Urea Volatilization

Heartland Seeds, Moccasin

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MONTANA STATE UNIVERSITY EXTENSION

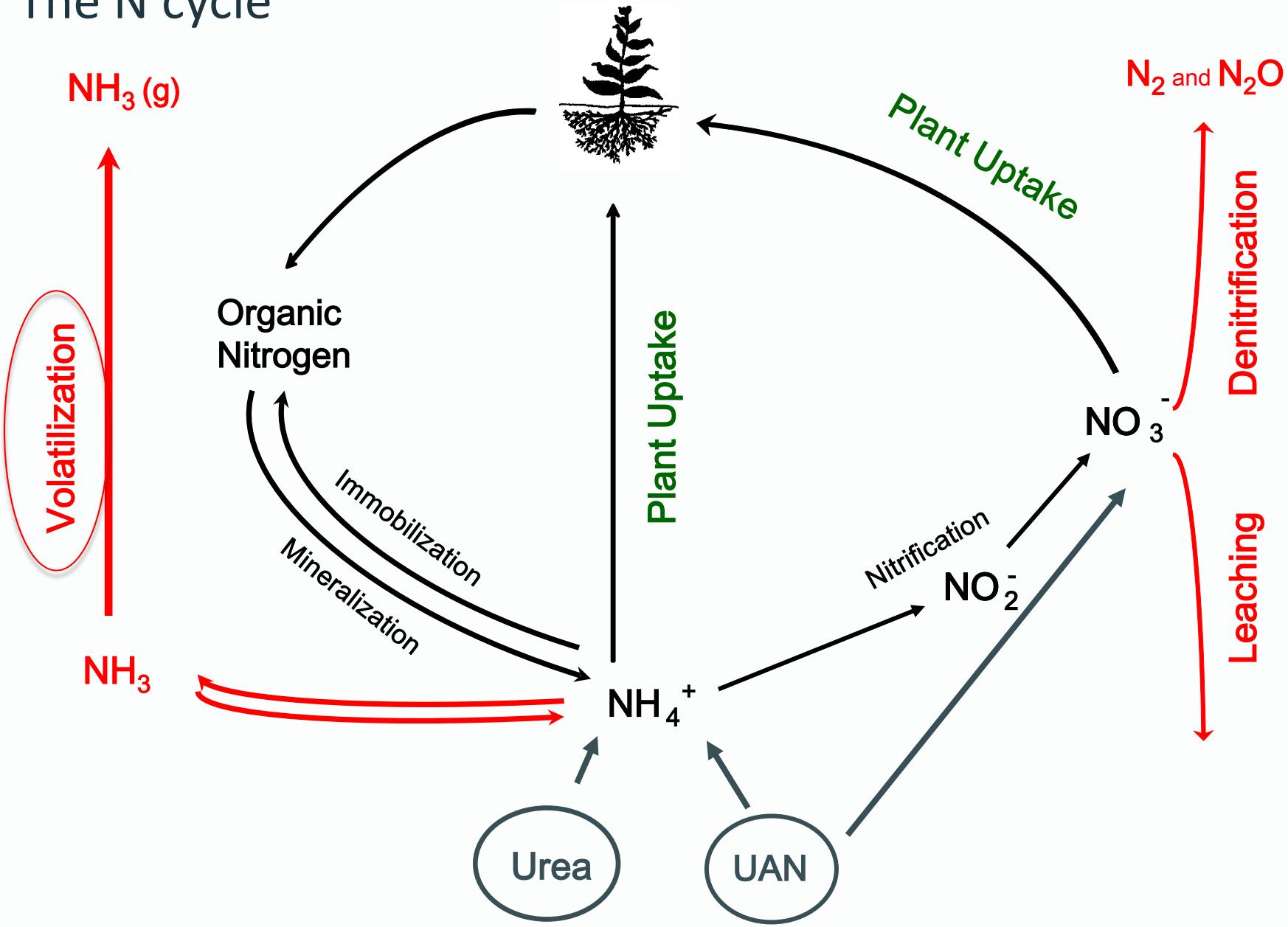
AGRICULTURE

MAKING A DIFFERENCE IN MONTANA COMMUNITIES

Objectives Today

- Discuss factors that affect volatilization and high risk conditions for volatilization
- Present timing, placement and source options to reduce volatilization
- Present results of different sources and timing on grain yield and protein

The N cycle


NH3 (g)
N2 and N2O
Plant Uptake
Volatilization
Organic Nitrogen
Plant Uptake
Denitrification
NO3-
Immobilization
Mineralization
Nitrification
NO2-
Leaching
NH3
NH4+
Urea
UAN

High risk conditions for urea volatilization

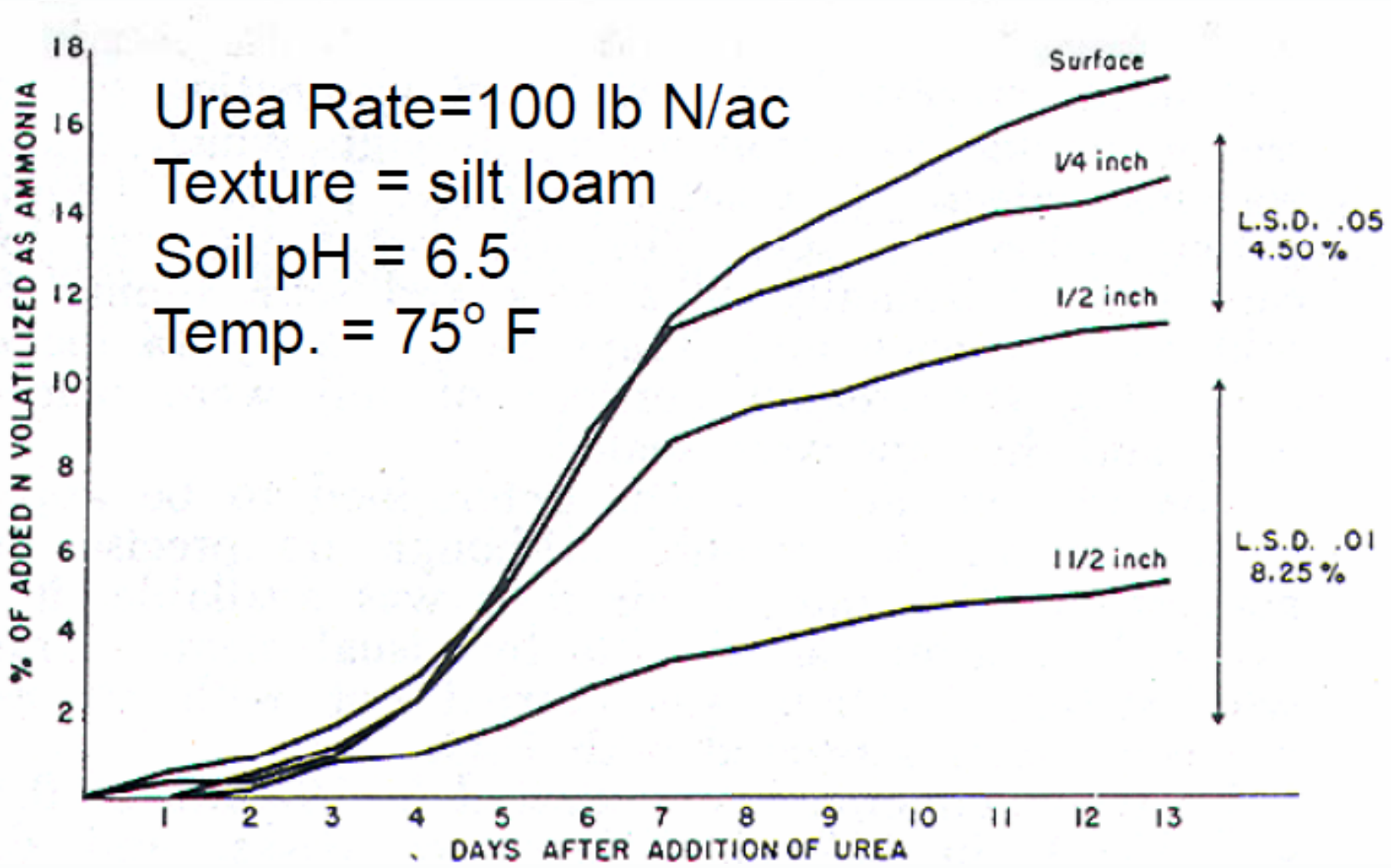
- Moist soil, heavy dew, or high humidity
- Wind
- High soil pH (>7.0)
- High soil temperature (>50 °F) or frozen soil
- Crop residue, perennial thatch or sod WHY?
- Low cation exchange capacity soil (sandy) WHY?
- Poorly buffered soils (low soil organic matter, low bicarbonate content)

- Large number of factors make volatilization amounts variable and difficult to predict.
- The risk of volatilization increases as the number of high risk conditions increase, with soil moisture likely being the most important.

Practices to decrease volatilization from N fertilizers, especially urea

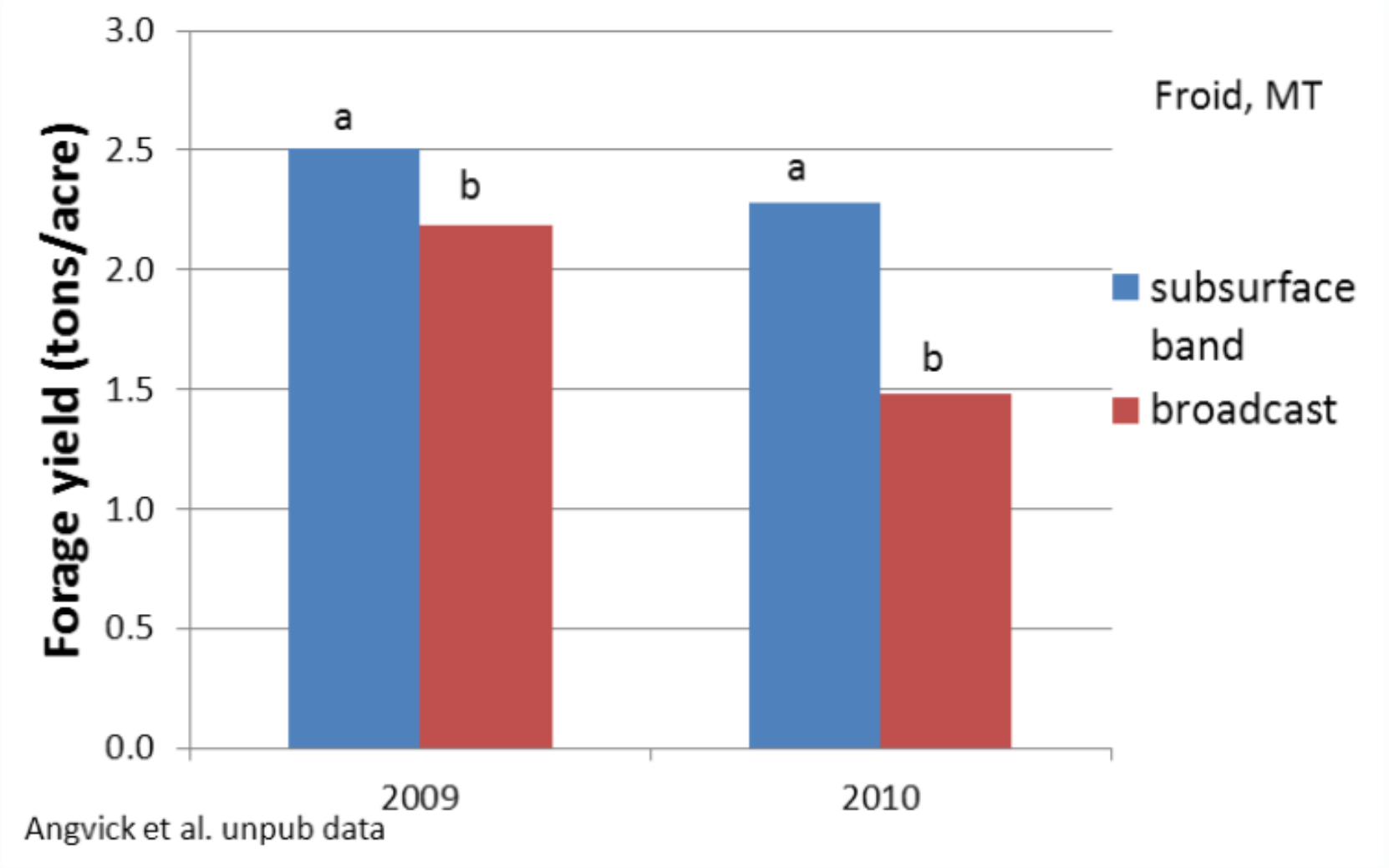
- Incorporate with tillage if possible, seed place (max 10 lb N/acre), mid-row, or subsurface band (in buffered or calcareous soils) at least 2” deep. Applying urea immediately in front of air-drills did not decrease volatilization b/c of insufficient incorporation.
- On thatch, UAN band better than foliar spray
- Apply to dry, cool, but thawed ground
- Apply prior to a large (> 0.5”) moisture event
- Use a protected product (e.g. Agrotain®= NBPT or slow or controlled release) if can’t apply during low risk periods, allows greater amount seed placed

Incorporation depth on volatilization



Ernst & Massey 1960

Effect of urea placement on Hays annual forage yield

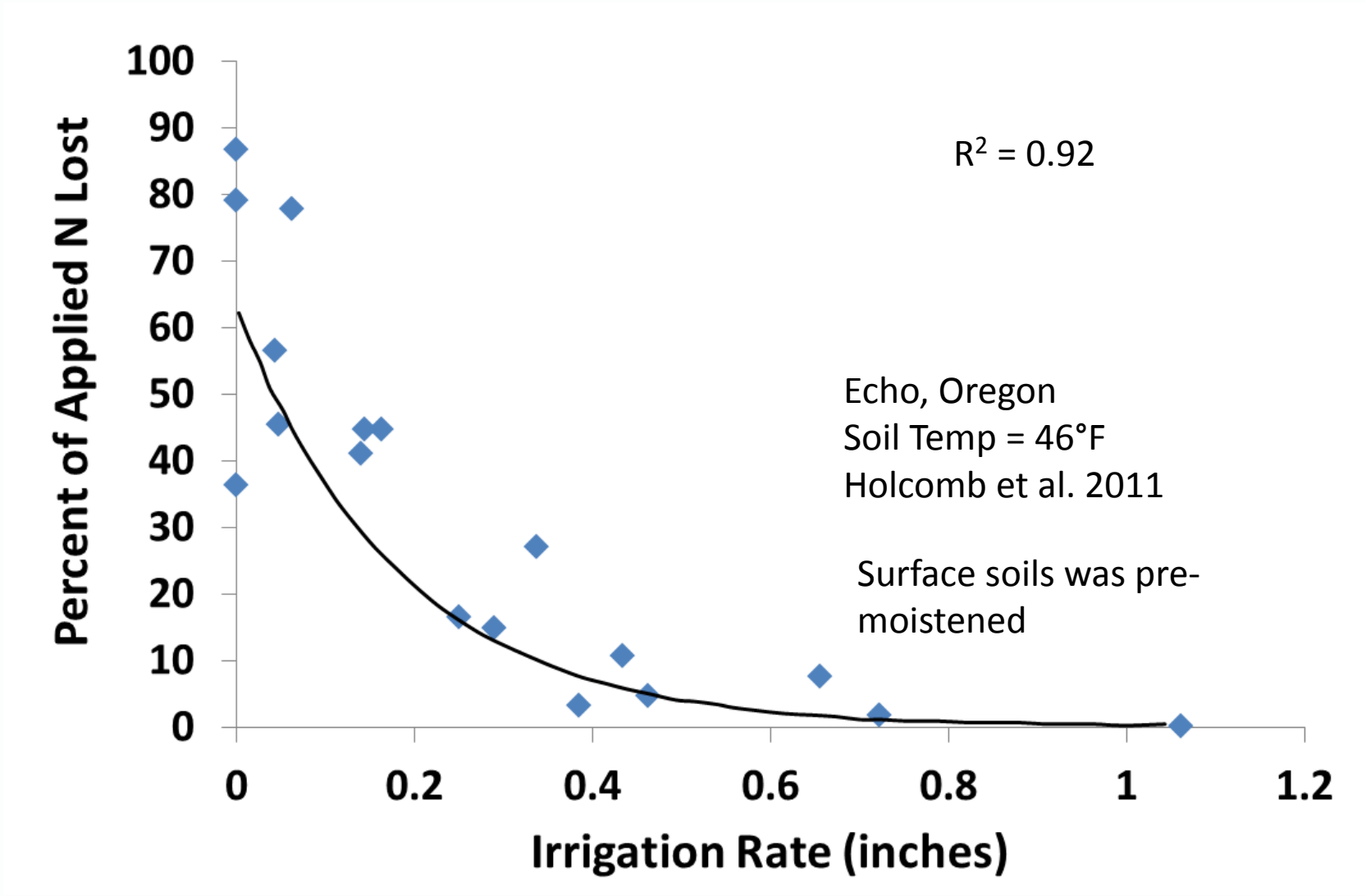


Timing

Generally better to apply near peak uptake to avoid losses, however, weather conditions near application and soil texture may be more important.

- Shallow, coarse soil. Fall or spring? **Spring**
- Cool fall temps with ability to irrigate or warmer spring temps before irrigation water delivered. Fall or spring? **Fall**

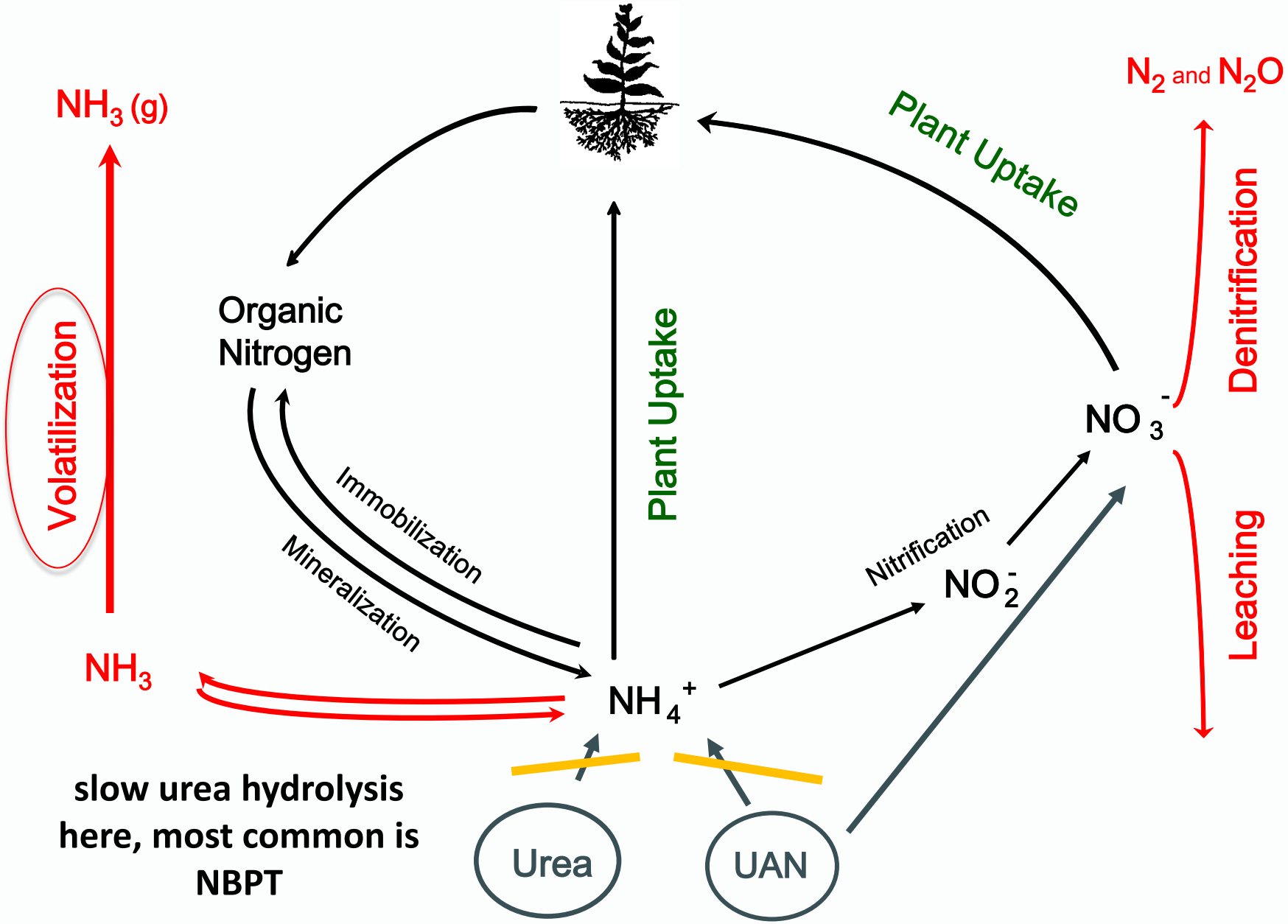
Effect of irrigation amount on urea volatilization



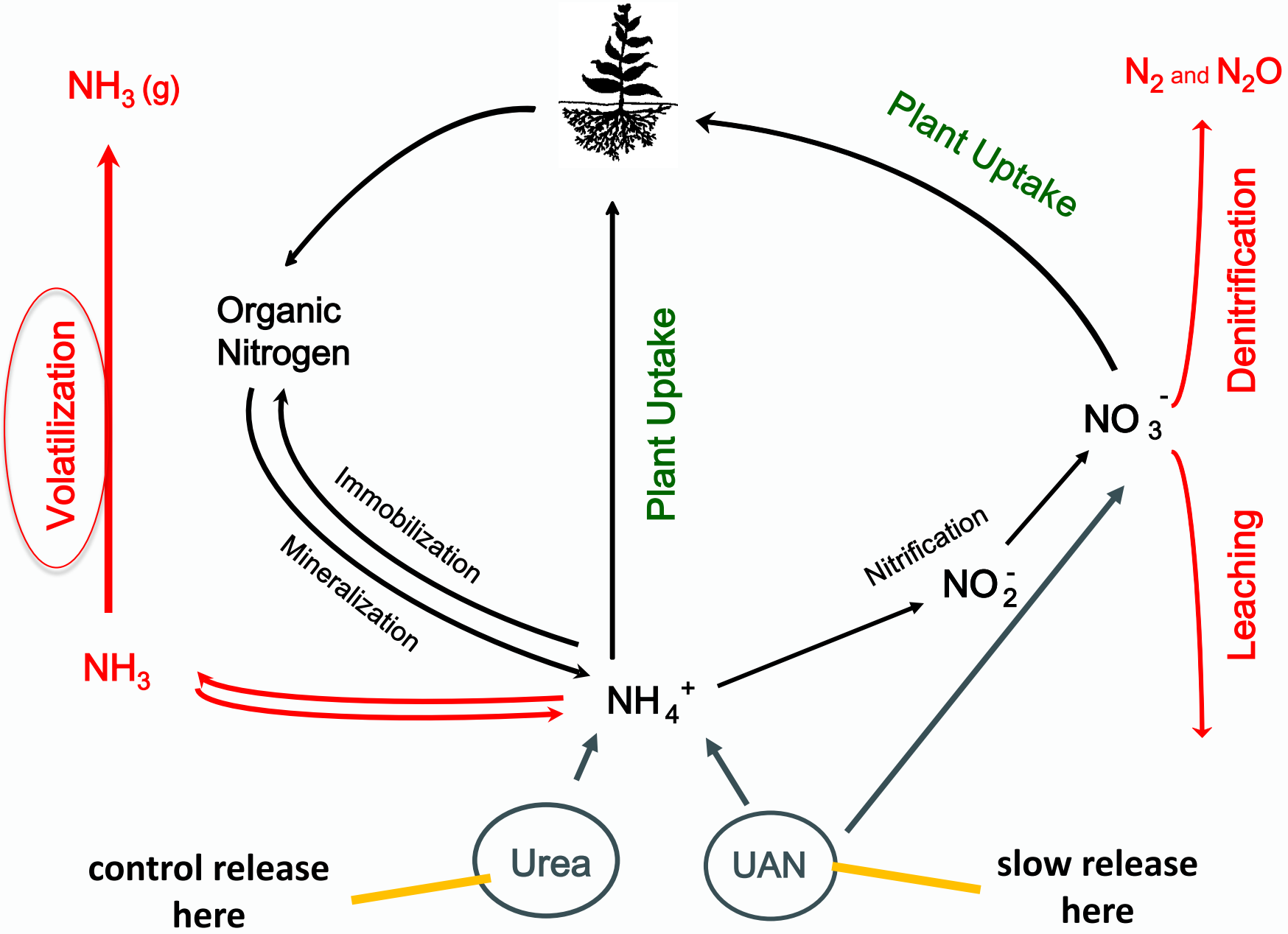
Different N sources have different volatilization loss potential

***POTENTIAL* volatilization loss compared to urea**	
Conventional Fertilizers	
Ammonium nitrate, CAN, ammonium sulfate	less
UAN (solution 28 or 32)	less
Enhanced Efficiency Fertilizers	
Urease inhibitors (NBPT=Agrotain)	less
Nitrification inhibitors (DCD, N-Source, N-Serve, Instinct)	≈
Combinations (SuperU)	less
Controlled release polymer coated (ESN)	less
Slow release (Nitamin, N-Sure, N-Demand)	≈

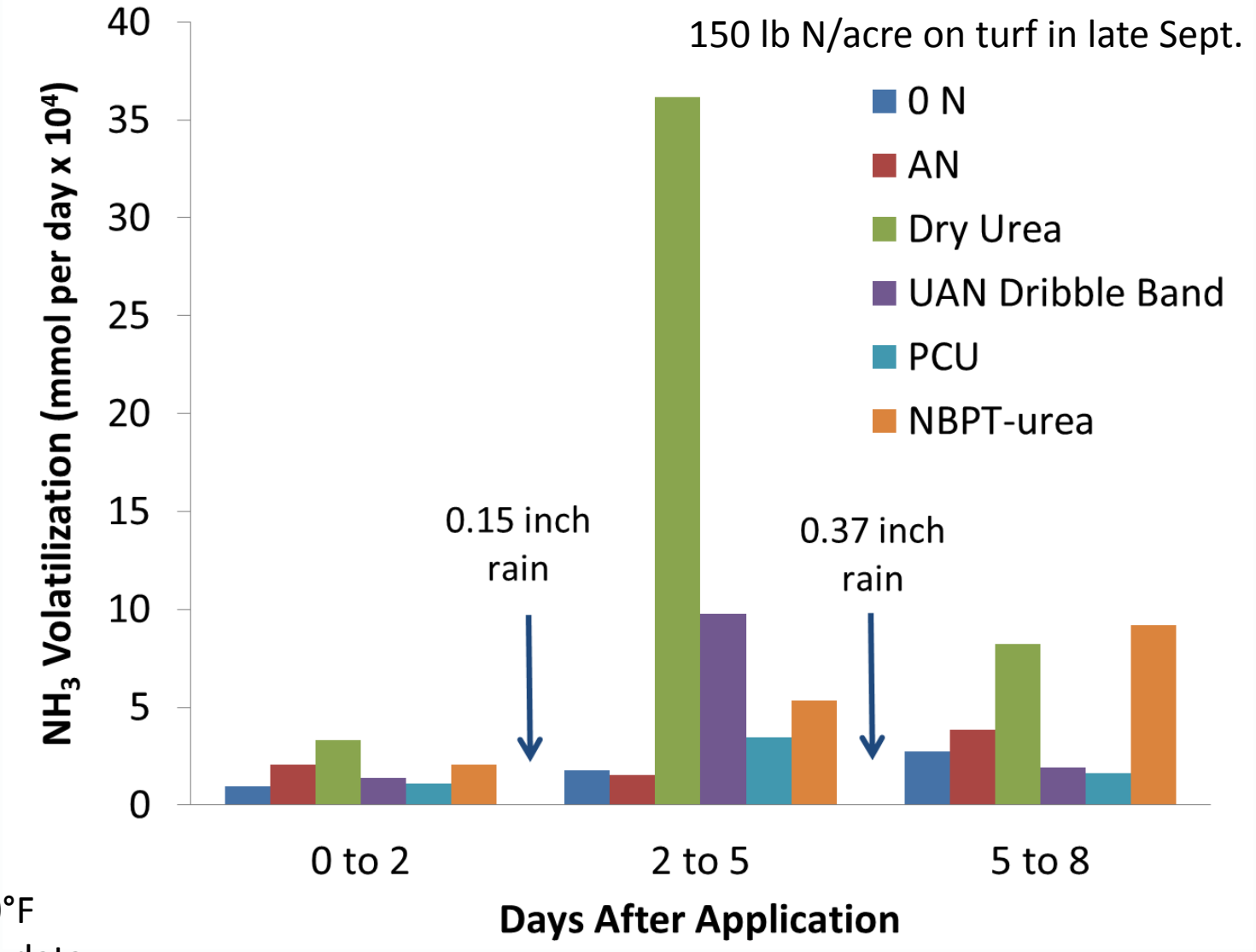
Stabilized fertilizers: Urease inhibitors



Slow and controlled release fertilizers



Effect of N source on volatilization



Washington
Soil Temp = 50°F
Koenig unpub. data

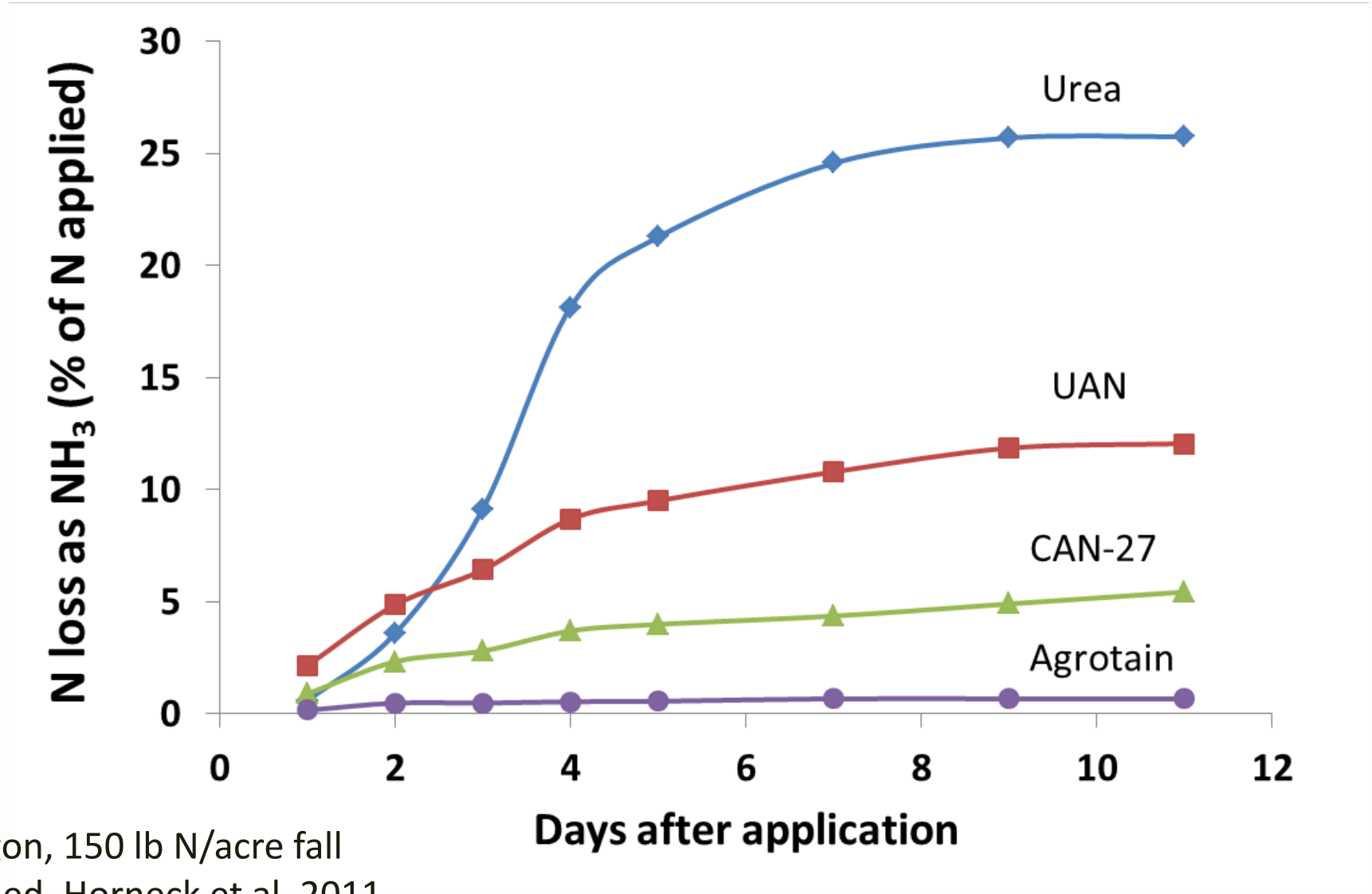
UAN volatilization with and without Agrotain®

% of surface applied N volatilized over 7 days

	Check	UAN	UAN+Agrotain
May (74°F)	0	7	1
July (86°F)	0.6	50	16

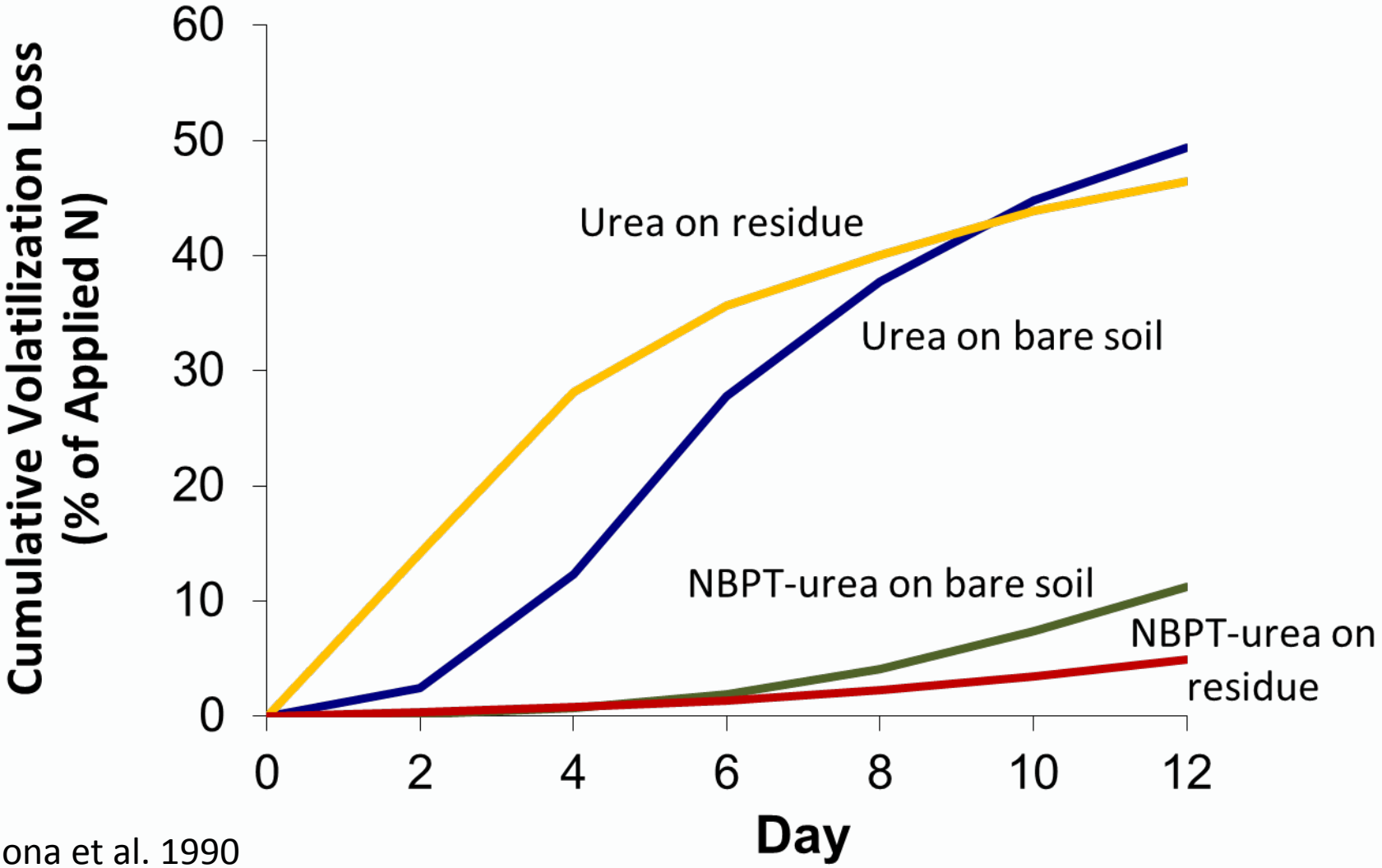
Grant et al. 1996, Manitoba

Sources to reduce volatilization on newly seeded grass field



Oregon, 150 lb N/acre fall applied, Horneck et al. 2011

Straw residue and NBPT effect on volatilization



Carmona et al. 1990
lab conditions

Does NBPT decrease volatilization losses in Montana (Engel et al.)?

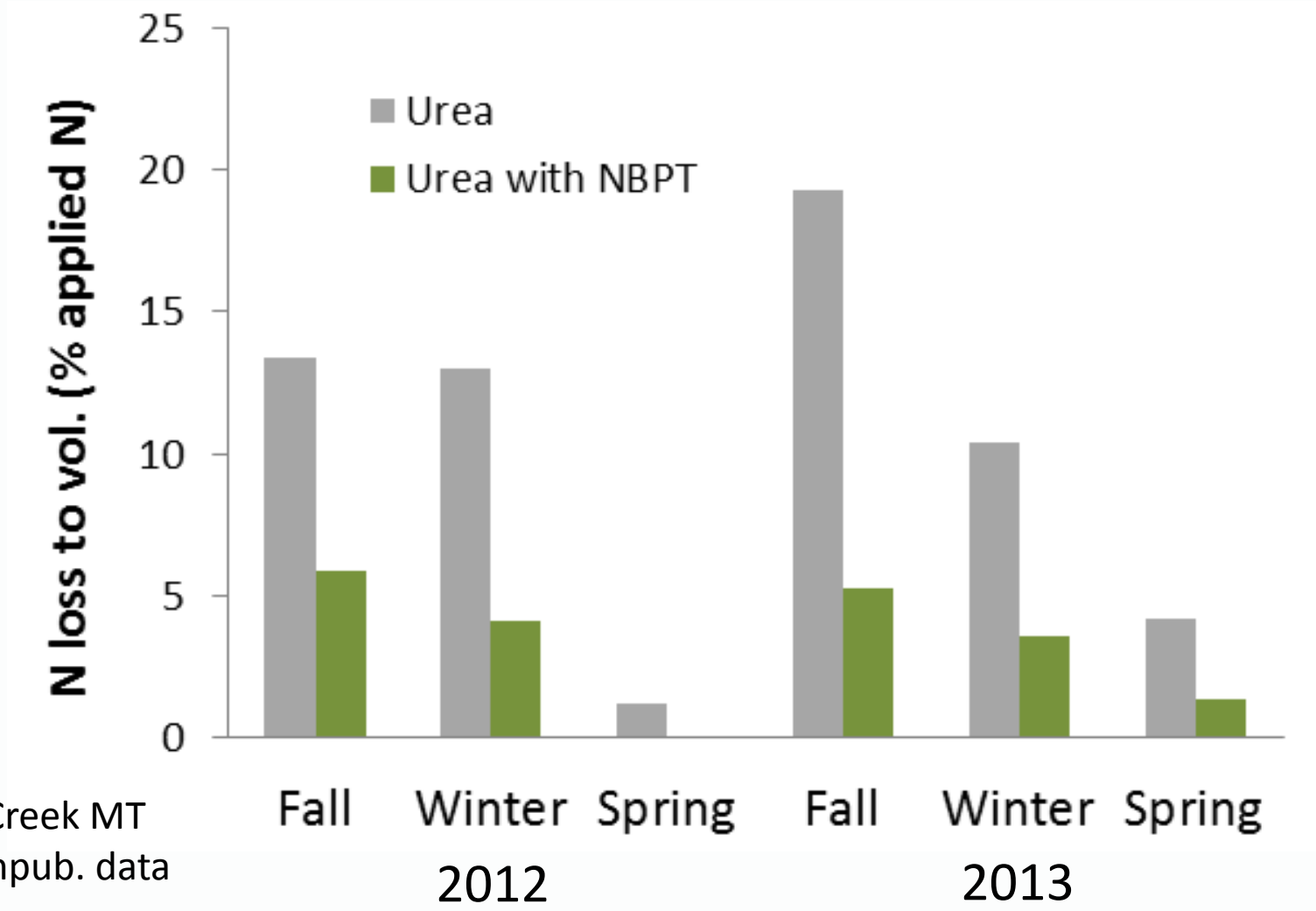
- Significant ammonia losses (30-40% of applied N) from surface-applied urea can occur even though soil temperatures are near freezing!
- Worst case-conditions for loss:

  moist surface with only sprinkles for weeks, prolonged damp commonly found in MT during late fall or early spring (Fertilizer Fact #59)
- Based on 17 studies:

  Average N lost from urea: 18.1%

  Average N lost from NBPT-urea: 6.5%

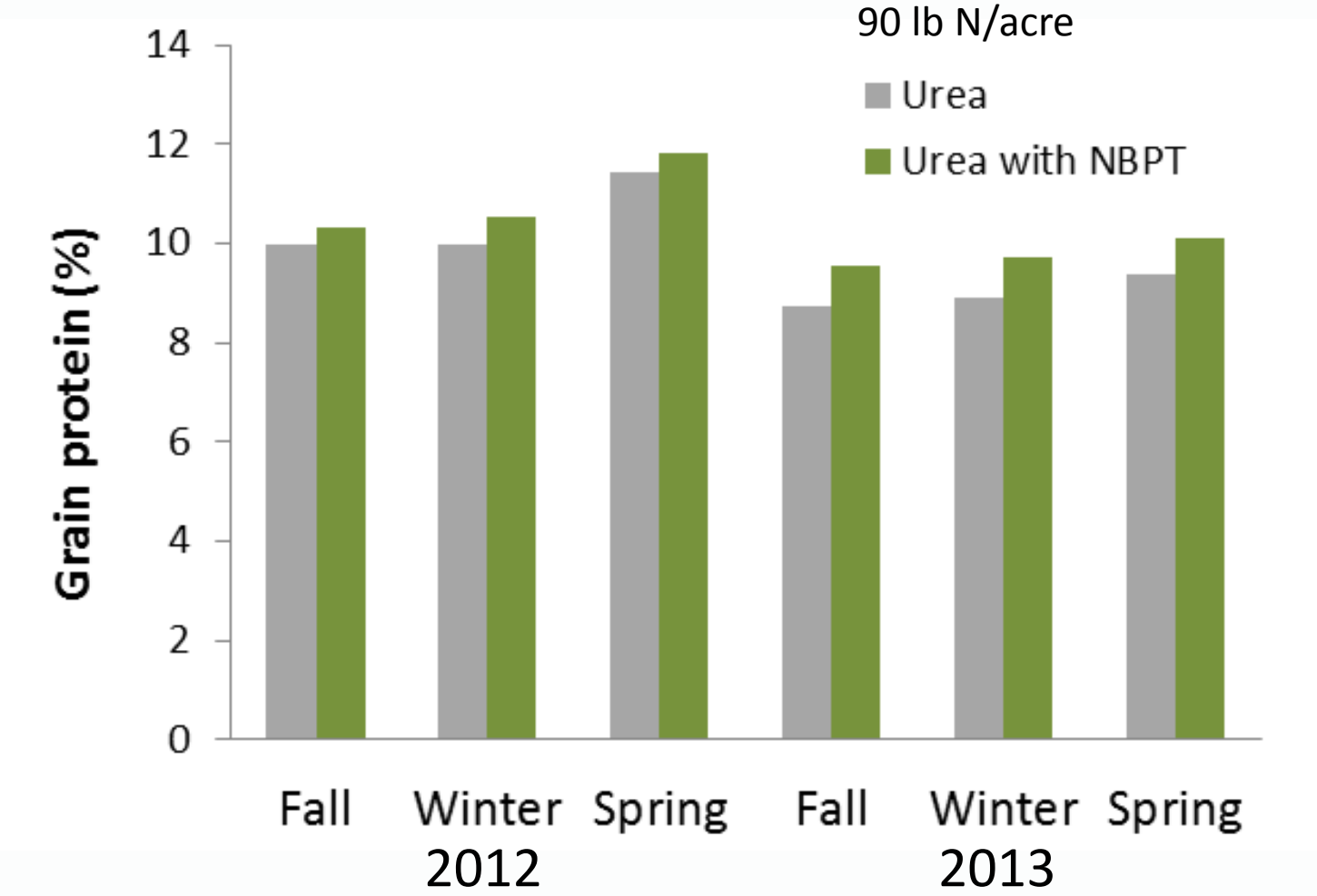
NBPT (Agrotain®) reduces N loss in central MT



Coffee Creek MT
Engel unpub. data

NH_3 losses observed for late-fall and winter app > than spring, even though temperatures were colder; mitigation by NBPT ≈ 65%

NBPT with broadcast urea can increase WW grain protein in central MT



NBPT sig increased protein by about 0.4 to 0.8 % points for both years. NBPT only increased yield in Fall 2012.

Coffee Creek, MT
Engel unpub data

Economics

- Agrotain is about $75/ton-urea. So if applied 200 lb urea this would be an additional $7.50/acre cost.
- Would need to grow at least 1 bu/acre more, which only happened fall applied (not winter or spring) in 1 of 2 years.
- However, this does not take into account increased protein and N recovery (9-10% increase with NBPT), with reduced risk to air and water quality.
- The best economic solution might be to use NBPT only when you need to apply during high risk conditions.

Conclusions

- Many factors contribute to volatilization loss; some can, others cannot be controlled
- Soil moisture is likely the most important factor
- Mechanical incorporation or >0.5” water in one event are best to reduce volatilization
- Products are available with lower volatilization potential (ex: UAN, CAN, NBPT, ESN)
- Management practices to reduce volatilization loss can increase yield and grain protein, and reduce risk to air and water quality

Additional info at:
http://landresources.montana.edu/soilfertility

Soil fertility publications:
Go to “Extension Publications”

- *Factors Affecting Nitrogen Fertilizer Volatilization*
- *Management to Minimize Nitrogen Fertilizer Volatilization*

MT research data on volatilization: Fertilizer Facts 59 & 60, and http://landresources.montana.edu/ureavolatilization

This presentation: Go to “Presentations”

To help us assess the impact of Rick Engel’s and my work on urea volatilization, please take a survey at

https://www.surveymonkey.com/s/7FNTZKL

Judith Basin Nitrogen Project (Ewing, Jones, Sigler, and Jackson-Smith)

- Start of 3rd year of studying alternative management practices that reduce nitrate leaching.
- 3 farms (Stanford, Moccasin, and Moore) and 3 alternative practices (replacing fallow with annual legume, slow release N, and split application)
- Practices to test were largely selected by our Producer Research Advisory Group (6 local producers) and Advisory Committee (14 members)
- We've learned a lot about what drives nitrate leaching process (like high mineralization)
- More info at: http://waterquality.montana.edu/docs/judith.shtml

Questions?