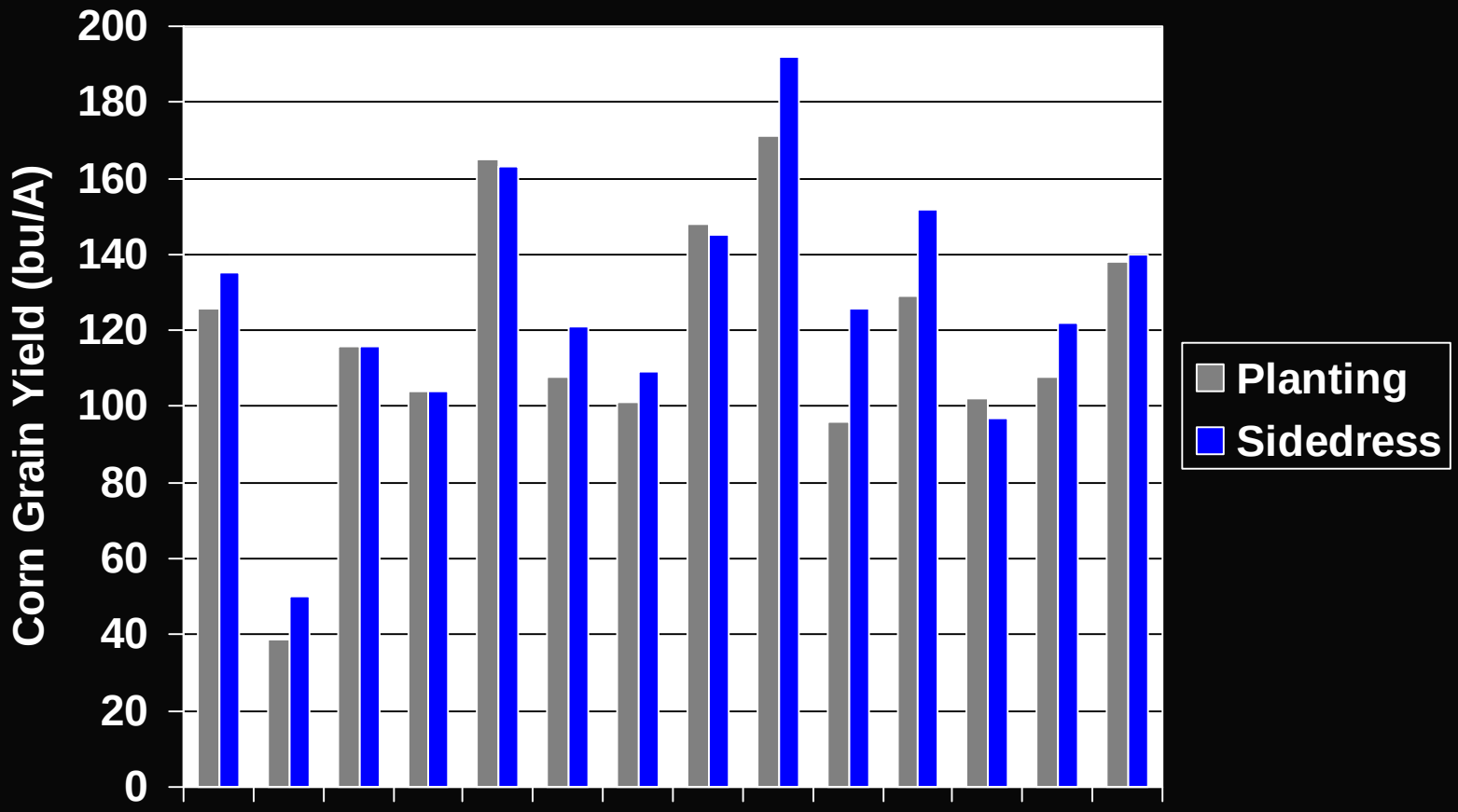
Timing Manure Applications

(Sharpley & Lord, 1998)



Planting vs Sidedress N for Corn

Fox & Beegle, PA St.



At-Plant = 118 bu/A **Sidedress = 127 bu/A**

Principles for Managing Nitrogen

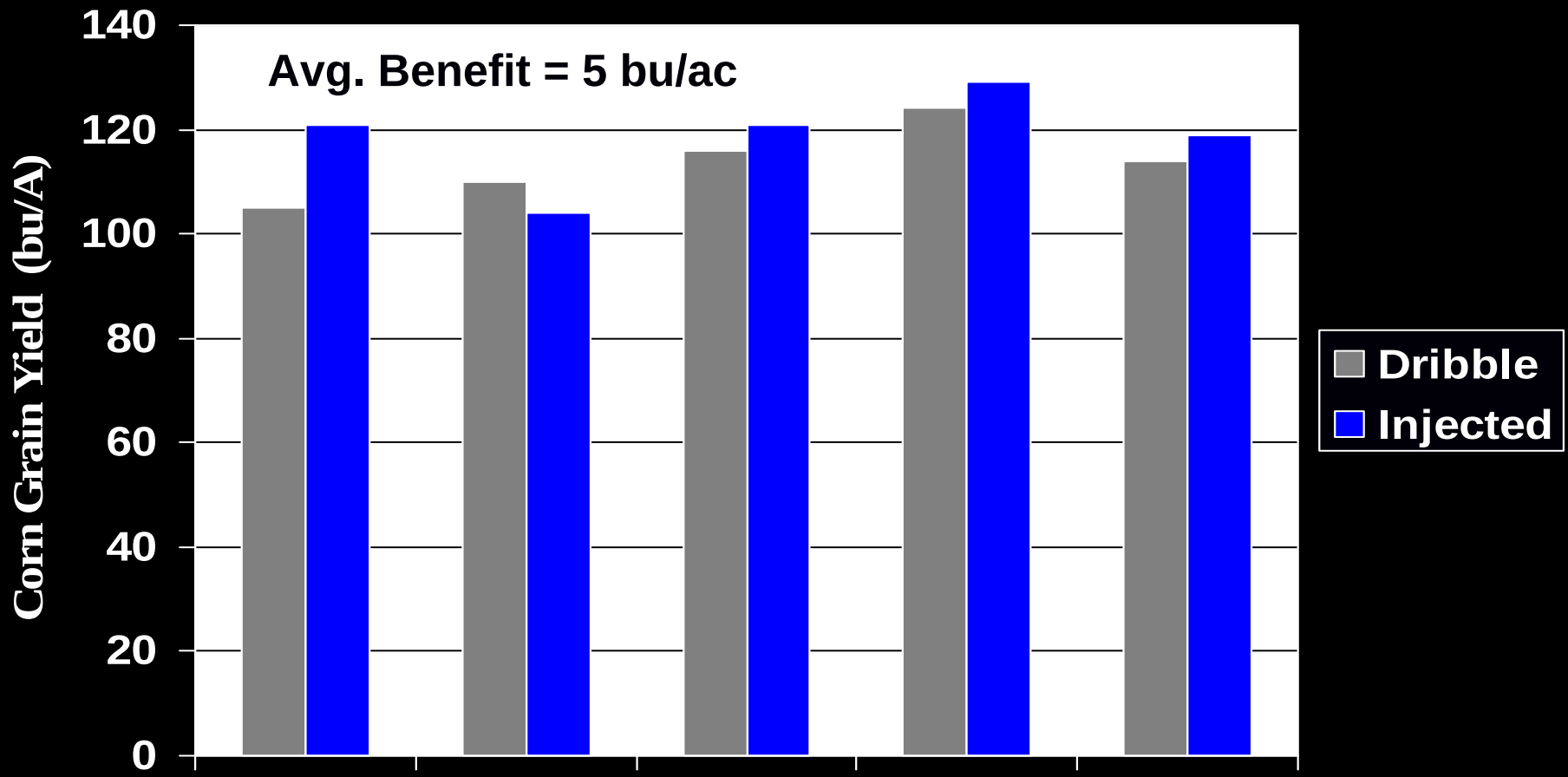
(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - Apply N with proper ***placement***
    - ✓ **Incorporate manure and urea** containing fertilizers, e.g. avoid surface applications with prolonged exposures to ammonia loss
    - ✓ **Use manure or UAN injection equipment** that can maintain some residue cover

UAN Fertilizer Injector

Dribble vs Injected UAN

(Fox & Beegle, PA St.)



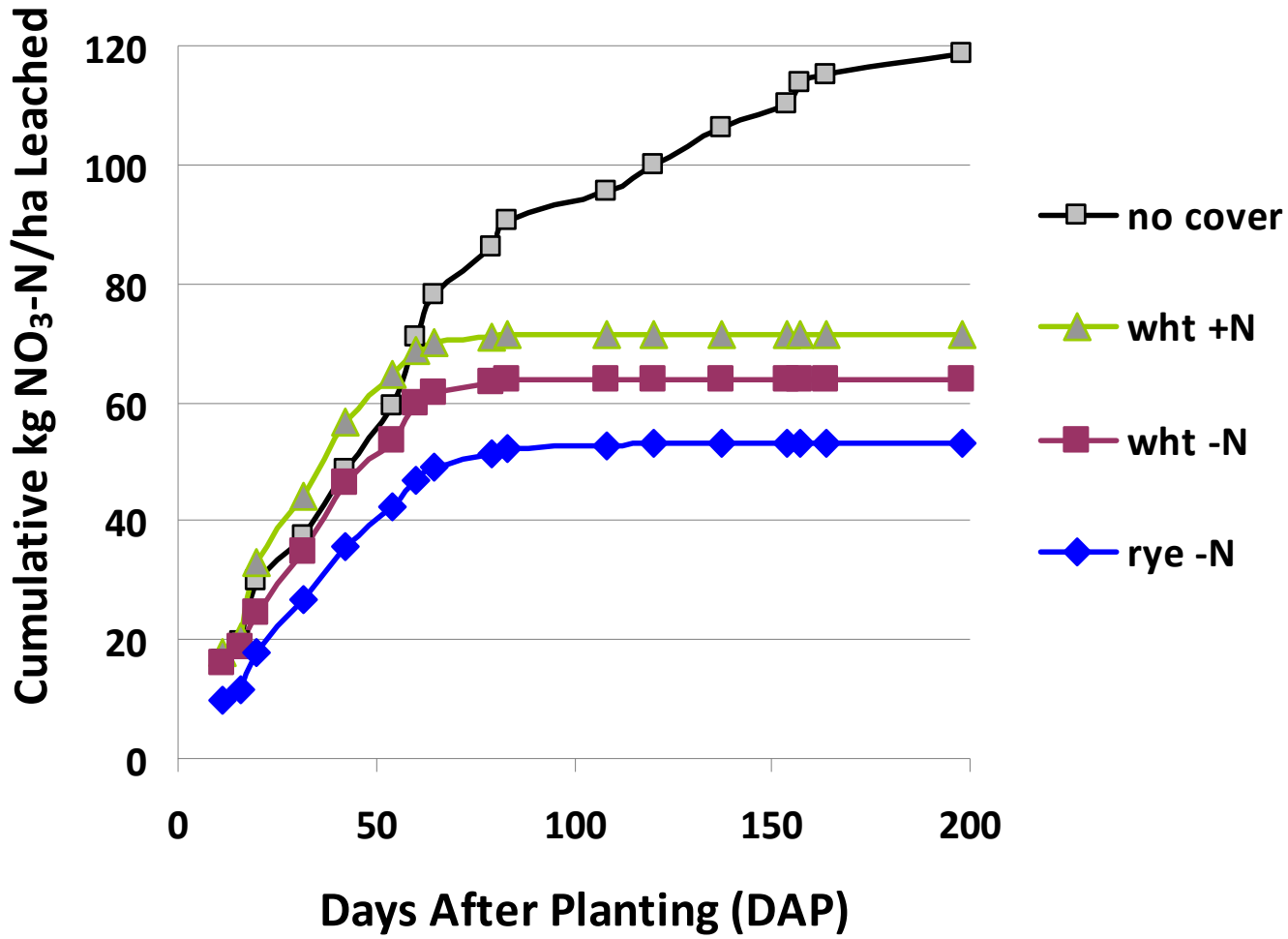
Principles for Managing Nitrogen

(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - **Cropping System Tools, *cover crop***
    - ✓ **Add a grass cover crop, rye or wheat, use good agronomic practices, e.g. good seed-soil contact, early planting,**
    - ✓ **Use covers especially if high residual N, manured sites, drought sites, etc.**
    - ✓ **Monitor establishment w/ remote sensing**

N Leaching from Cover Crops, Beltsville Lysimeters, 2009-2010

(Meisinger & Ricigliano, 2010, Pers. Commun.)



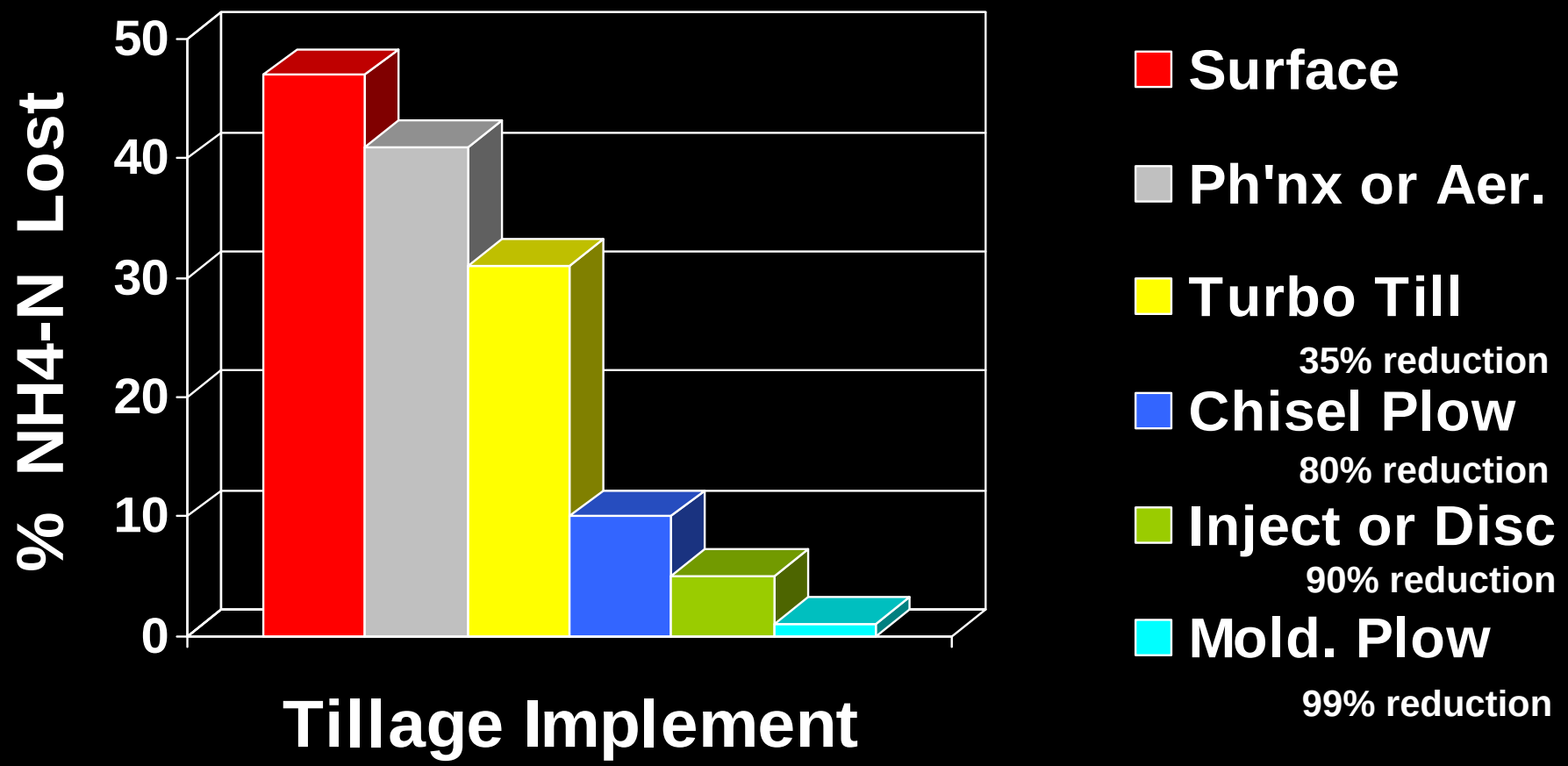
Principles for Managing Nitrogen

(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - **Ammonia Management Tools, *tillage or injection***
    - ✓ **Ammonia loss is rapid, 50-70% of NH4-N lost the first day from slurries**
    - ✓ **Use immediate tillage or injection to reduce losses**
    - ✓ **Conserve surface residues to manage erosion, e.g. use vertical tillage such as turbo-till or injection**

Tillage Effects on NH_3 Loss
Dairy Slurry, Wind Tunnels, 7d

(Thompson & Meisinger, 2001, Meisinger unpub. 2009)



Within-Season N Management Approaches

- **Within-Season Approaches: Leaf Chlorophyll Meter (LCM), Pre-sidedress Soil NO_3 (PSNT), Ear Leaf N, Petiole NO_3 for Vegetables, End-of-Season Corn Stalk NO_3 (CSNT), Sensors**

- **Advantages:**
  - **Can adjust for: prior crops, manure, irrigation, *weather & soil interactions during the first part of the season***
- **Disadvantages:**
  - **Future weather still uncertain, spatial variability remains**
  - **Tests are labor intensive and slow,** e.g. 1 PSNT person = 2,000 ac

MD Pre-sidedress Soil Nitrate Test (PSNT)

(Meisinger et al., 1992)

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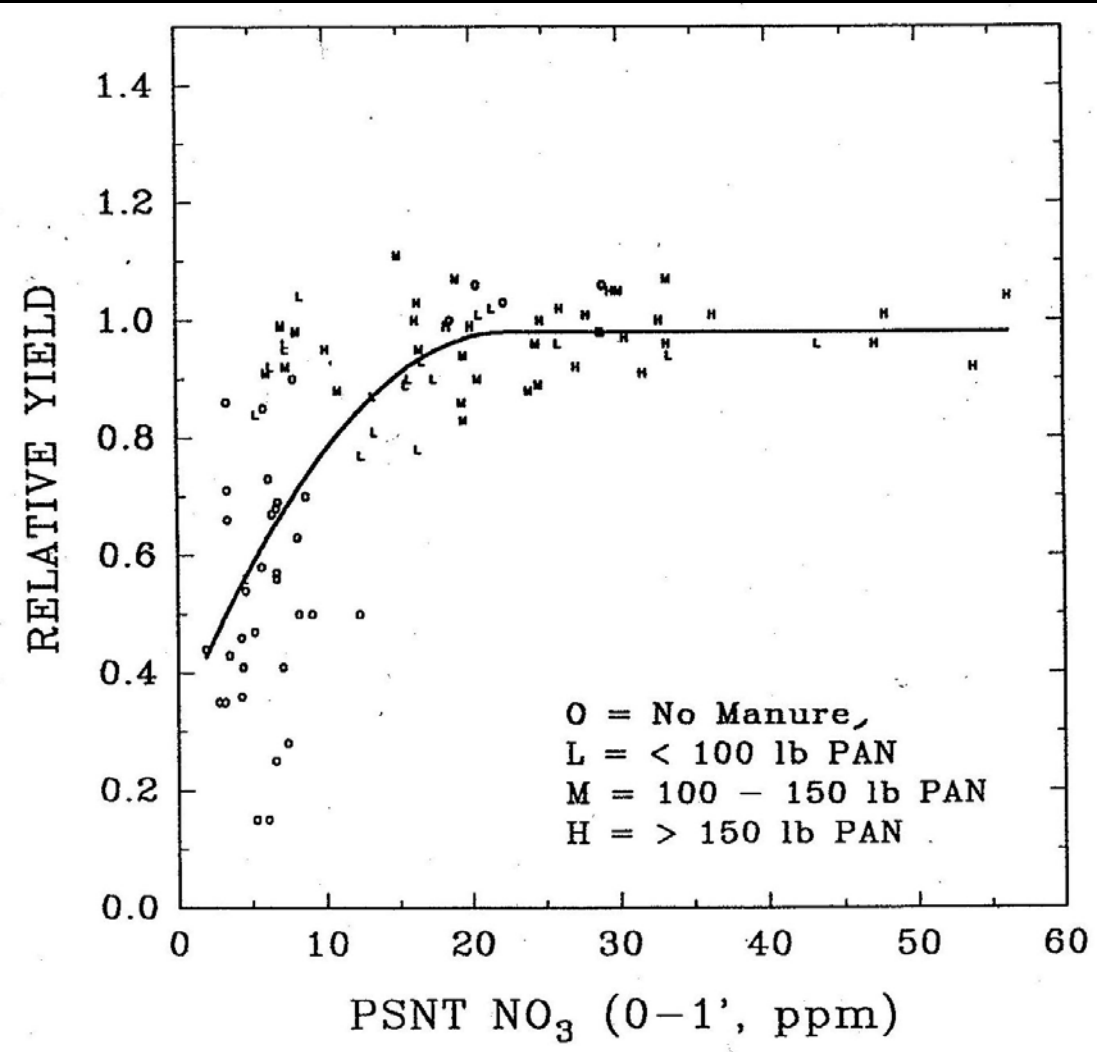
(Meisinger et al., 1992)



PSNT

- Good for ID'ing N sufficient sites
- Very useful for manured sites, which are problematic
- > 21 ppm sufficient
  < 15 ppm deficient
  15-21 ppm gray area

Adaptive N Management for PSNT: Adapt-N Information needed

Soil/Tillage

- User ID / Field ID
- Latitude / Longitude
- Soil textural group
- Approximate field slope
- Drainage
- Soil test information
- Tillage information

Organic Inputs

- Manure applications:
  - Two previous years / current year
- Previous sod crop
- 1st year corn after soybean?

Fertilizer/Crop

- Starter fertilizer
  - type/rate/application date
- Additional fertilizer
- Cultivar maturity class
- Planting date
- Expected harvest population

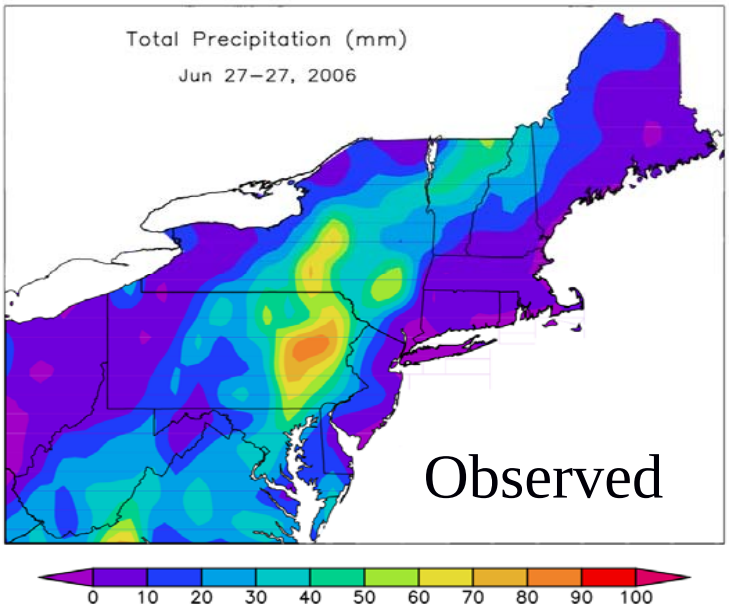
H. van Es, Cornell Univ.

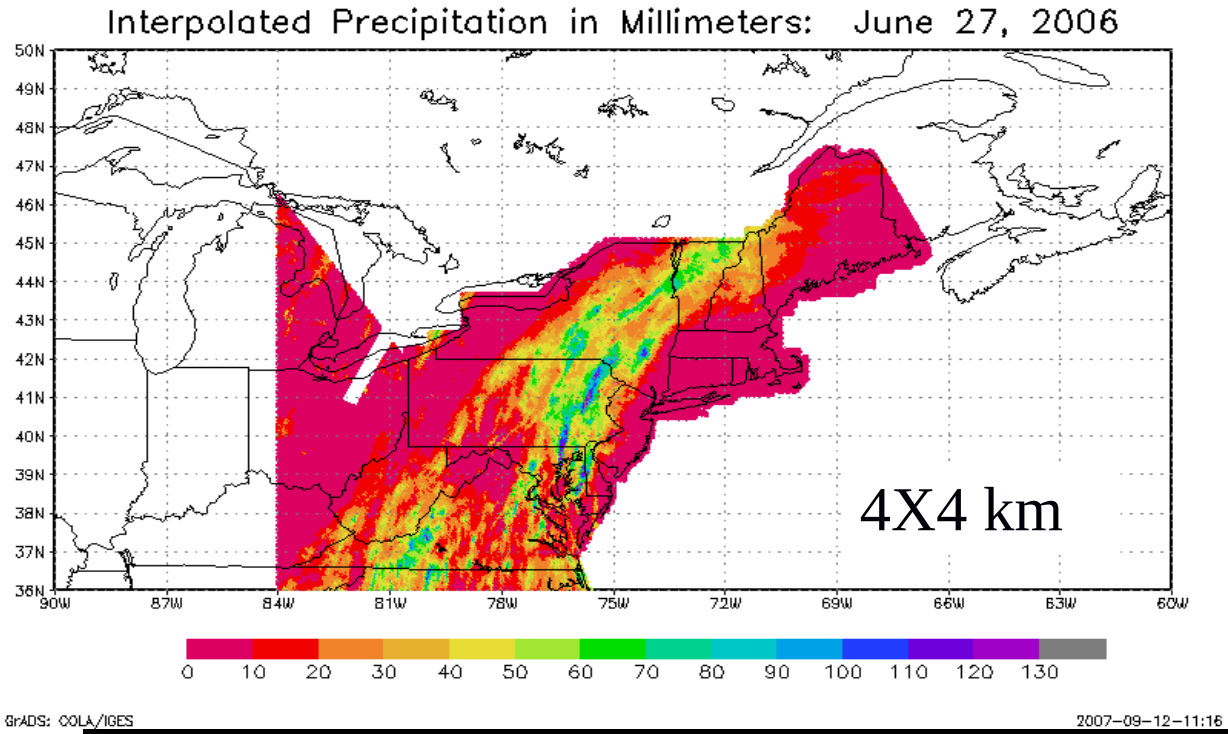
Adapt-N Input:

High Resolution Precipitation Data

Error-Corrected Radar Estimates

Northeast Region Climate Center





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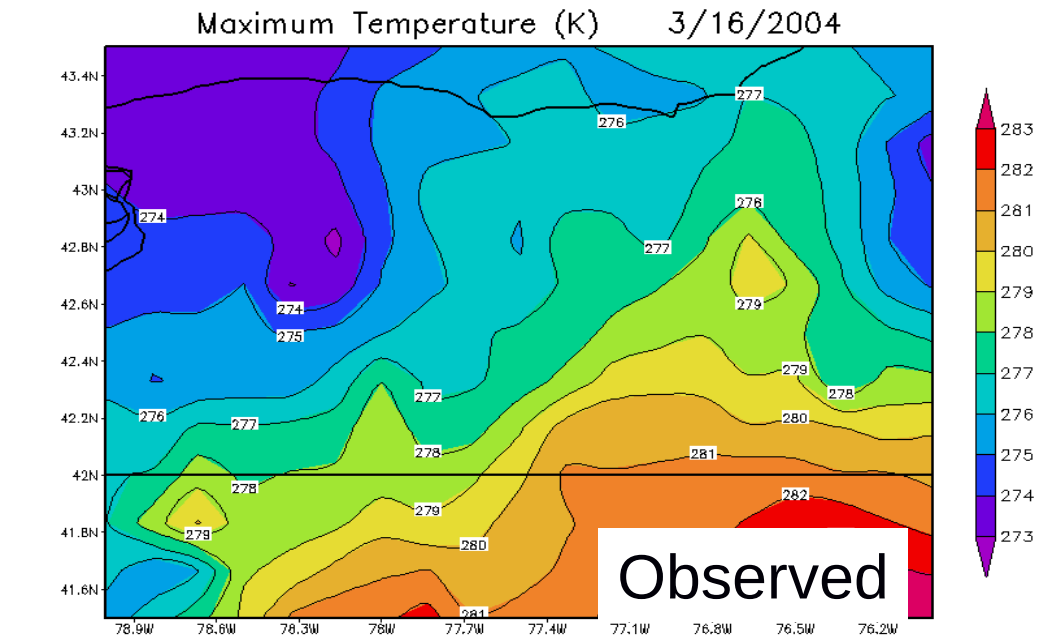
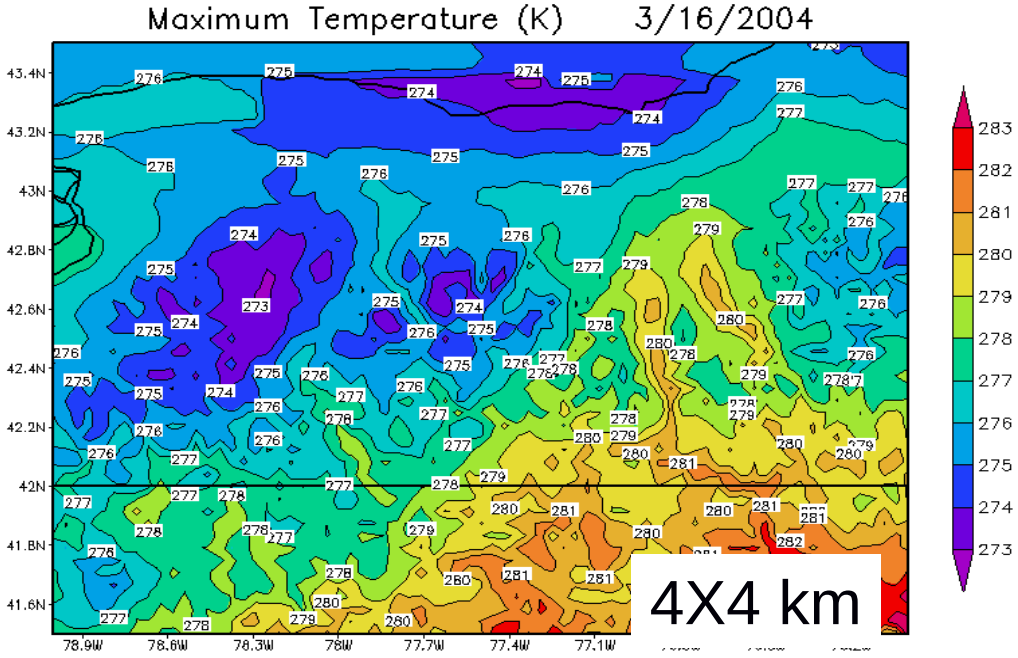
Adapt-N Input:

High Resolution Temperature Data

Elevation-Corrected Spatial Interpolations

Northeast Region Climate Center





H. van Es, Cornell Univ.

Corn Stalk Nitrate Test (CSNT)

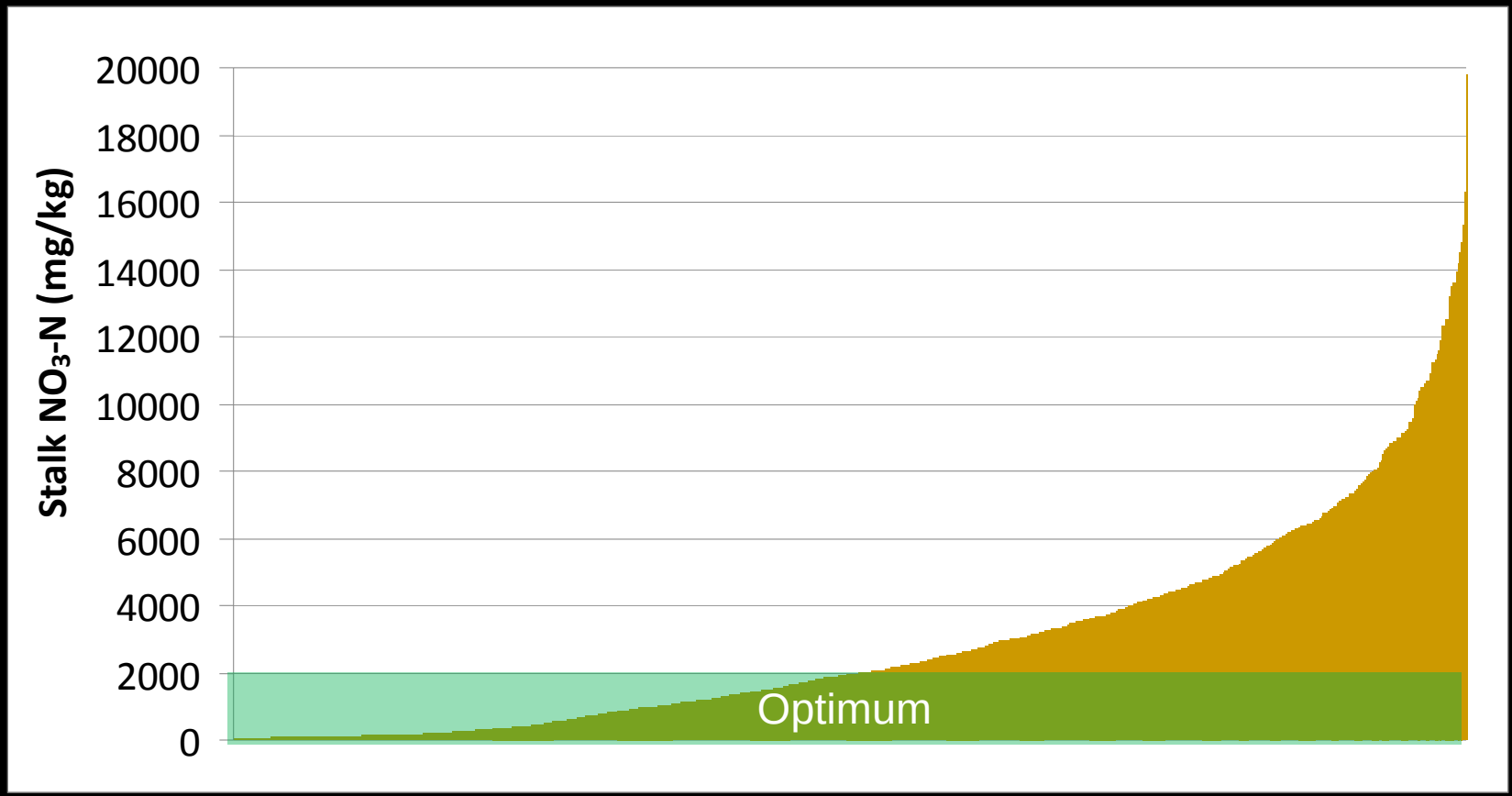
- Late Season Stalk Nitrate Test
  - **An autopsy of N management**
  - **Procedure:**
    - **Sample between ¼ milkline and 3 weeks after black layer**
    - **8” piece of stalk 6” above the ground**
    - **Cut into pieces, dry, and send to the lab**
    - **Opt. 700-2,000 ppm NO_3-N**

Late Season Stalk Nitrate Test

Test Level	Interpretation	Management
<700 ppm NO_3-N	Low	N likely limited yield
700-2000 ppm NO_3-N	Optimal	N adequate for high yield, but not excessive
>2000 ppm NO_3-N	Excessive	N was in excess of that needed for high yield

Pennsylvania Stalk Nitrate Summary

2000-05 from 1,692 obs. **(D. Beegle PA St.)**



Real-Time Sensor with Sprayer

NDVI

Red

NIR

Reflectance in Red and NIR,
Outputs data as NDVI & Ratio

8 rates

60 cm

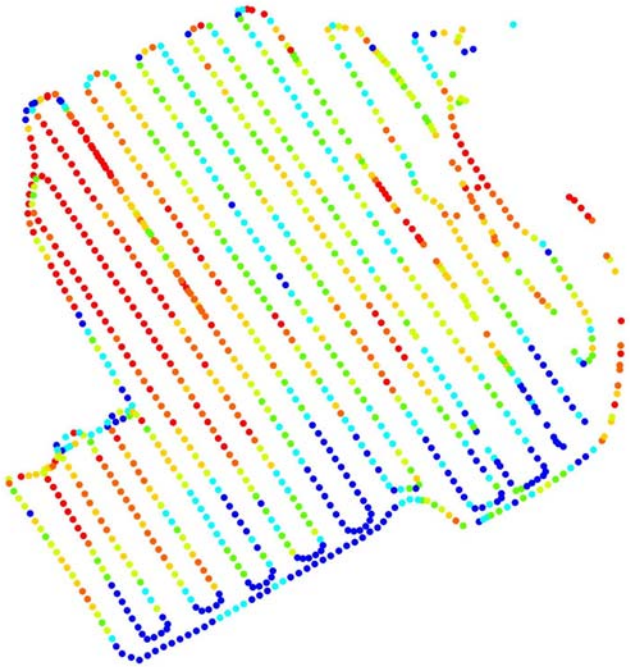
60 cm

NTech Industries, Inc.

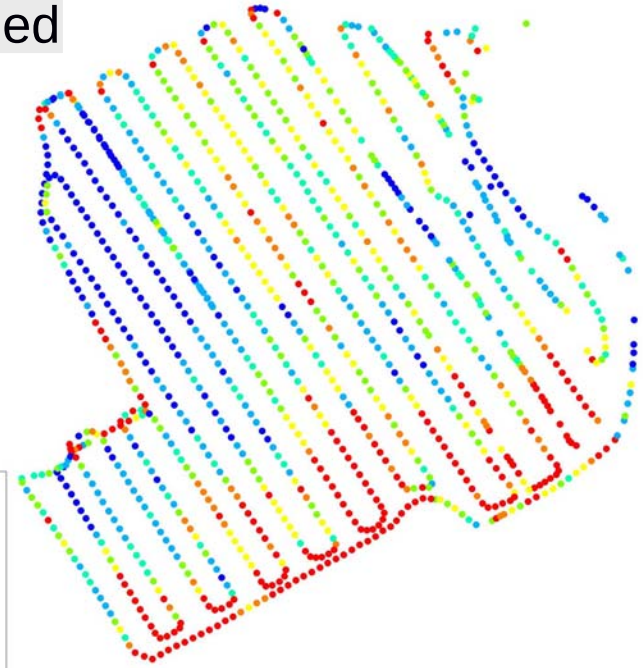
Oklahoma State Univ.

Real-Time Sensor with Sprayer

GDVI



N Applied



Field Strip Tests: A Valuable Approach

The Original Strip Test
The Broadbalk Experiment, Rothamsted UK, 1853

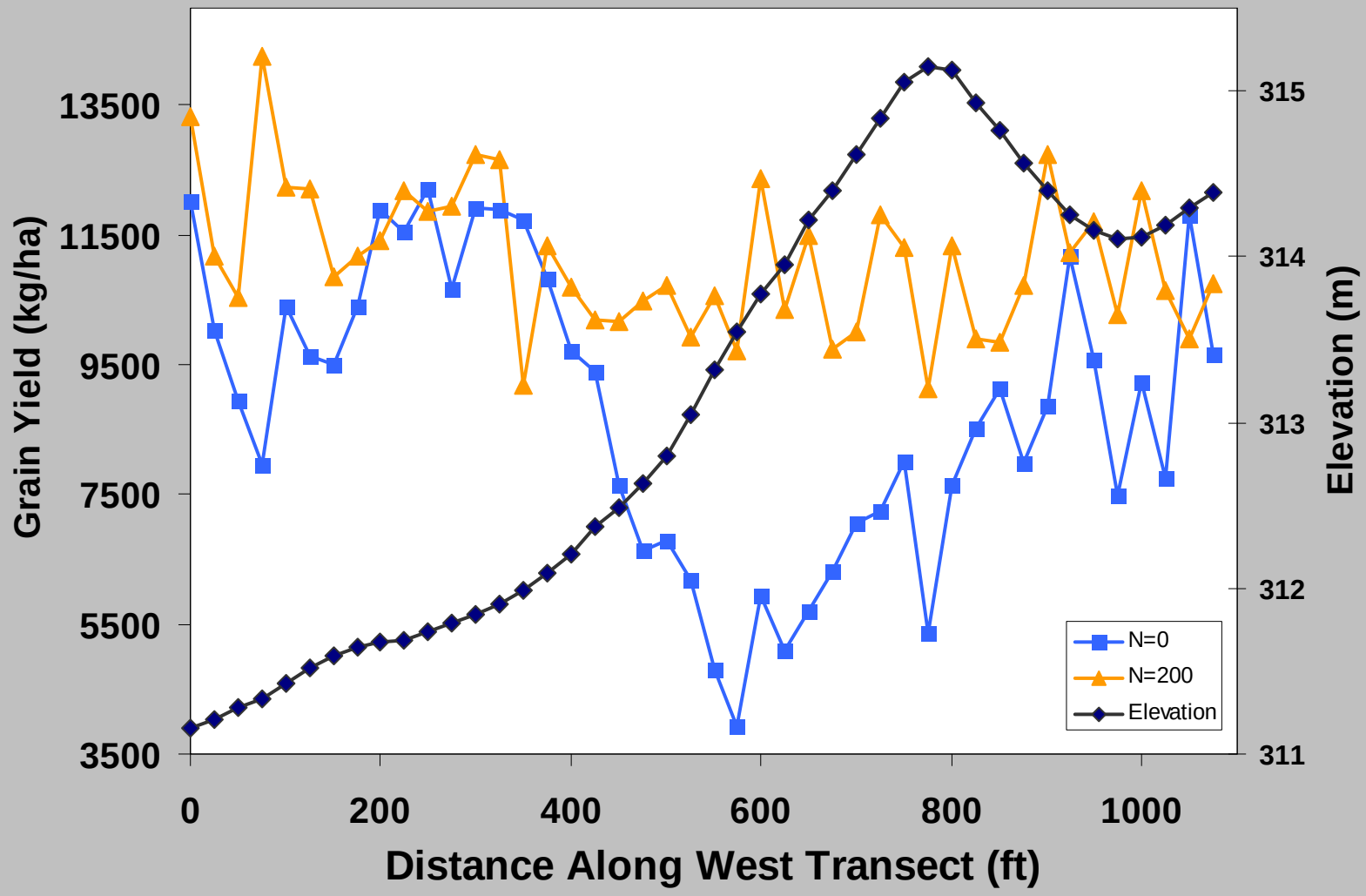
Principles for Managing Nitrogen

(Meisinger & Delgado, 2002)

- **Universal N Management Principles :**
  - **Conduct Field Evaluations, Replicated Strip Tests**
    - ✓ **Used for >150yrs, standard practice vs. alternative practices, keep it simple, but replicate**
    - ✓ **Ex. Strip Tests: current N rate, +25% current N rate, -25% of current rate, and no-N strip**
    - ✓ **Site data: soil types, rainfall, temperature, previous manure or legume, etc.**
    - ✓ **Measure: yield w/ yield monitor, crop N status with leaf chloro. meter, PSNT, CSNT, etc.**

Another Important in-field Corn Test

N rates of 0 or 200 lb/ac along a transect



Note:

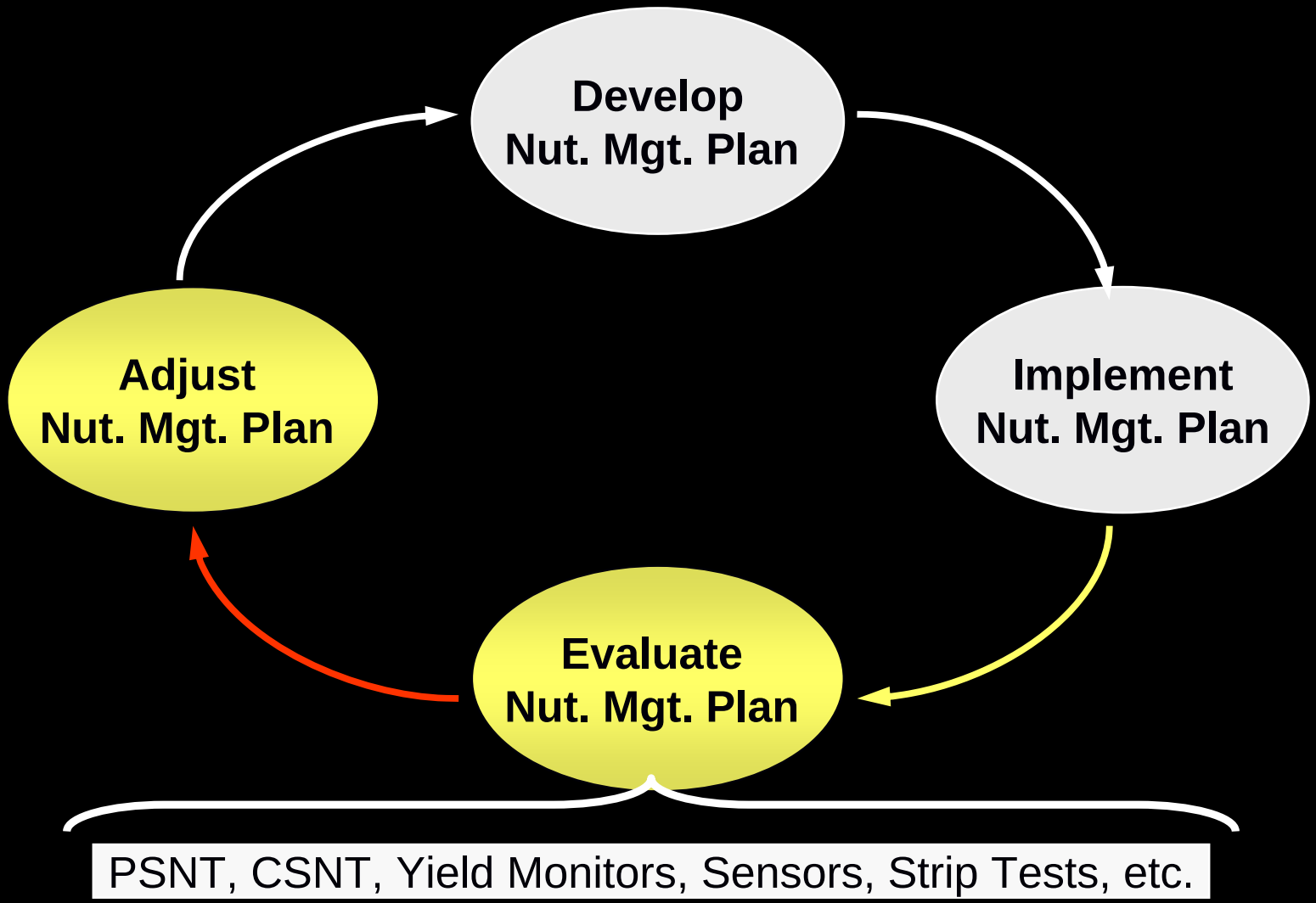
1. Check ylds. lowest, & N response highest, on eroded side slope

2. High check ylds. and high soil N supply, at footslopes and areas with concave curvature.

3. For most of the field, opt. N rate between 80 and 120 lbs N/ac.

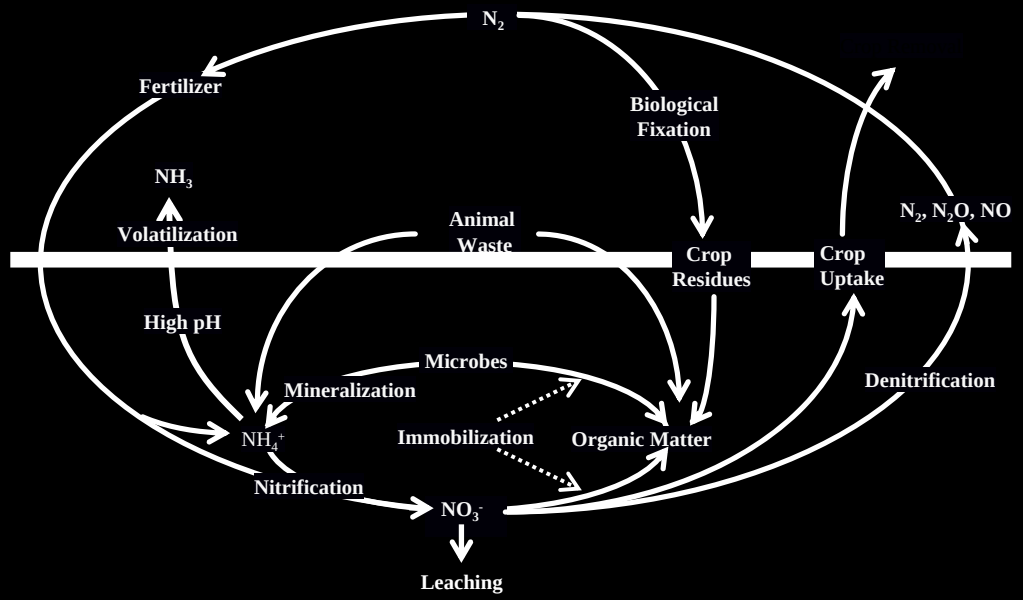
Kasper et al., 2003

Basics of Adaptive Nutrient Management

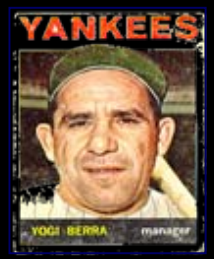


Real World N Management Is Tough!

- ✓ N is very complex
- ✓ The N cycle is leaky
- ✓ Dependent on weather
- ✓ We understand N behavior, but it is very difficult to predict



"Predictions are difficult, especially about the future" Yogi Berra



Short-term and Long-term Needs

- **Short-term Implementation needs:**
  - Expand cover crop acreage, target high residual N sites
  - Expand manure storage for dairies, to 12 month storage
  - Expand manure injection in the Bay watershed
- **Long-term Implementation needs:**
  - Develop private professional consultant program to implement adaptive nutrient management
  - Develop N rate strip test program to optimize N rates for management zones within fields
  - Research and develop algorithms for interpreting adaptive management tests (e.g. PSNT, etc)

Questions ?
Discussion !