Nitrogen Management

Prepared for 2007 Montana/Wyoming Sugarbeet Symposium

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MONTANA STATE UNIVERSITY EXTENSION

QUESTIONS FOR YOU

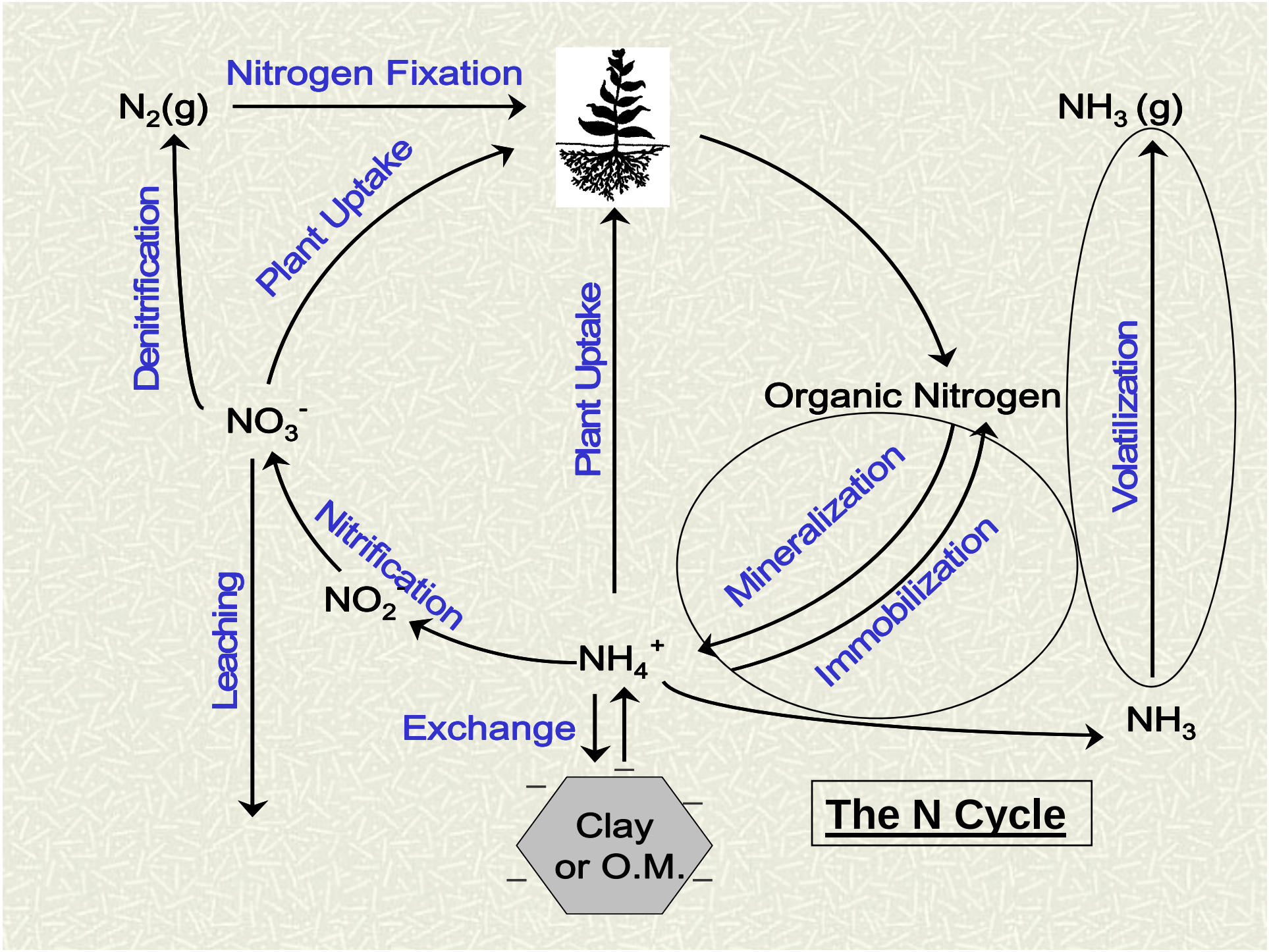
- How many of you use urea as your primary N fertilizer?
- How many had to leave sugarbeets in the ground this year?
- What crops do you rotate with sugarbeets?

Topics to discuss:

- Nitrogen cycling
- Management of N fertilizer to minimize volatilization
- Nitrogen rates for both flood and sprinkler irrigation
- Adjusting N rates for fields with 2006 sugarbeets

Nitrogen Forms and Nitrogen Cycling

Nitrogen form	Molecular formula	Notes
Nitrogen gas	N_2 (g)	Represents about 80% of the air we breathe but not available to plants
Ammonia gas	NH_3 (g)	Generally cheapest form of N, toxic at high concentrations
Ammonium	NH_4^+	Plant available, attracted to exchange sites on clay particles
Nitrate	NO_3^-	Very mobile, requires more energy by plant than ammonium
Organic N	-	Slowly supplies available N to soil solution


Nitrogen Fixation
$N_2(g)$
NH_3 (g)
Denitrification
Plant Uptake
Plant Uptake
Organic Nitrogen
Volatilization
NO_3^-
Mineralization
Immobilization
Nitrification
NO_2^-
Leaching
NH_4^+
Exchange
NH_3
Clay
or O.M.
The N Cycle

‘Mineralization’

Release of minerals as organic matter (O.M.) is oxidized, releasing available N

Organic-N → Plant-Available N

If have higher than normal O.M. (>3%), can back off on N fertilizer by 20 lb/ac.

If leave sugarbeet tops in field, back off on N fertilizer by 40-50 lb N/ac.

‘Immobilization’

Incorporation of available N into microbial cells or plant tissue

Plant-Available N → Organic-N

If leave more than ½ ton stubble on surface, increase N fertilizer by 10 lb/ac per ½ ton.

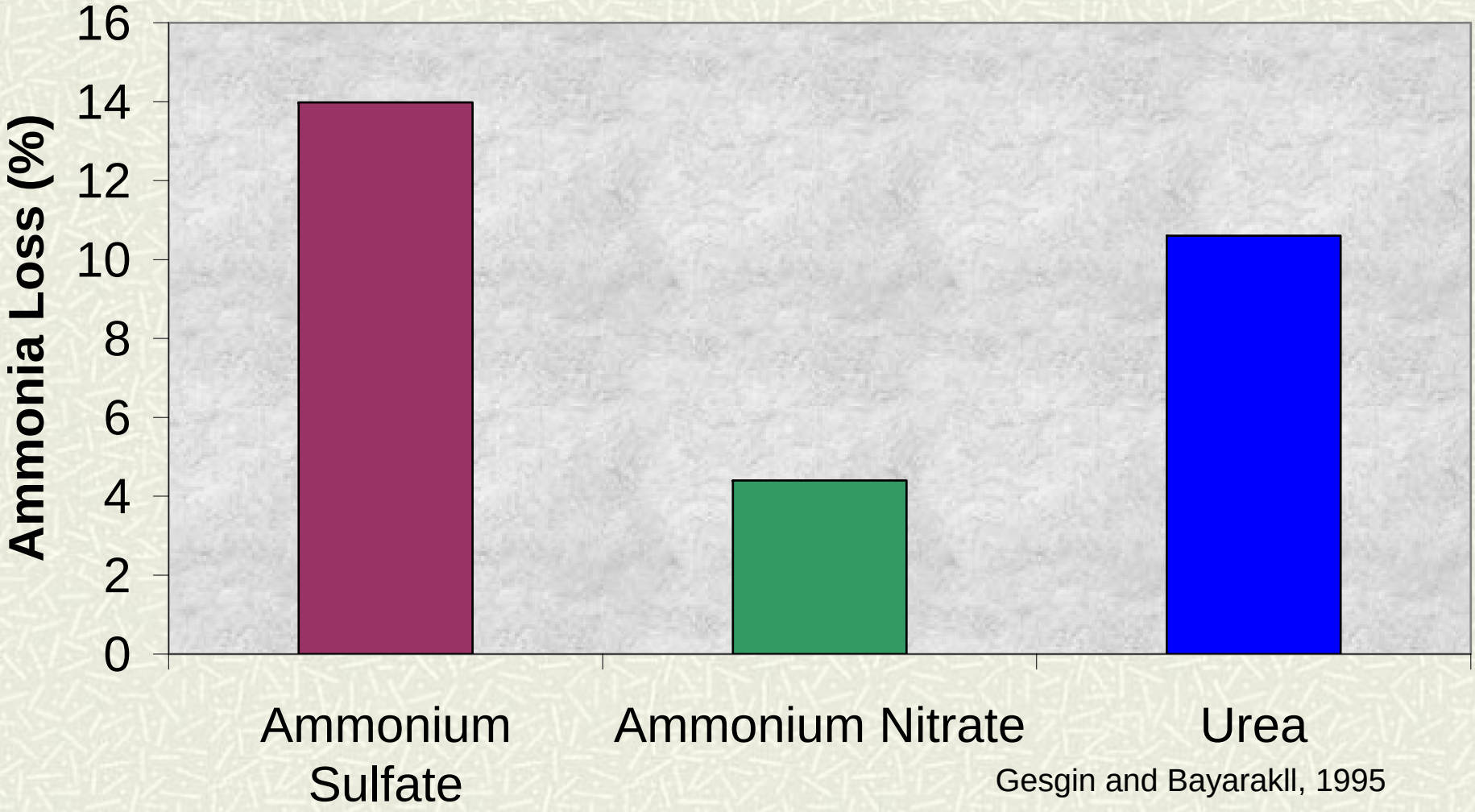
Volatilization

Mechanism:

Urea is converted to ammonium, which CAN be converted to ammonia gas

Volatilization occurs more at high pH

Ammonia Volatilization Losses from a Calcareous Soil



Gesgin and Bayarakll, 1995

Why differences in volatilization?

- Urea and ammonium sulfate cause larger pH increases than ammonium nitrate in calcareous soils.
- ½ of ammonium nitrate is nitrate which can’t volatilize

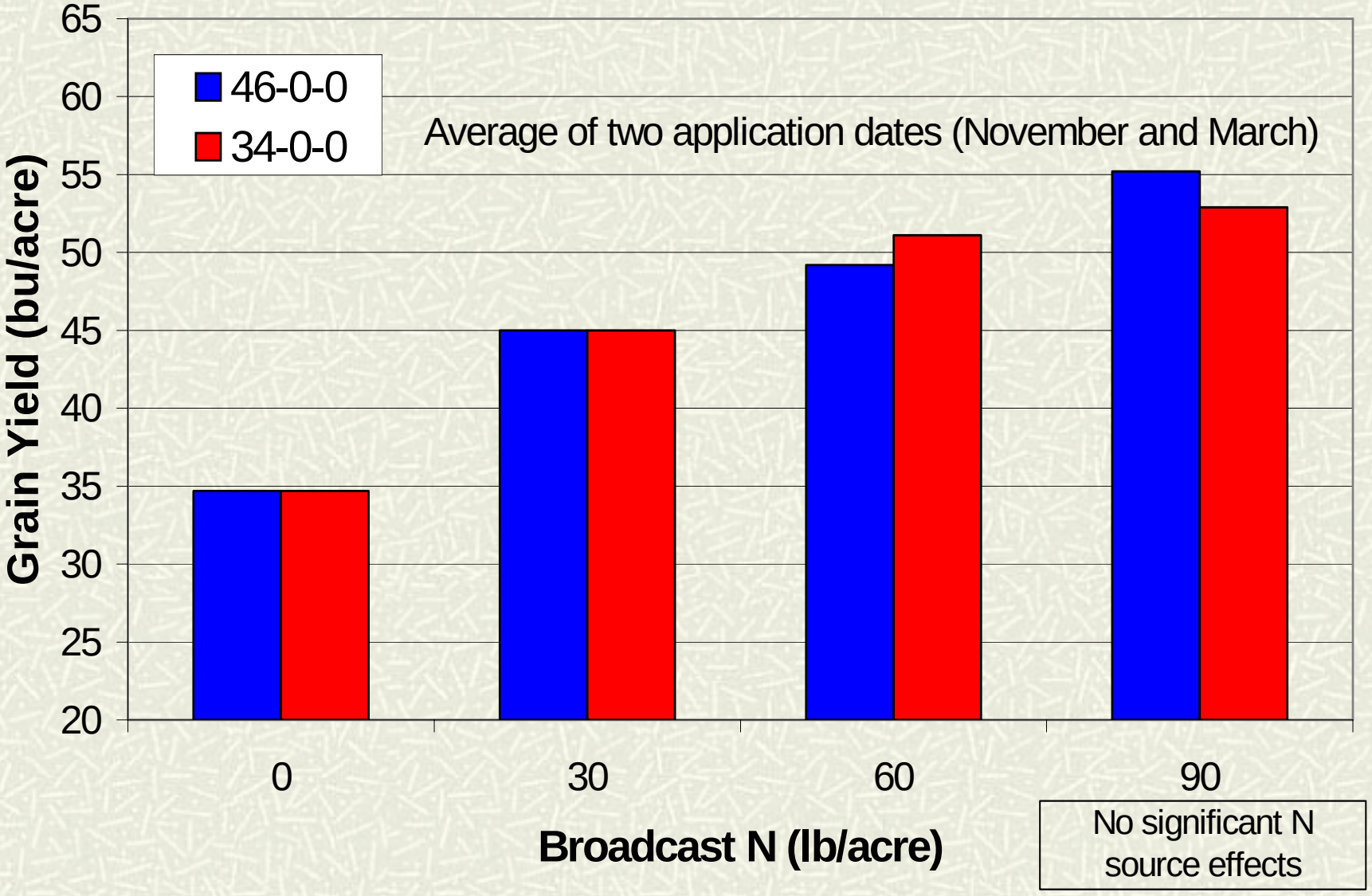
Factors Affecting Volatilization of Surface Applied N Fertilizer

- Drying of moist soil
- 0.1 in. of rain dissolves urea, allows volatilization
- 0.5 in. of rain/irrigation pushes dissolved urea into soil, preventing volatilization
- High temperature, wind
- High soil pH
- Low Cation Exchange Capacity. WHY?
- Ground cover/vegetation/residue. WHY?

Effect of N Source on Winter Wheat Grain Yield

North Central MT

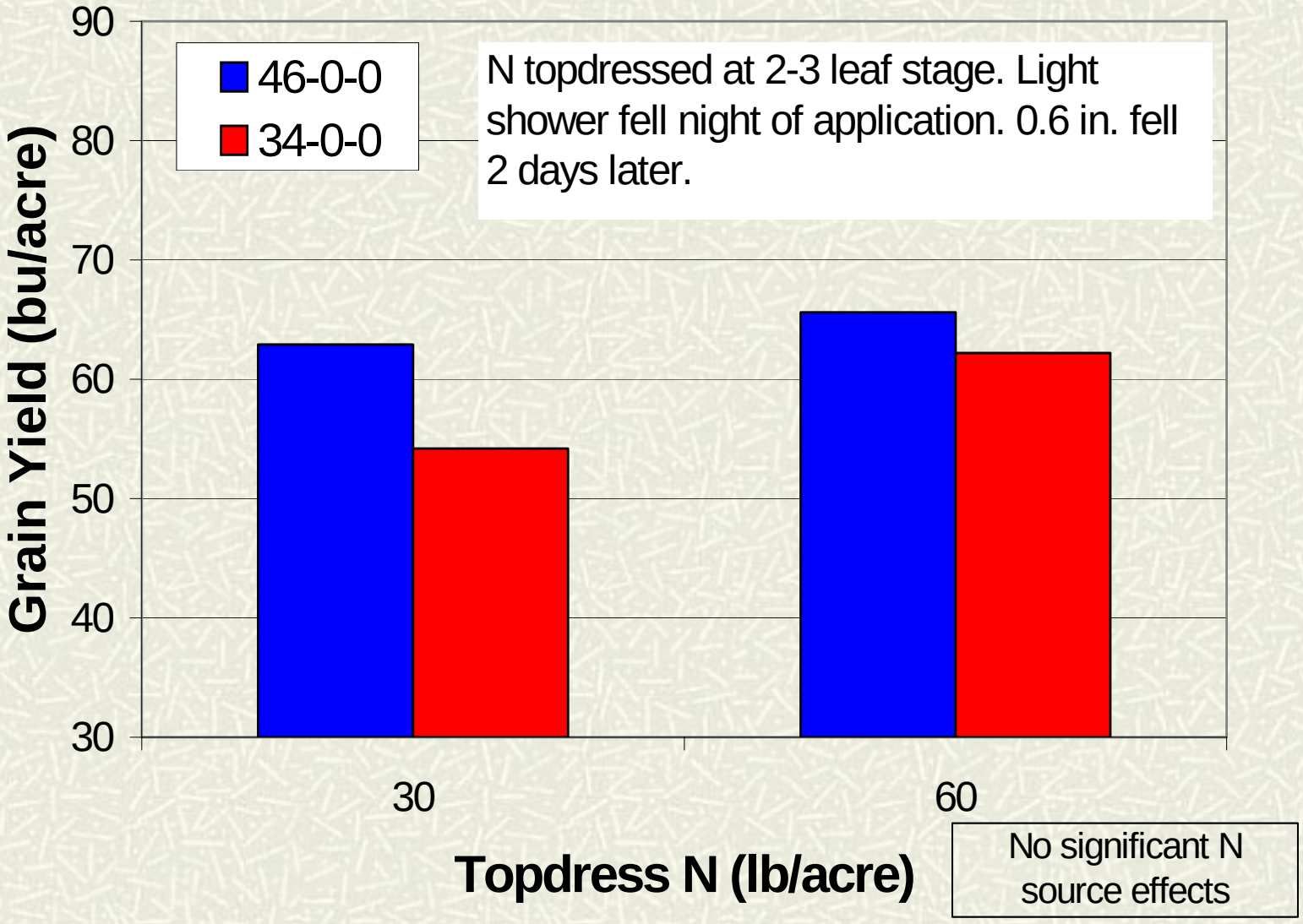
Christensen and Meints. Agron J. 74:840-844.



Effect of N Source on Feed Barley Yield

Townsend, MT

Smith, C. 1973. MSU Research Center Soils Report to TVA.



Summary: Urea volatilization can happen, but in Montana studies it has not had significant effects on yield based on comparisons with ammonium nitrate.

How can I minimize my volatilization losses?

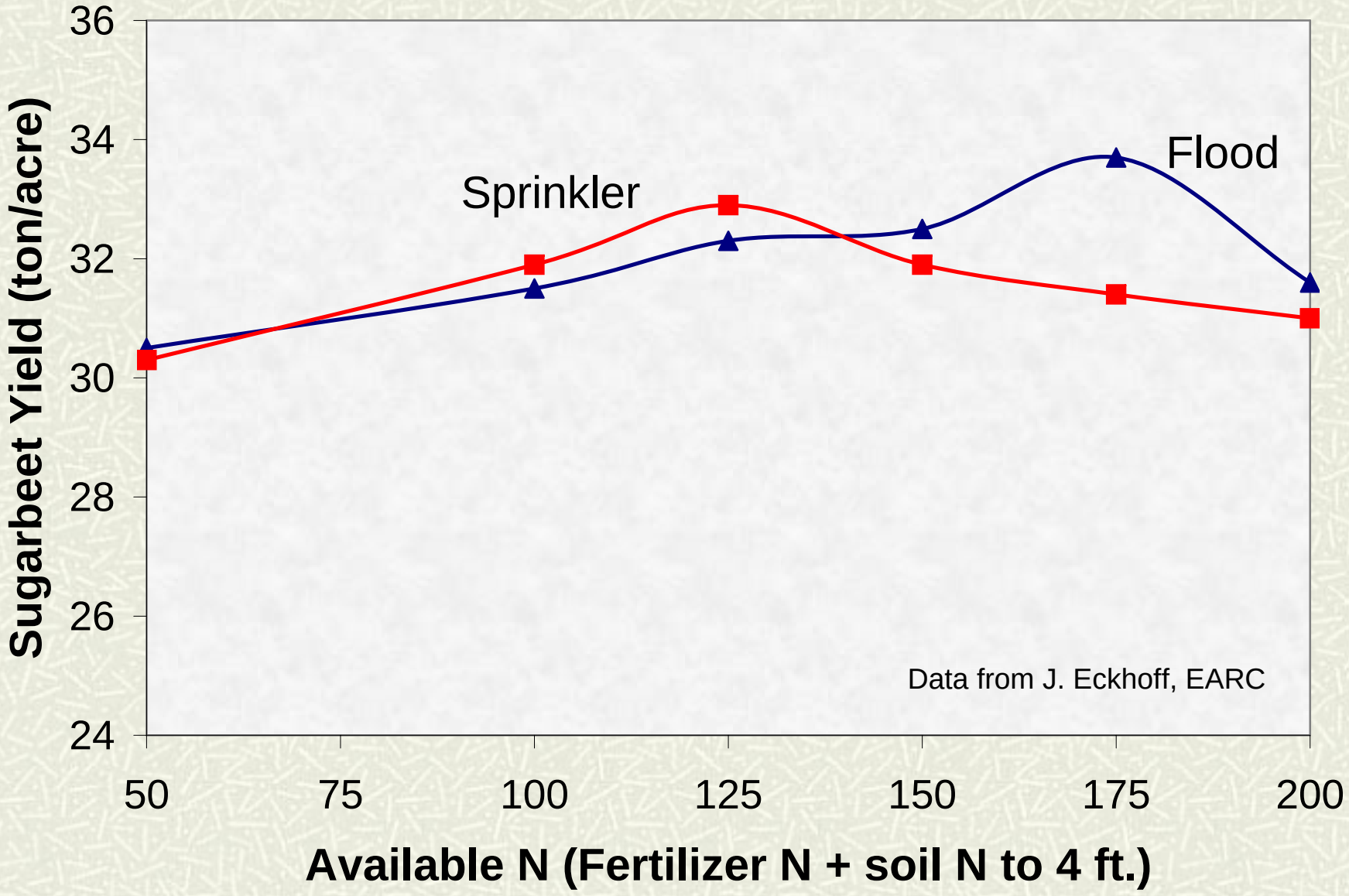
- When possible, apply broadcast N during cool periods (< 50^{o}F)
- If surface broadcast, irrigate with at least ½ inch within 2 days of application. If warm, irrigate within 1 day, if possible.
- Apply fertilizer at least 2 in. below surface- this should essentially stop volatilization. UI recommends 3 in. below seed to prevent germination problems.

QUESTIONS?

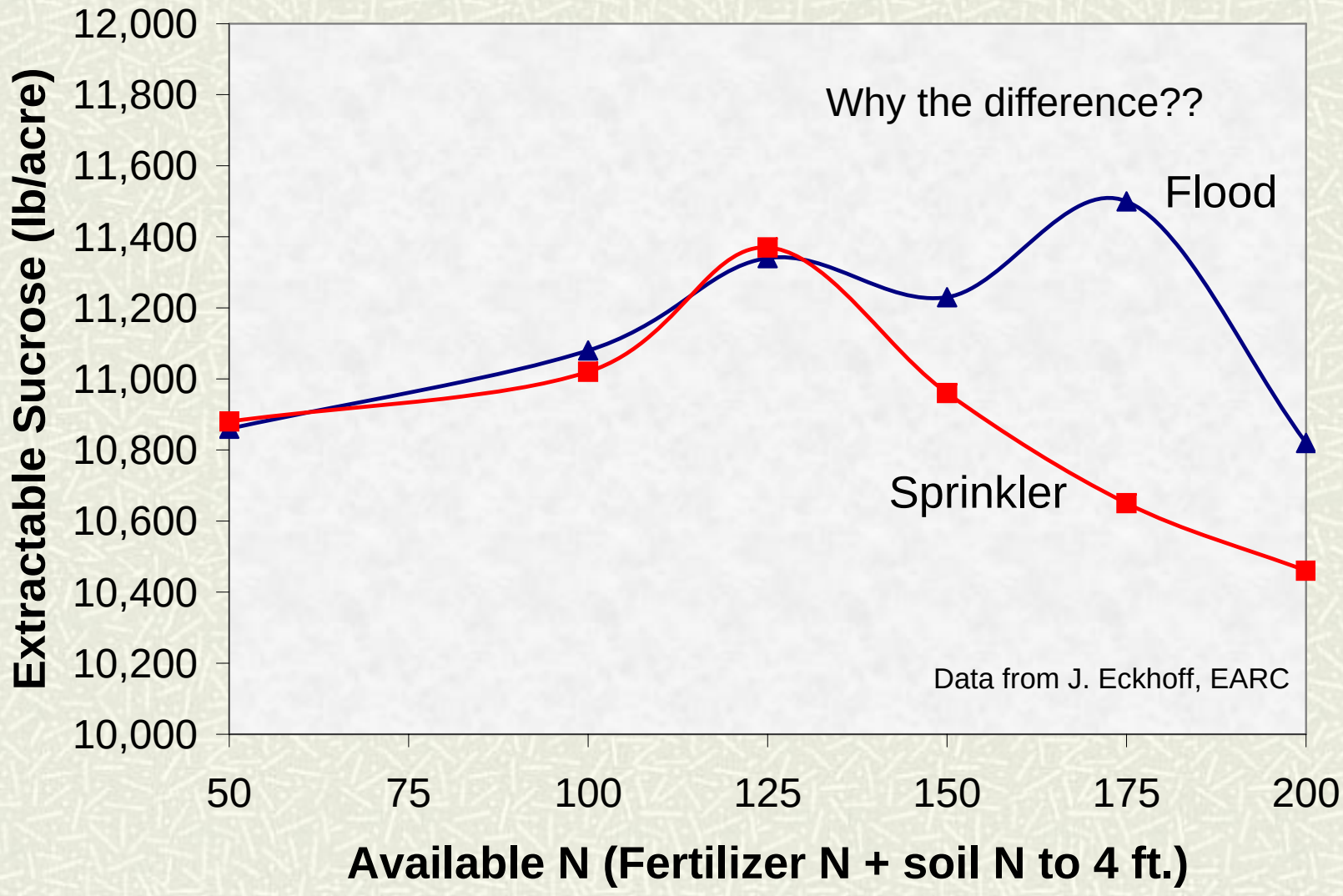
Effect of irrigation system on N needs of sugarbeets

- Four year study conducted in Sidney, MT by Dr. Joyce Eckhoff
- Compared N response curves
- Compared groundwater nitrate-N concentrations (issues?)

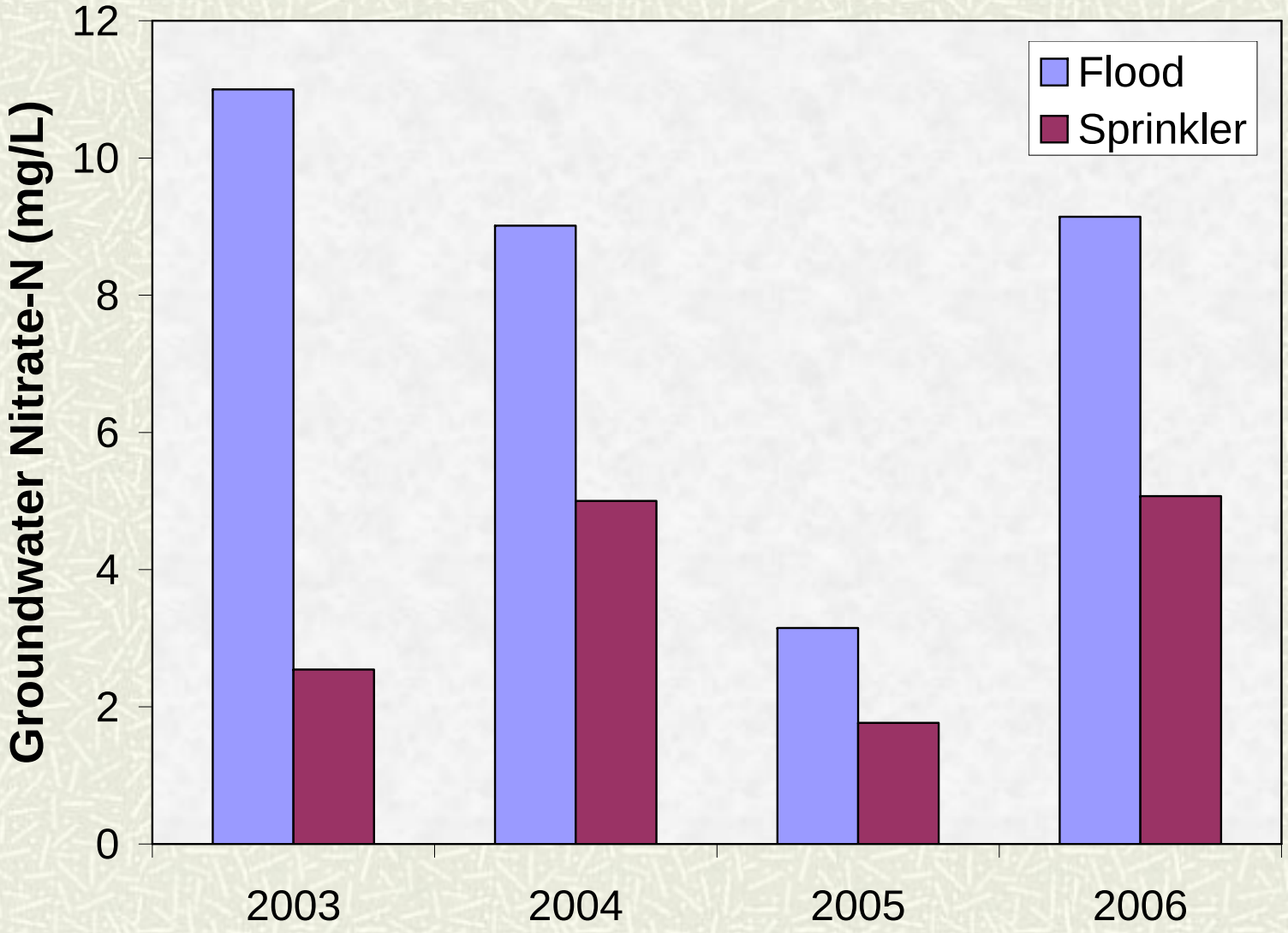
Effect of N Rate on Yield (Sidney)



Effect of N Rate on Extractable Sucrose



Effect of Irrigation System on Average Groundwater Nitrate Levels



Adjusting N if last year's sugarbeets are in the ground

- Experiences from 'PIK' years?
- Two crop advisers I spoke to suggest that:

  No adjustment is necessary
- WHY?

Mineralization is positive (nitrate is released) when:

- Carbon:Nitrogen ratio is below ~40:1.
- Sugarbeet root:

  Sucrose: ~18%; sucrose is 42% carbon
- Carbon = 18% x 0.42 = 7.6% C
- Nitrogen = 3.6 lb N/ton = 0.18% N

Carbon:Nitrogen ratio = 7.6/0.18

Carbon:Nitrogen ratio = 42:1

Take home message:

Roots will likely have little effect on overall available N in soil.

Conclusions

- Urea volatilization can be minimized with proper management-incorporating urea is best bet.
- Based on a 4 yr study in Sidney, optimum available N rates range from 125 to 175 lb N/acre and are less for sprinkler irrigation.
- For fields with 2006 sugarbeets, it’s likely that N rates will not need to be adjusted from normal recommendations.

For additional information

- Soil Fertility Website:

  http://landresources.montana.edu/soilfertility