

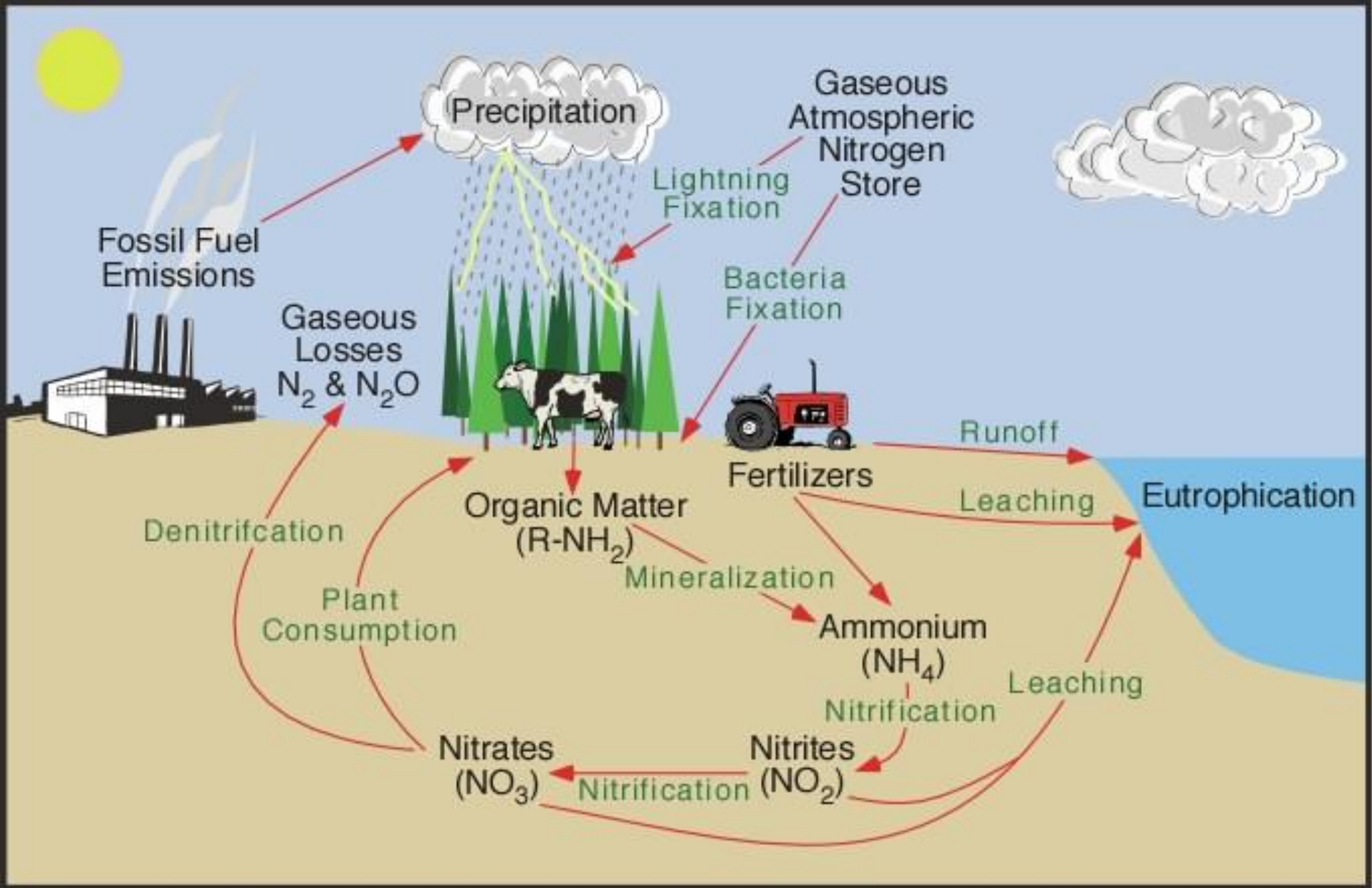
Basics of Nitrogen Management

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<http://www.physicalgeography.net/fundamentals/9s.html>

Forms of N Present in Soils

THREE major forms of N?

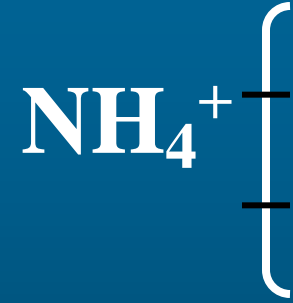
- 1) Organic N (e.g., plant residues, manures)
- 2) Ammonium (NH_4^+)
- 3) Nitrate (NO_3^-)

Organic Nitrogen

- 1) Plant residues, manures, soil OM
- 2) Plants **CANNOT** use until mineralizes
- 3) Mineralization: Biological Process
Organic N => Ammonium (NH_4^+)
- 4) **Soil Organic Matter: 5% = 3,000 lb N/ac**
- 5) SOM can supply 50 to 150 lb N/ac per year

Ammonium N (NH_4^+)

- 1) Plant available form of N
- 2) Held in soils on CEC
- 3) What happens to Ammonium in a soil?
 - Taken up and utilized by the plant
 - MAIN thing is...



NITRIFICATION

1) Conversion of Ammonium to Nitrate



3) Biological Process

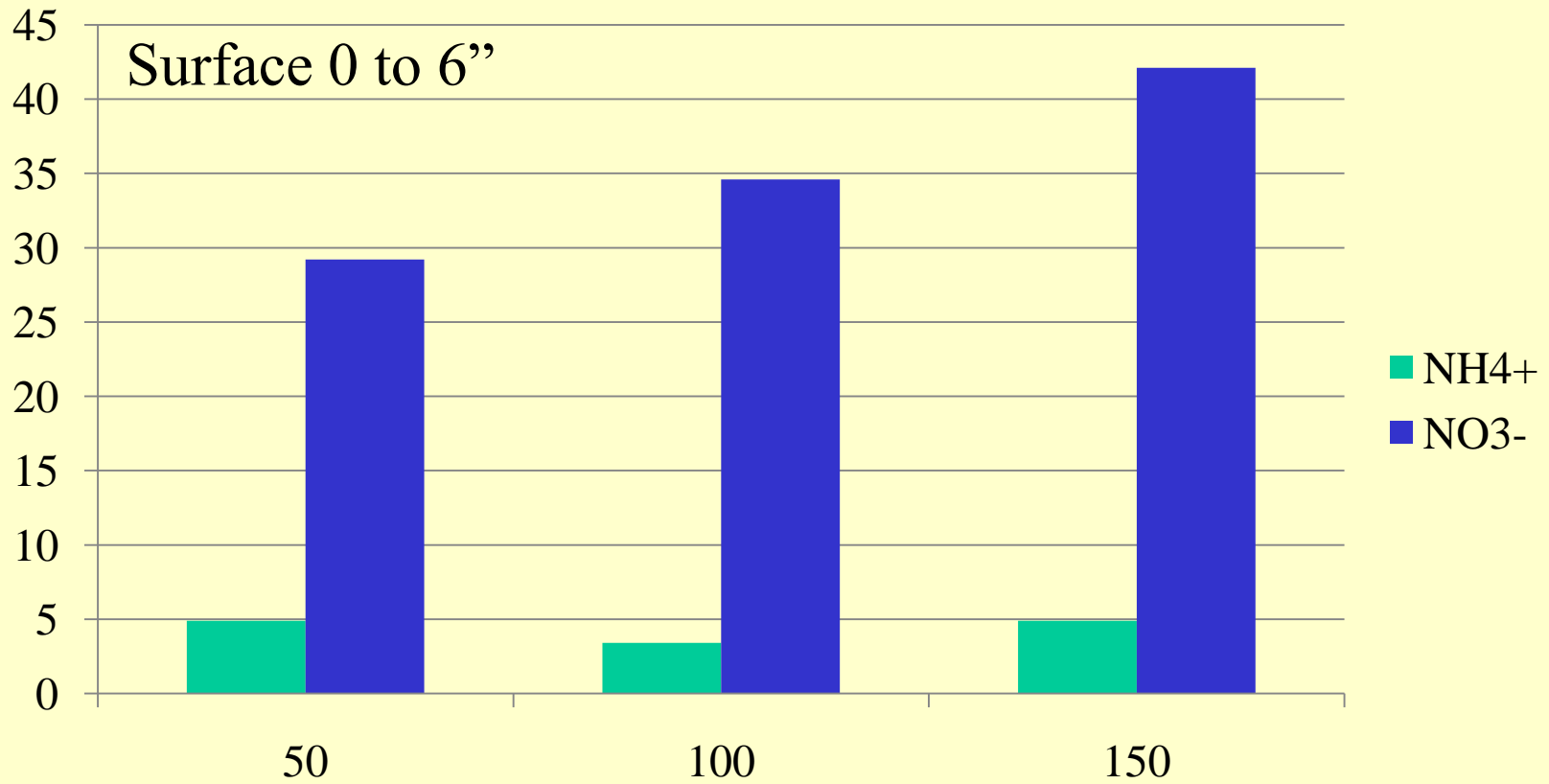
4) Nitrification is temperature dependent

5) Nitrification insignificant below 50 °F

6) How fast does the conversion occur?

Nitrification of Ammonium Sulfate

N Concentration in Late May (ppm N)



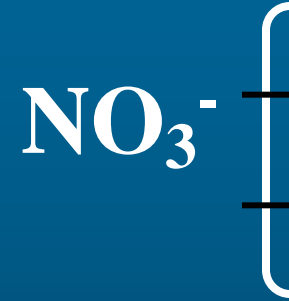
Rate of Fertilizer N Applied in Early April (lb N/acre)

Nitrification Inhibitor Technology

- 1) Slows conversion of ammonium to nitrate**
- 2) $\text{NH}_4^+ + 2\text{O}_2 \Rightarrow \text{NO}_3^- + \text{H}_2\text{O} + 2\text{H}^+$**
- 3) Reduces N loss potential**
- 4) Some studies have shown a benefit**
- 5) Potential benefit greater in today's fertilizer market**
- 6) Potential value increases with length of time between application and plant demand**

Nitrate N (NO_3^-)

- 1) Plant available form of N
- 2) **NOT held in soils on CEC**
- 3) Due to nitrification, NO_3^- most common
Nitrification: $\text{NH}_4^+ \Rightarrow \text{NO}_3^-$
- 4) Nitrate is **lost** relatively easily from soils



How is Nitrogen Lost?

THREE ways N is lost from soils:

1) LEACHING

2) DENITRIFICATION

3) VOLATILIZATION

LEACHING

- 1) Primary form of N lost this way? NO_3^-
- 2) Nitrate with Excess Water = Leaching
- 3) Soil Type is a major influence
Greater Sand content = Greater leaching
- 4) Leaching can occur in most soils
- 5) How can this be MINIMIZED?
- 6) Minimize amount of time that N is present in soil without plants growing

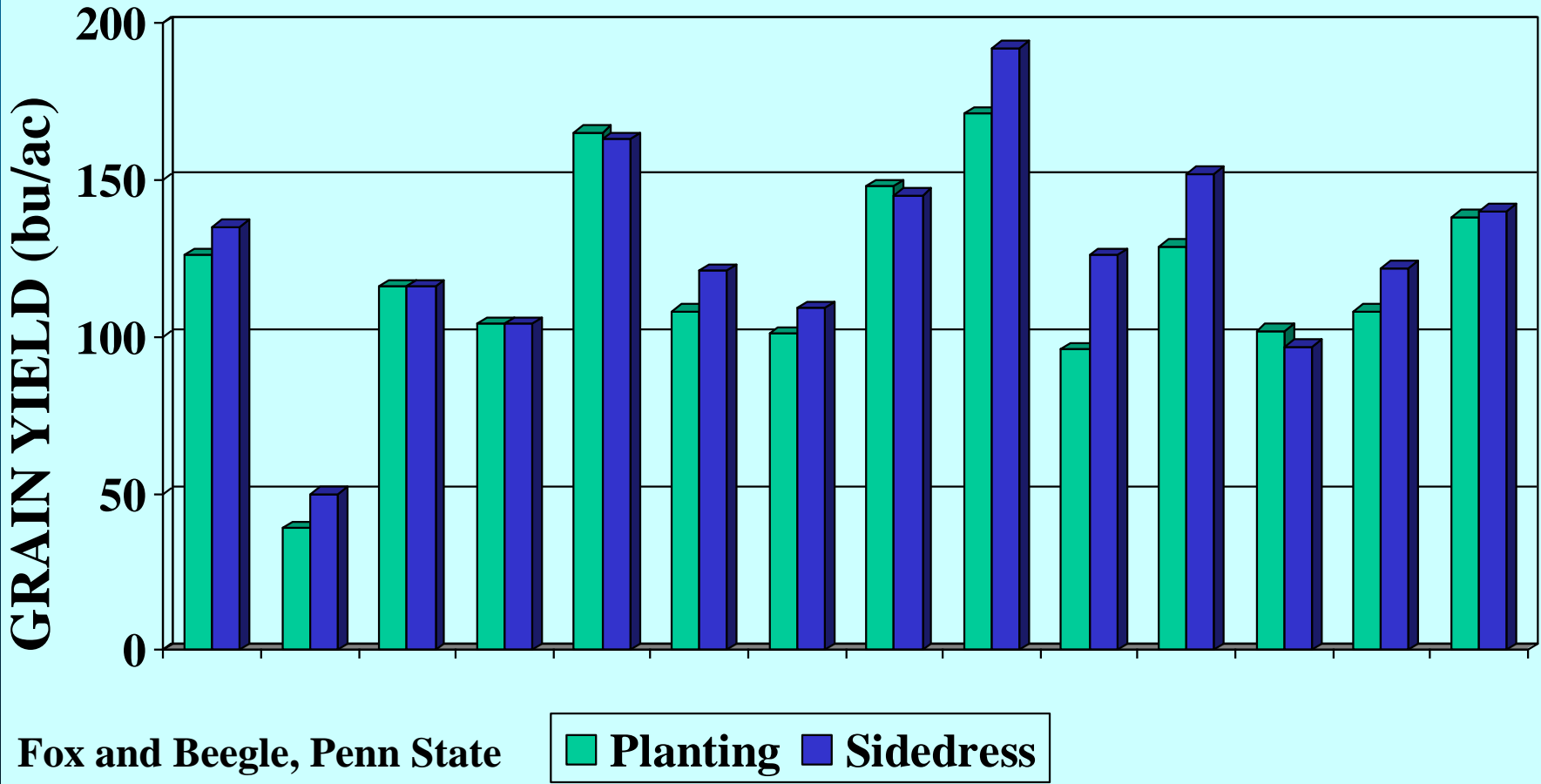
DENITRIFICATION

- 1) Form of N lost this way? NO_3^-
- 2) Nitrate with no oxygen = denitrification
- 3) Soil Type is a major influence
Poor drainage = Greater denitrification
- 4) Fine-textured soils = greater potential
- 5) How can this be MINIMIZED?
- 6) Minimize amount of time that N is present in soil without plants growing

Time of N Application

At-Plant = 118 bu/A

Sidedress = 127 bu/A

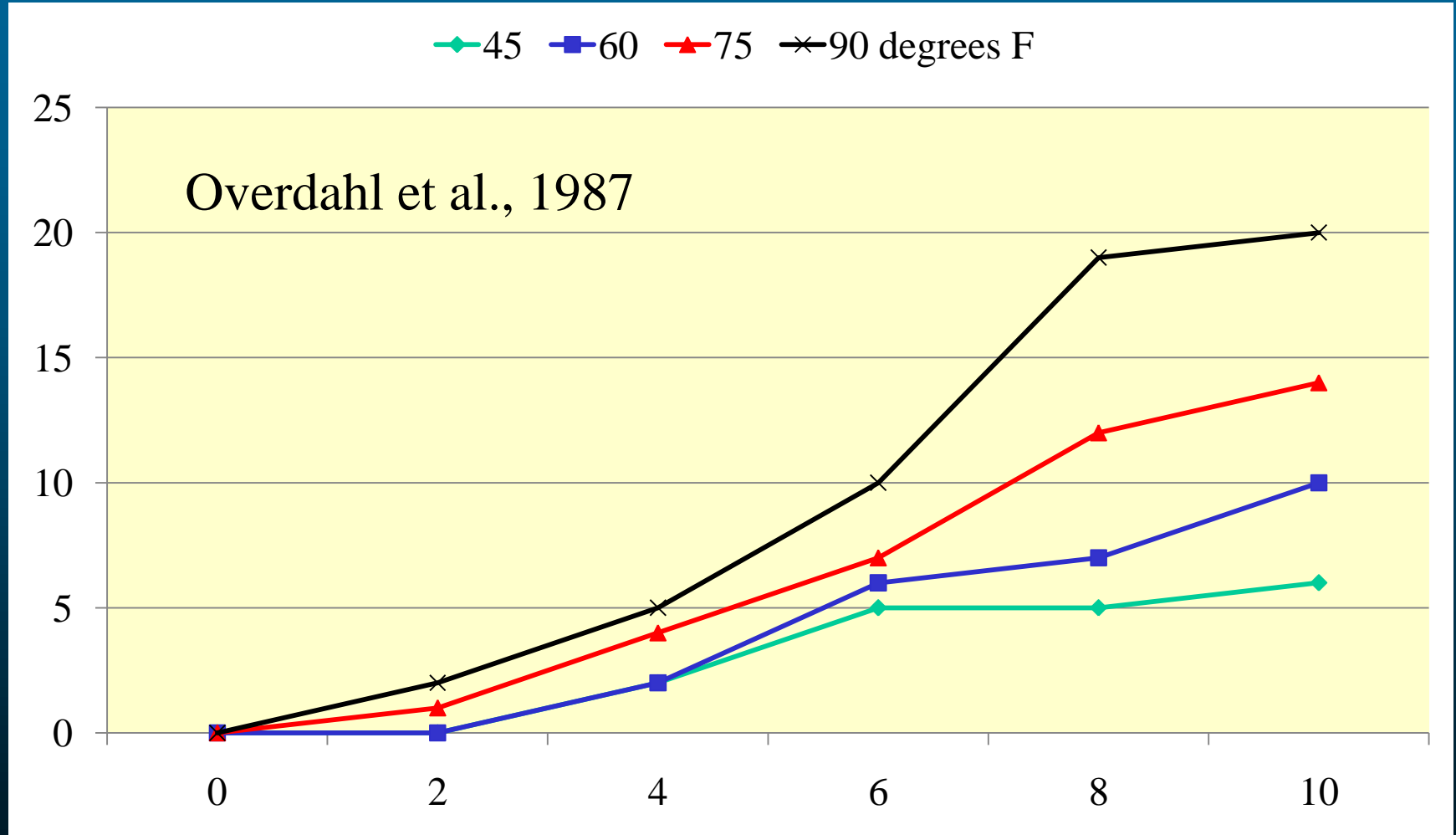


VOLATILIZATION

- 1) Form of N lost this way? NH_4^+
- 2) Ammonium in high pH environment
- 3) Soil pH is THE major influence
- 4) $\text{NH}_4^+ \rightleftharpoons \text{NH}_3(\text{g}) + \text{H}^+$
- 5) Other important factors: CEC, wind, and TEMPERATURE

Ammonia Volatilization

NITROGEN VOLATILIZED (%)



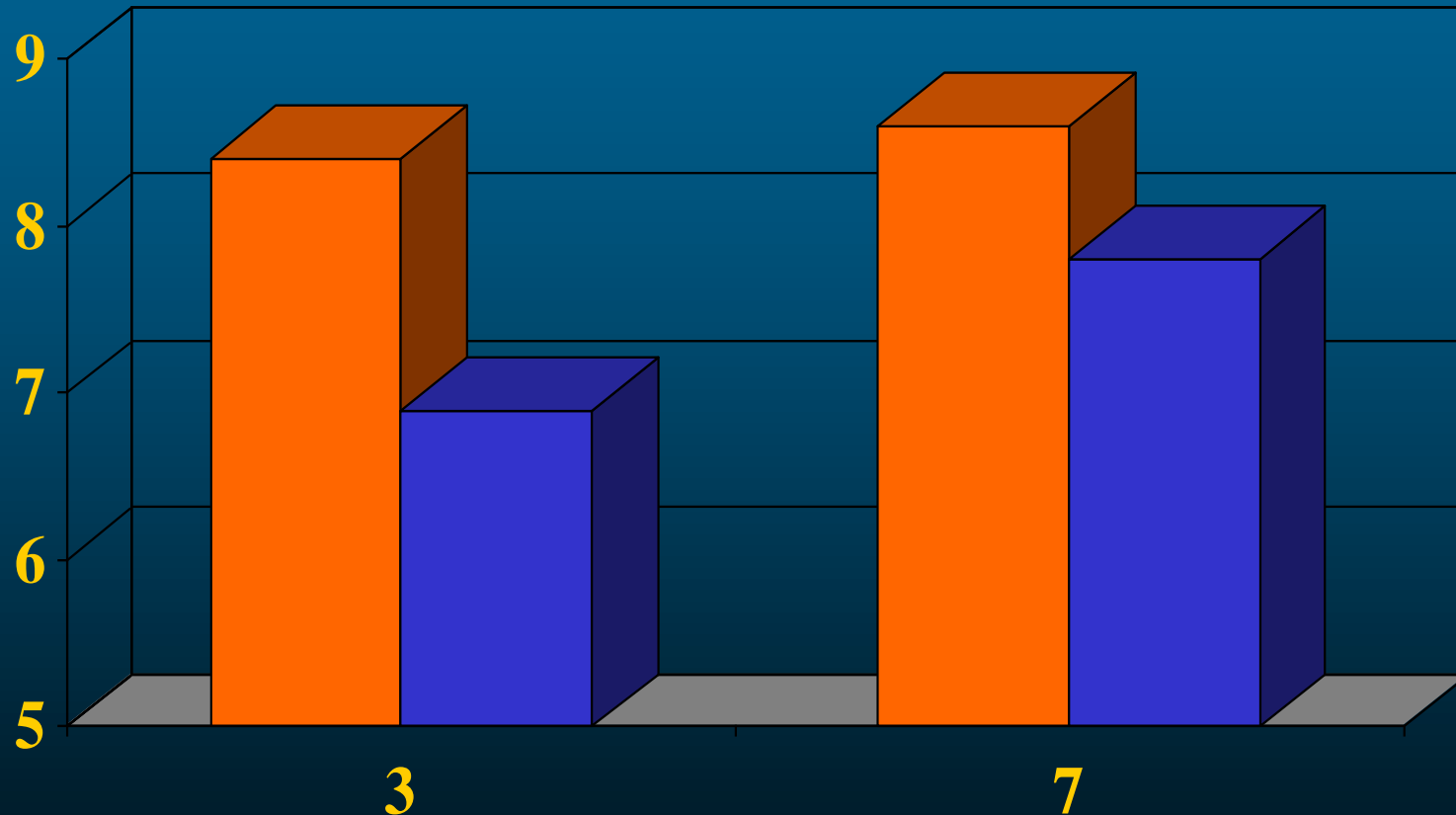
DAYS SINCE APPLICATION OF UREA FERTILIZER

VOLATILIZATION

- 1) Form of N lost this way? NH_4^+
- 2) **Ammonium in high pH environment**
- 3) Soil pH is **THE** major influence
- 4) $\text{NH}_4^+ \rightleftharpoons \text{NH}_3(\text{g}) + \text{H}^+$
- 5) Other important factors: CEC, wind, and **TEMPERATURE**
- 6) **Prevent by incorporation of ammonium**
- 7) Two big concerns: Surface applications of Manures and UREA containing fertilizers

Urea Prill Microsite pH


8 mm 25 mm



Hauck, 1984

Days After Application

VOLATILIZATION

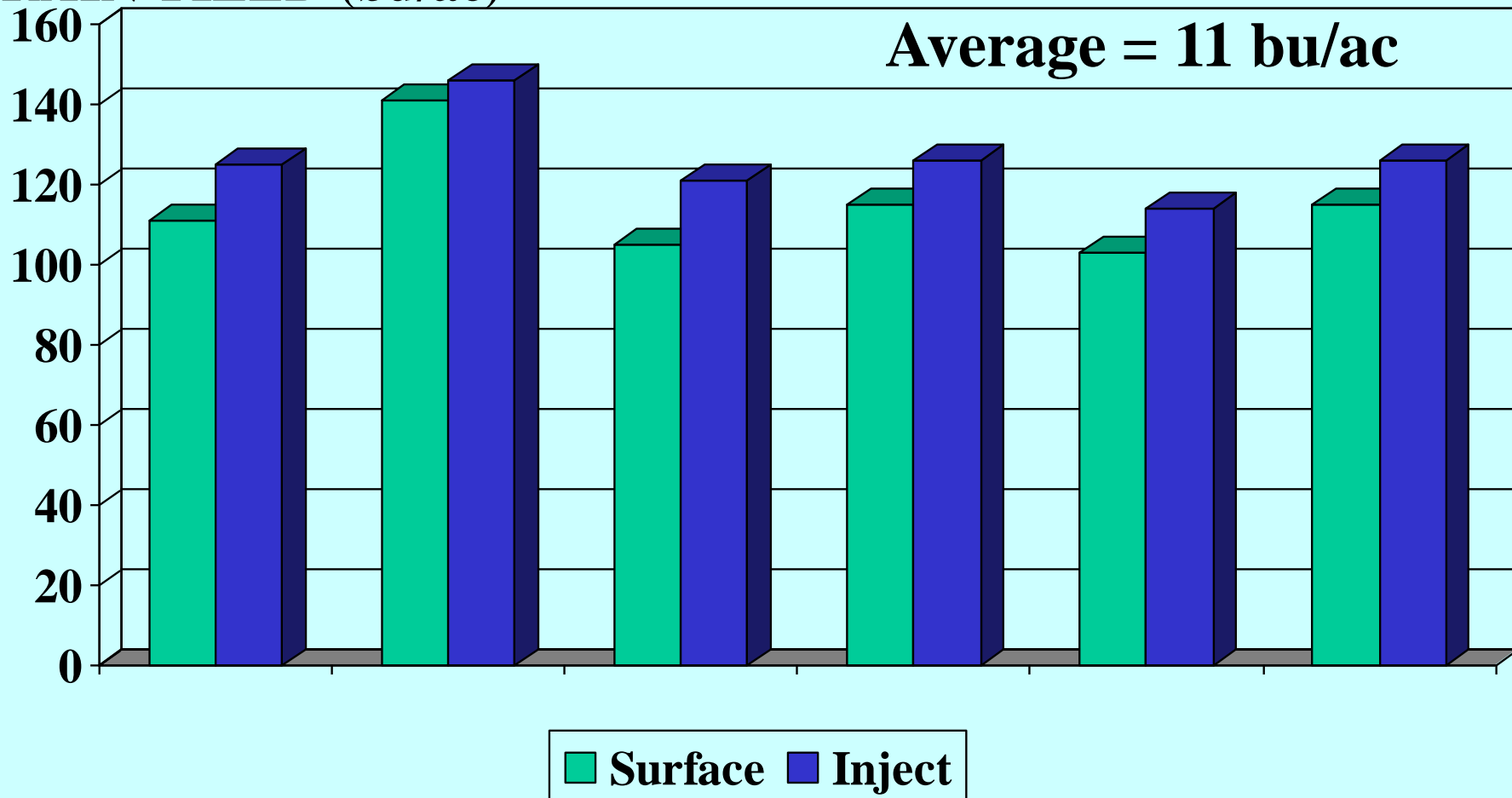
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Soil pH effects on percentages of N present as ammonia and ammonium

Soil pH	Ammoniacal N	
	Ammonia	Ammonium
	-----%-----	
6	0.058	99.94
7	0.57	99.43
8	5.4	94.6
9	36.5	63.5

Volatilization of Urea

GRAIN YIELD (bu/ac)

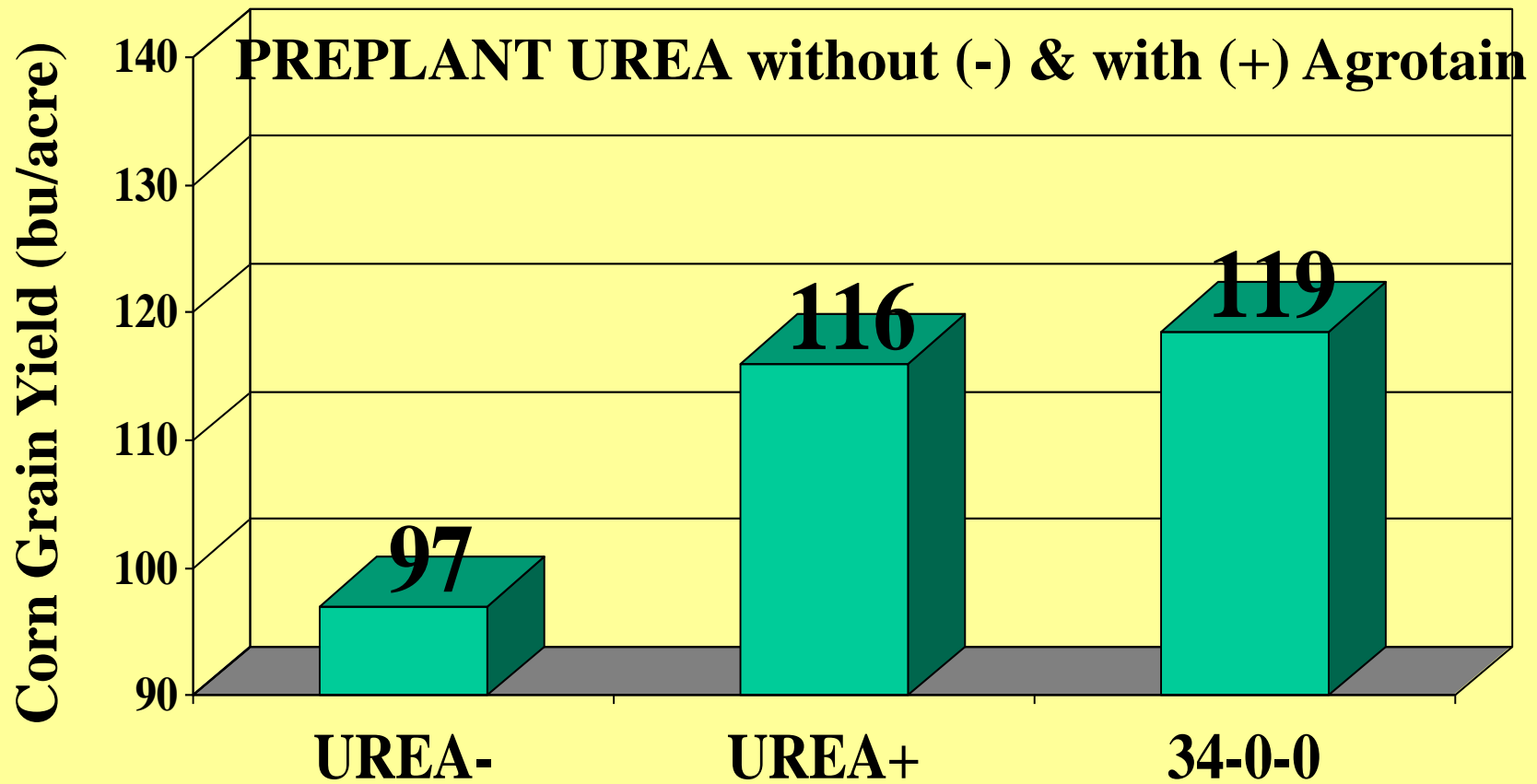


Source: Fox and Beegle, Penn State

Urease Inhibitors

- 1) Urease is the enzyme that breaks down urea
- 2) Urea ($\text{NH}_2 - \text{CO} - \text{NH}_2$) \Rightarrow NH_4 Carbonate
- 3) NH_4^+ in a high pH environment goes to $\text{NH}_3(\text{g})$
- 4) Urease inhibitors keeps N as urea until in soil
- 5) Rating the potential for response:
 - 1) UREA broadcast on soil surface
 - 2) UAN broadcast on soil surface
 - 3) UAN in a dribble band ??
- 6) If urea gets into the soil (rain or tillage), then there is no need for a urease inhibitor

PA Study (Fox & Piekielek, 1993)

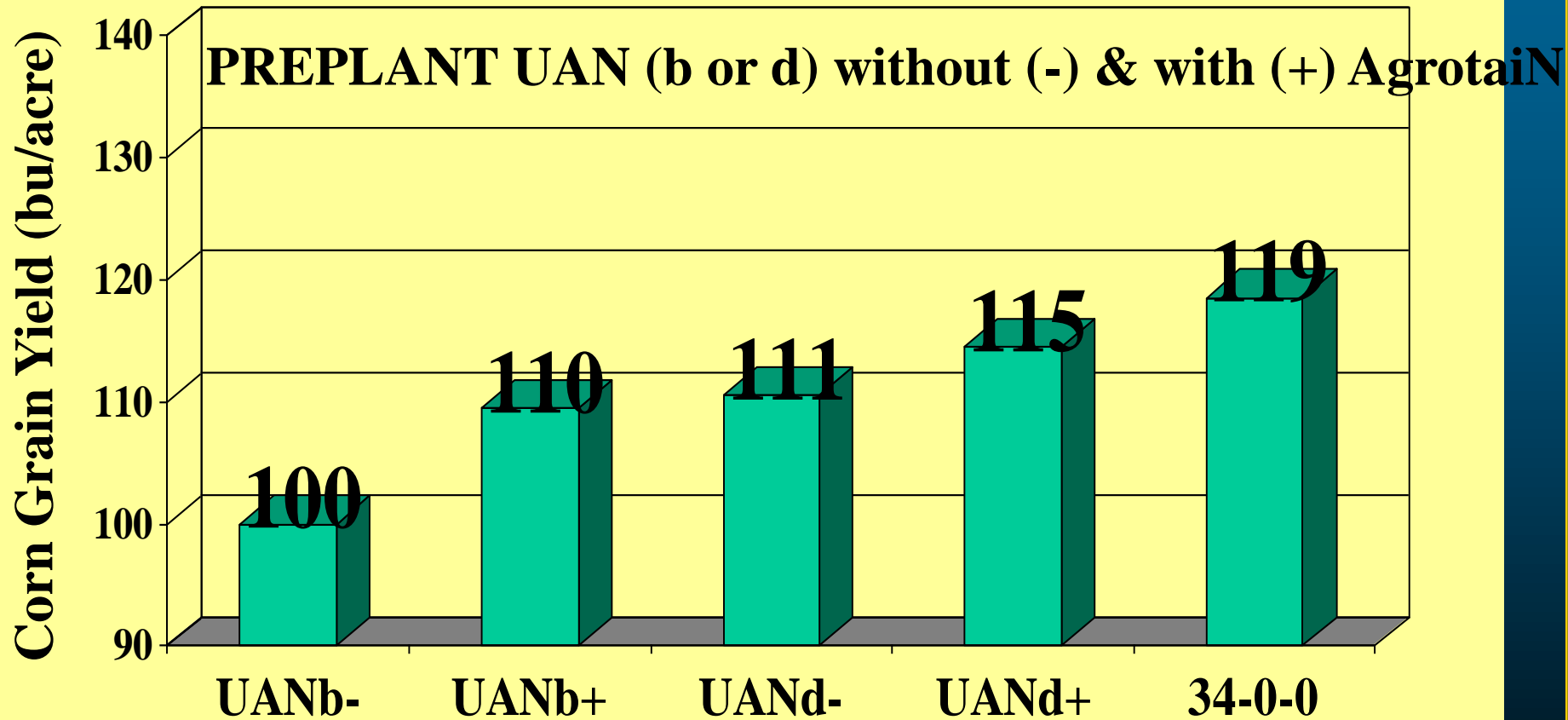


3-year study

Type of Nitrogen Treatment

Avg. 100 + 150

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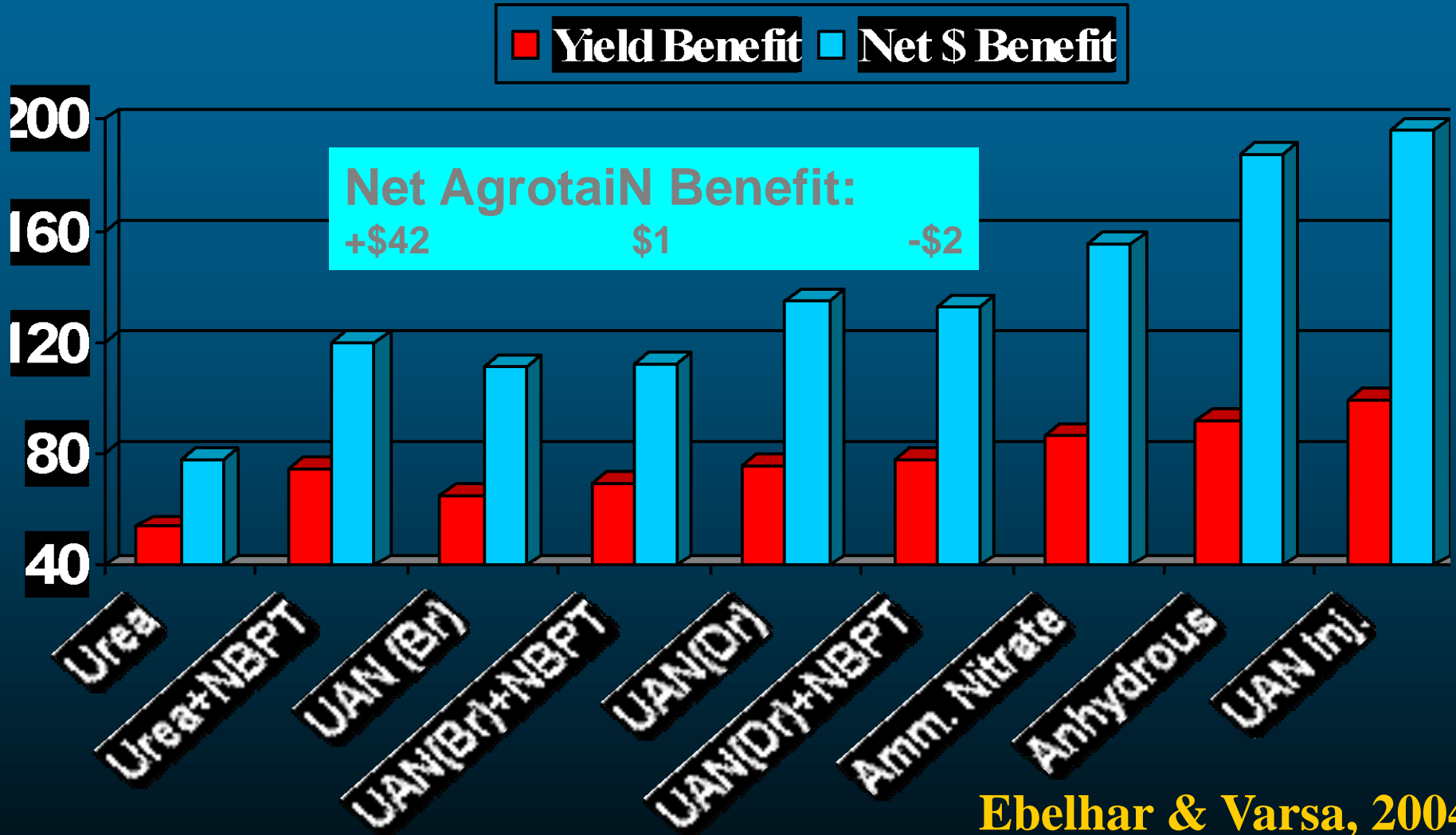
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N Sources for No-till Corn

Summary: Eight Site-years

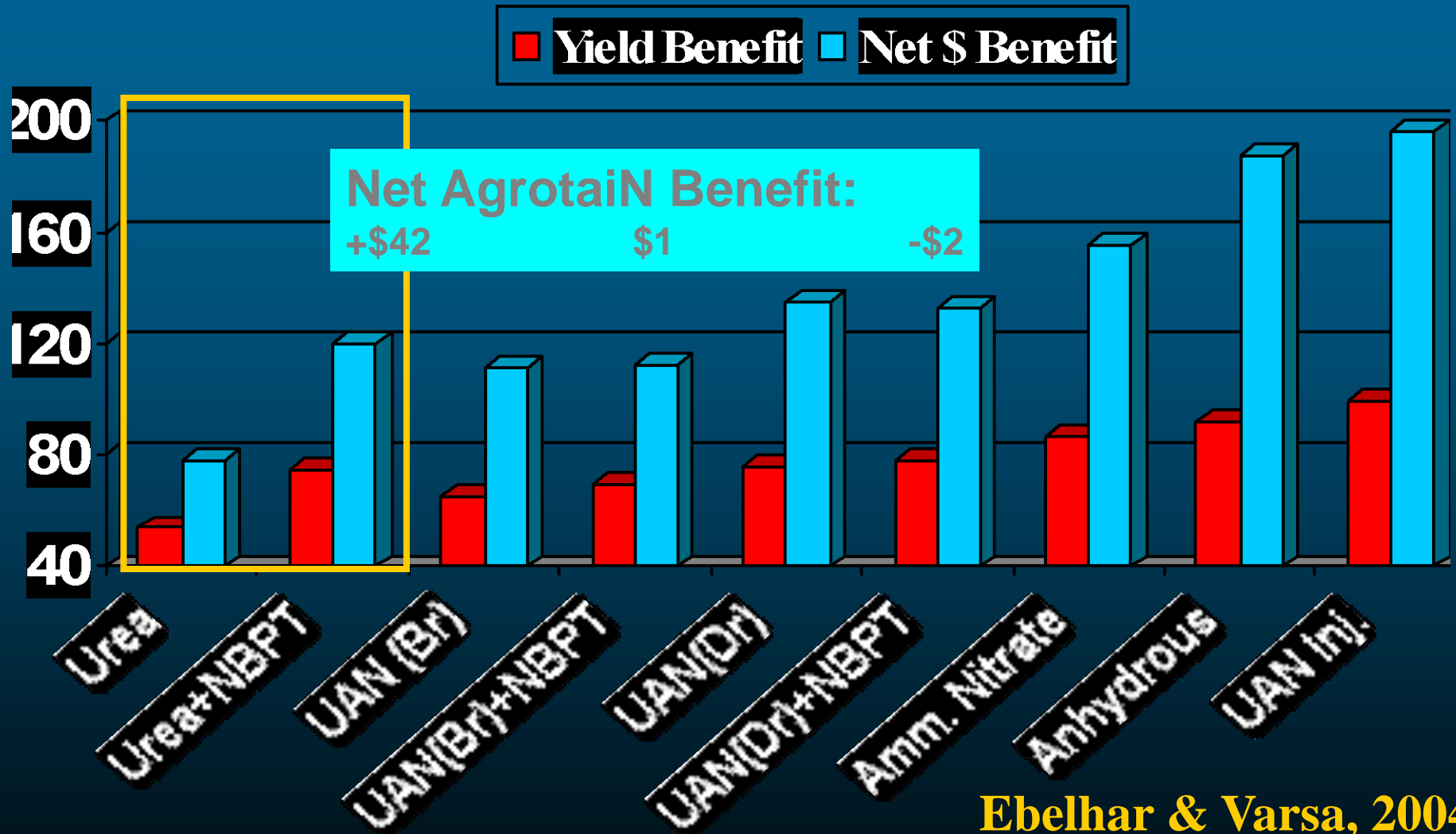


Ebelhar & Varsa, 2004

Yield and Net \$ Benefit compared to check treatment.

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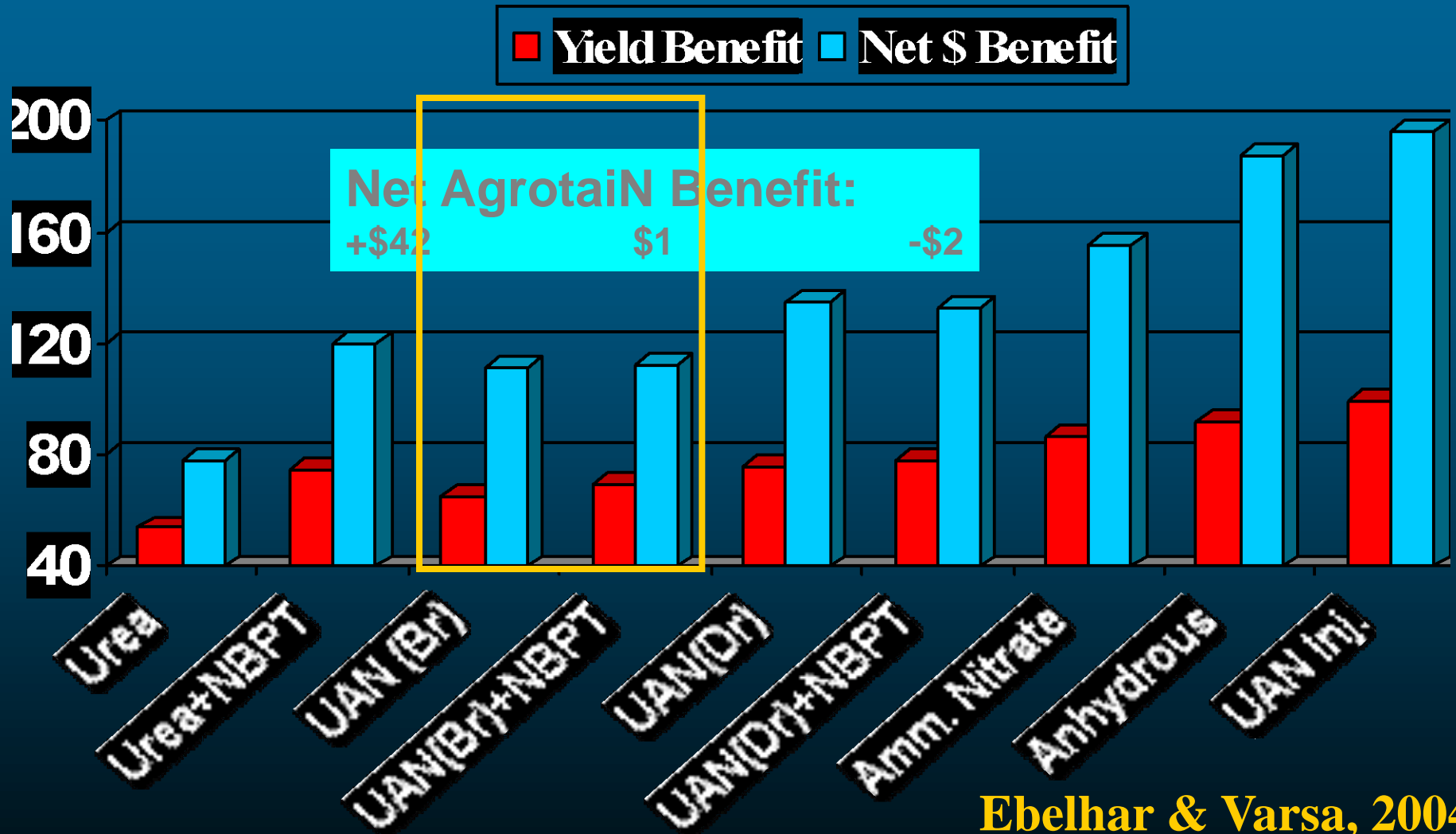


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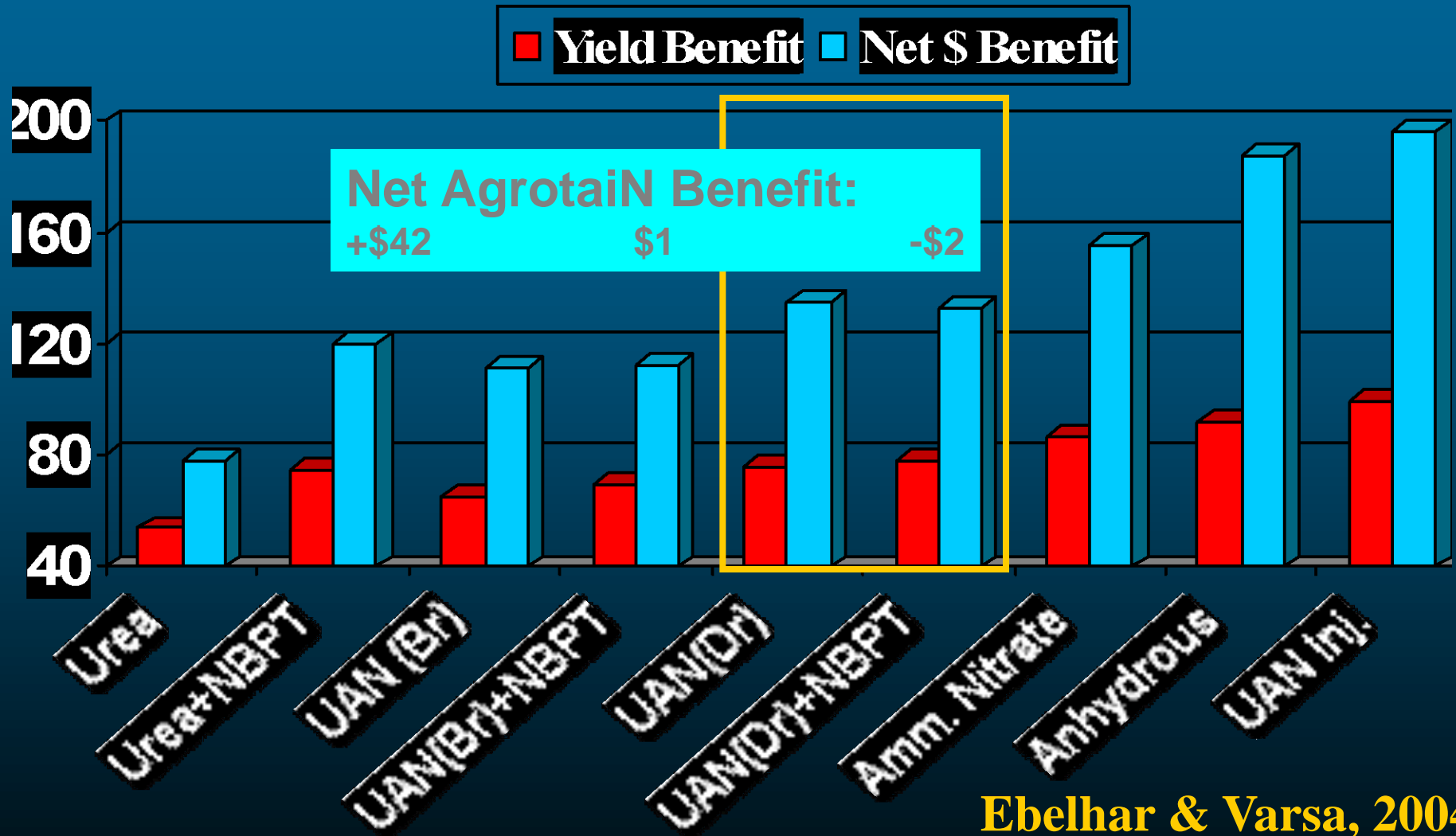


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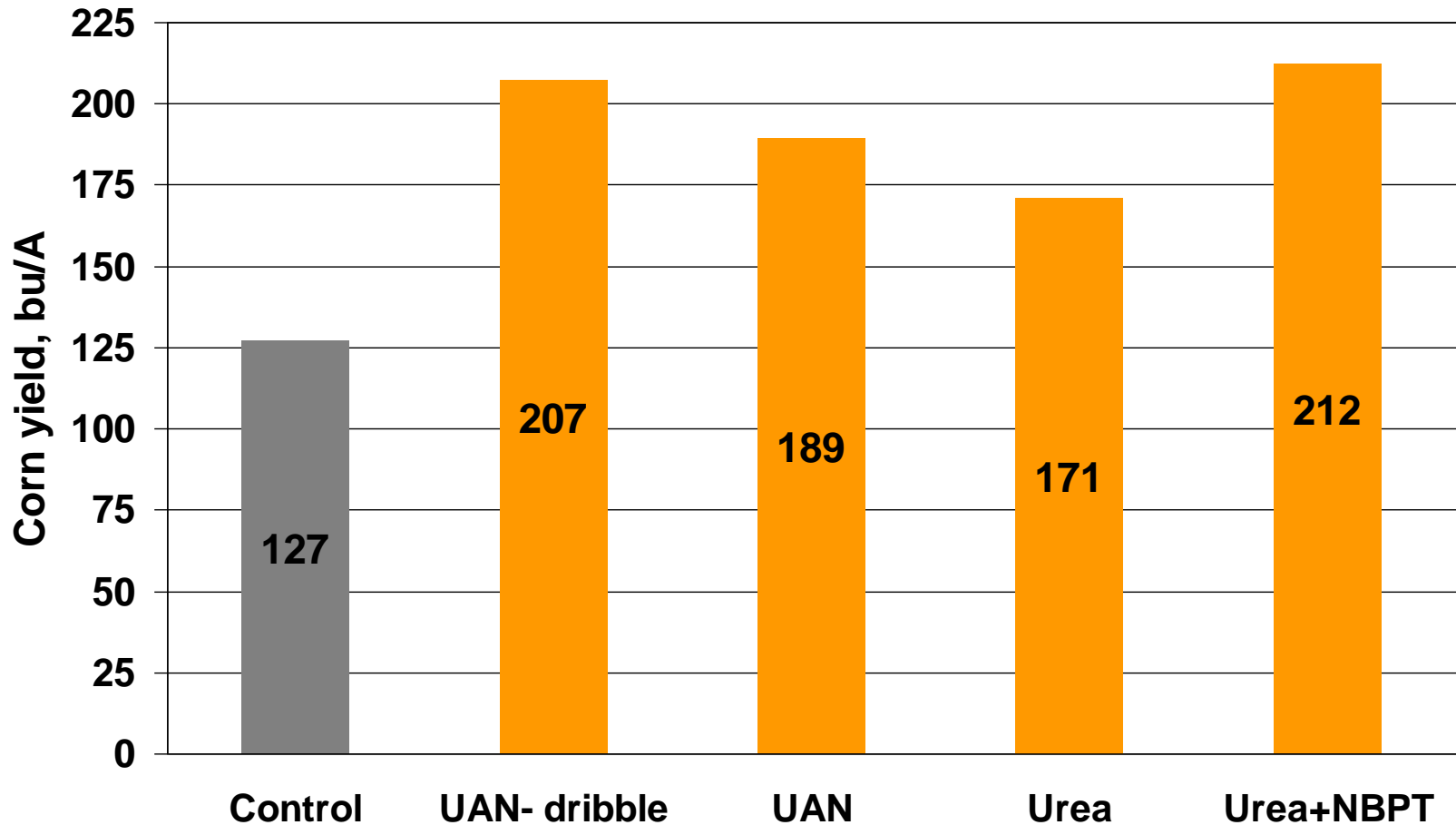
Summary: Eight Site-years in Illinois



Ebelhar & Varsa, 2004

Yield and Net \$ Benefit compared to check treatment.

Irrigated No-Till Corn in Kansas



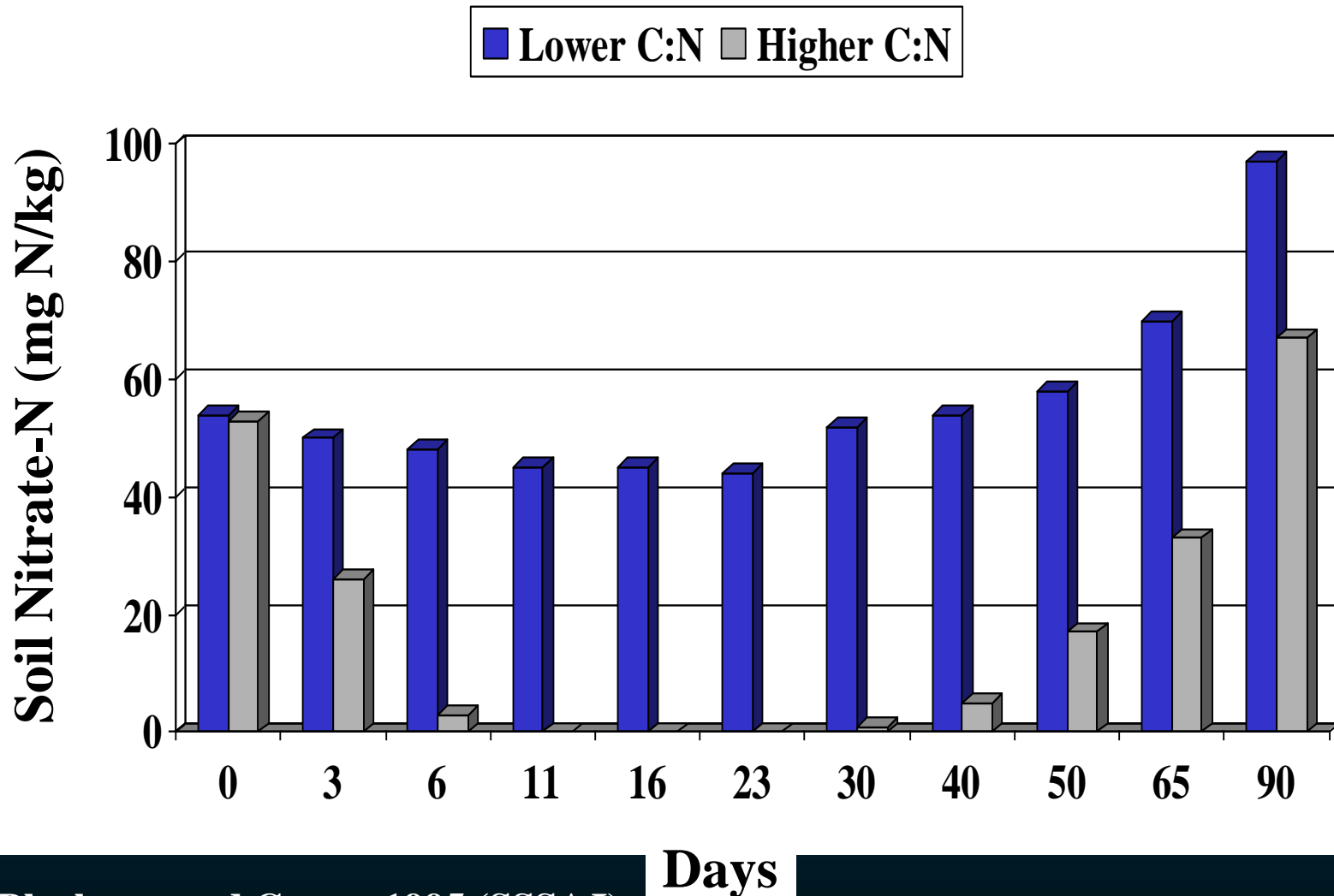
Gordon. Kansas, 2006.
2-year average

N applied preplant, 160 lb/A

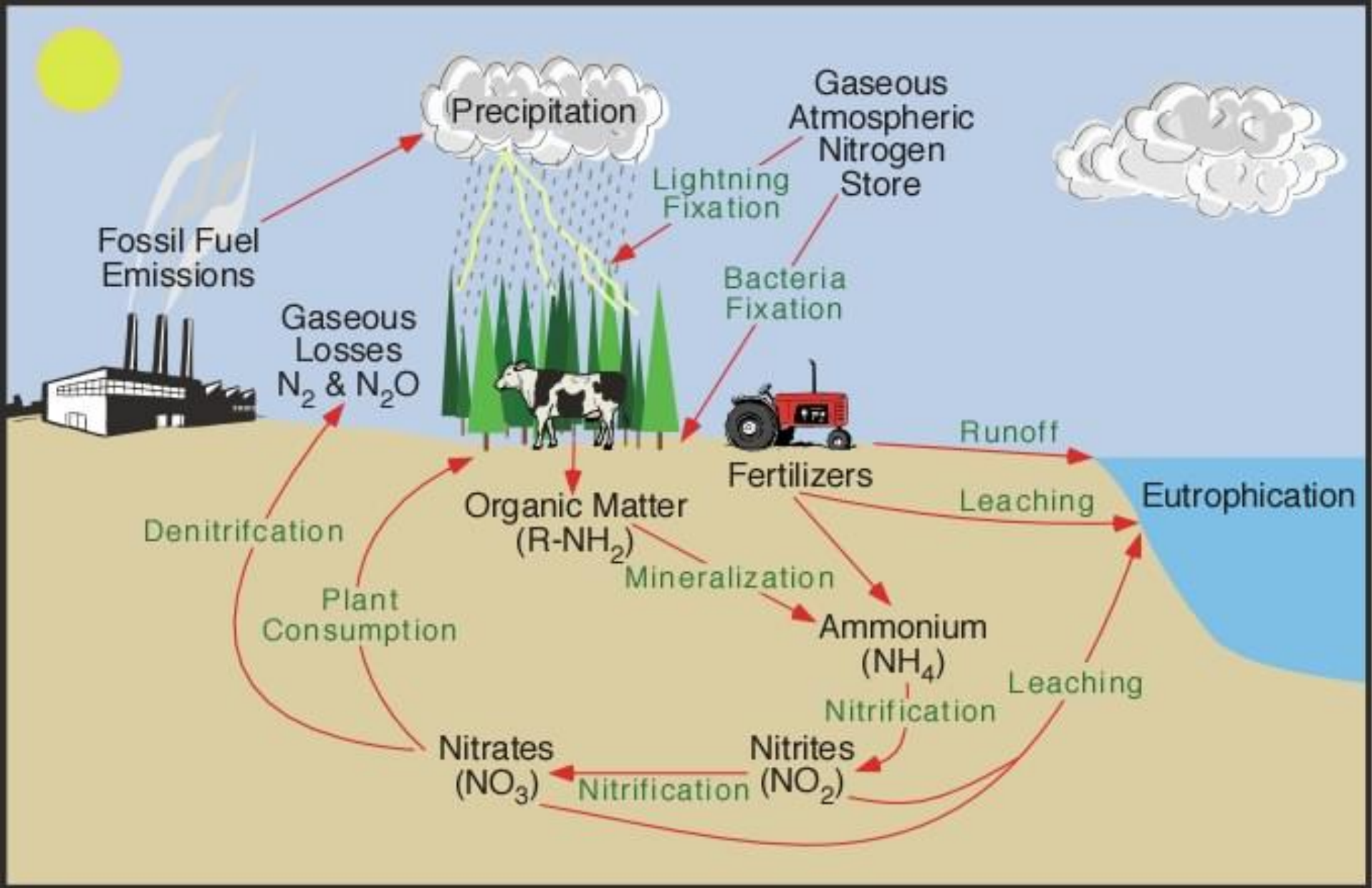
IMMOBILIZATION

- 1) This is **NOT** a net loss of N?
- 2) This is a **TEMPORARY** “tie-up” of N
- 3) Influenced by the **C:N** ratio of residue
- 4) **Microorganisms break down residue**
- 5) **>30:1 = immobilization (N is unavailable)**
- 6) **<20:1 = mineralization (N is released)**
- 7) Important when broadcasting N onto residue with high C:N ratio

Effect of C:N Ratio on Immobilization



Blackmer and Green, 1995 (SSSAJ)



<http://www.physicalgeography.net/fundamentals/9s.html>

SUMMARY

- 1) The N cycle is a dynamic system
- 2) **Understanding = improved management**
- 3) Improved management = ↓ loss potential
- 4) **Improved management = ↑ profitability**

QUESTIONS???

