FERTILIZER SOURCES

Extension Agent Agronomy College

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Clain Jones

clainj@montana.edu 994-6076

Goals for this section

- Source, placement and timing are interconnected, hard to treat individually
- Present pros and cons of various fertilizer sources

Generalizations on different nutrient sources

Source	Immediately available	May increase availability & reduce environmental losses	Used for in-season adjustments	Take time to become available
Conventional				
Enhanced efficiency				
Foliar				
Elemental or SOM				

Generalizations on different nutrient sources

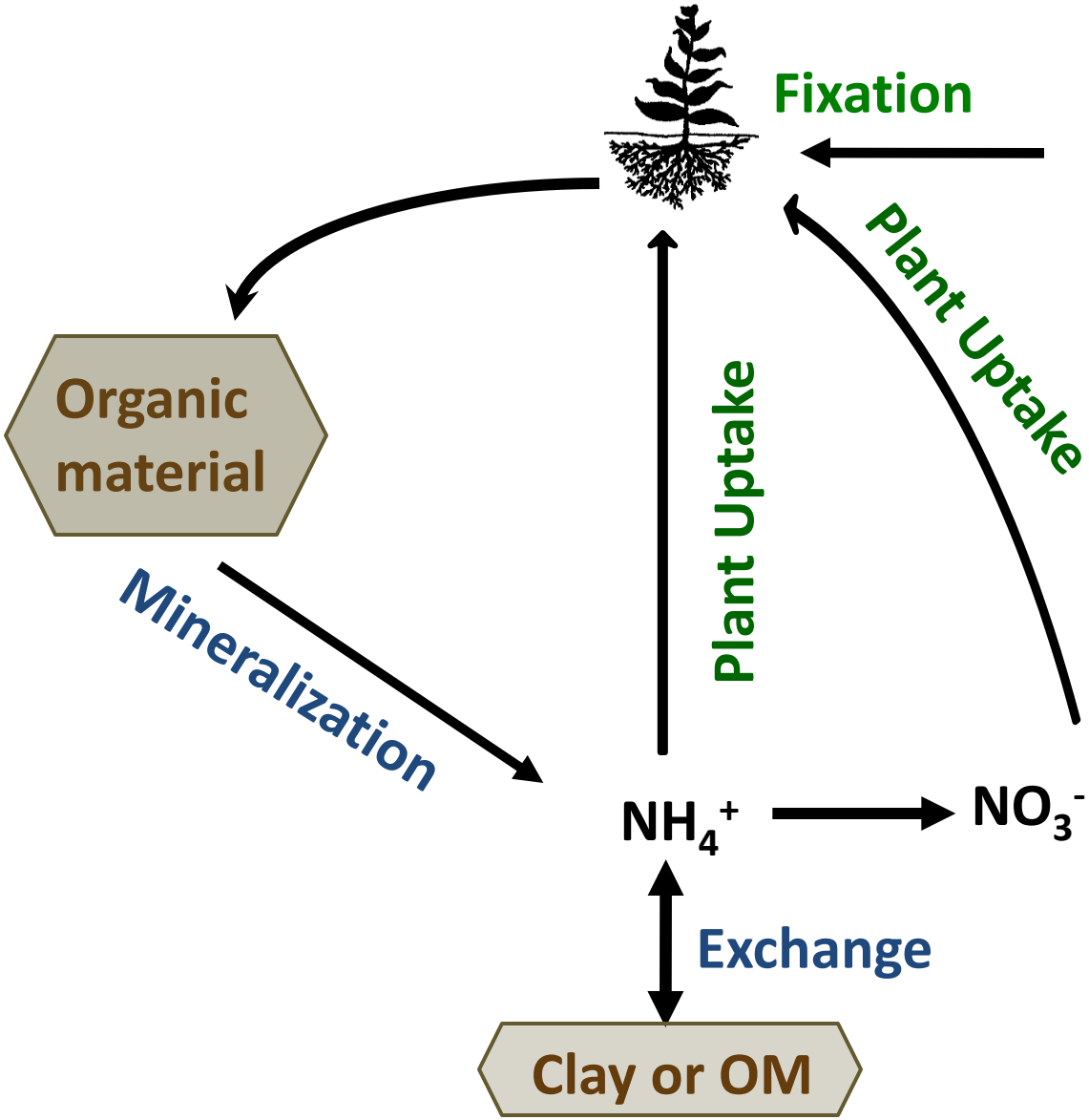
Source	Immediately available	May increase availability & reduce environmental losses	Used for in-season adjustments	Take time to become available
Conventional	✓		✓	
Enhanced efficiency		✓		✓
Foliar	✓		✓	✓
Elemental or SOM		✓		✓

Nutrient sources are not equally plant available

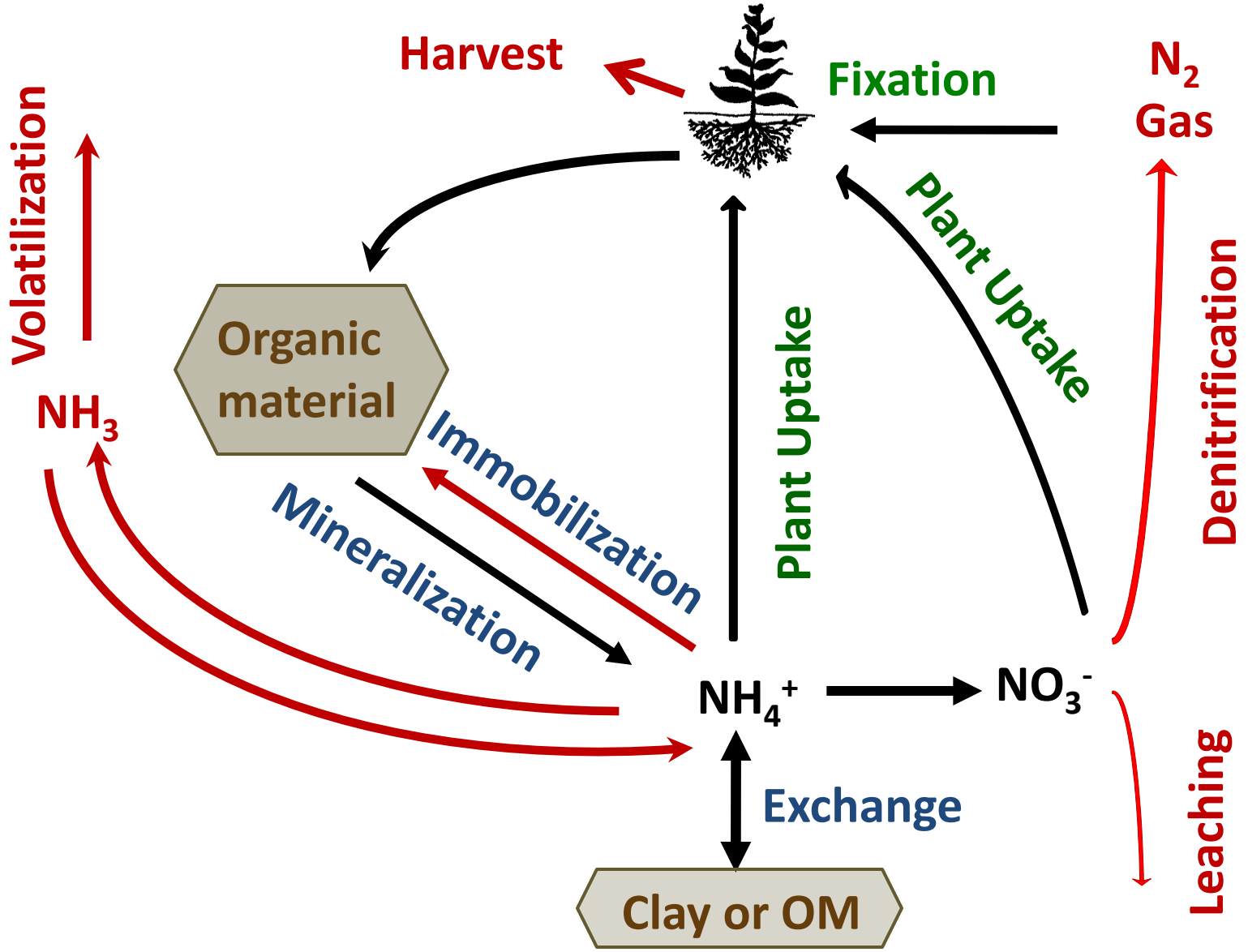
Nutrient	"Immediately" available	Growing season	Several Years
N	Urea (46-0-0) UAN (28-0-0, 32-0-0, liquid) CAN (27-0-0) AS (21-0-0-24)	ESN, SuperU	Legume residue manure
P	MAP (11-52-0)*, MAPS (16-20-0-13)* DAP (18-46-0)* APP (10-34-0, liquid)* MESZ (12-40-0-10-Zn1)*		Phosphate rock Ca-phosphate
K	Potash (KCl 0-0-60)		
S	Ammonium Sulfate		Elemental sulfur Ca-sulfate

* Get tied up in mineral form making some unavailable to plants
Those more plant available are more easily lost
Plant availability affects timing and placement – discussed later

Basic N Cycle



How does N get ‘lost’ from the system?



Different N sources have different volatilization and leaching loss potential

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

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

- Based on 17 studies:

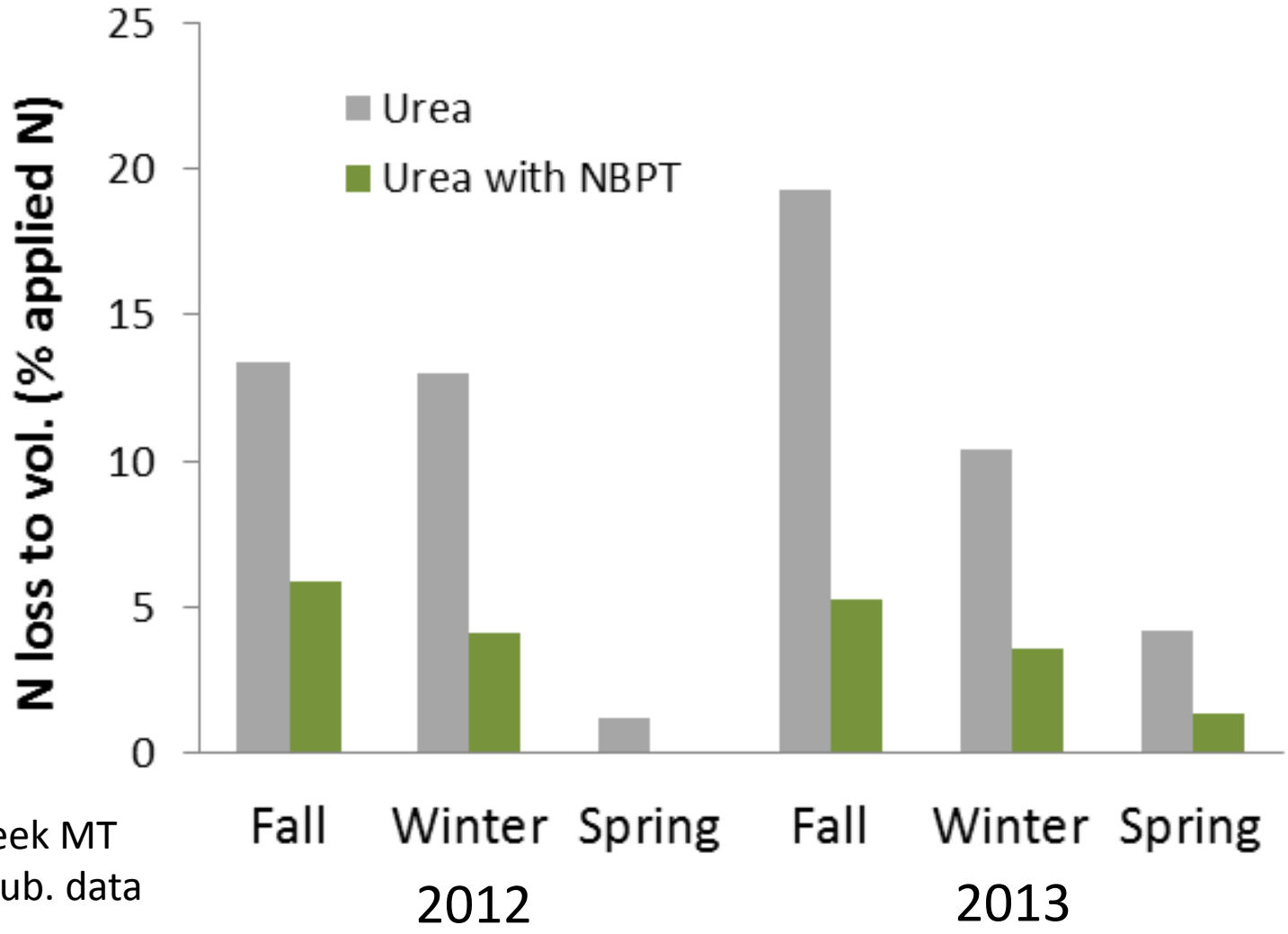
  Average N lost from urea: 18.1%

  Average N lost from NBPT-urea: 6.5%

- Worst case-conditions for loss:

  moist surface with only sprinkles for weeks (Fertilizer Fact #59)

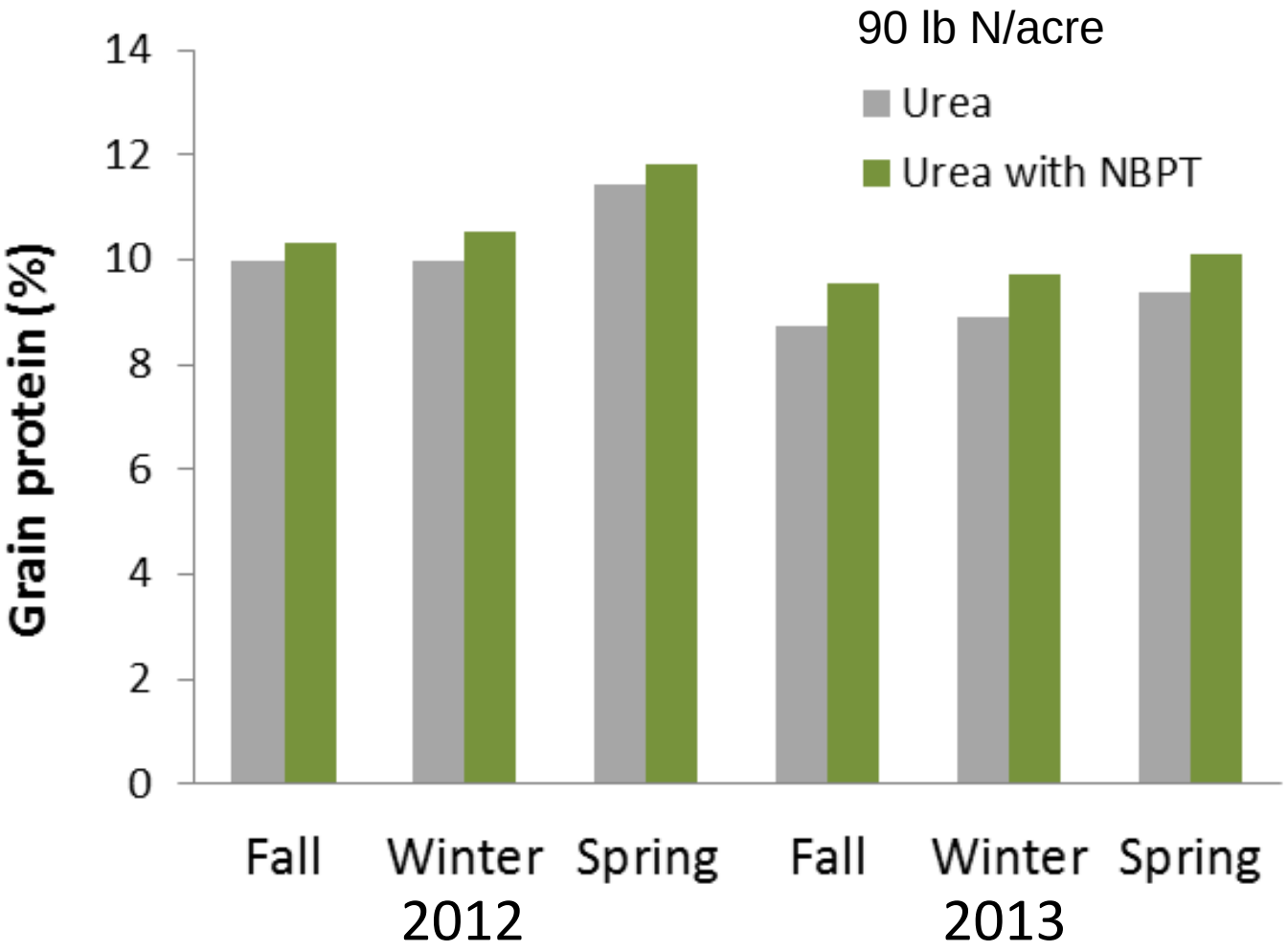
NBPT (Agrotain®) reduces N loss



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%

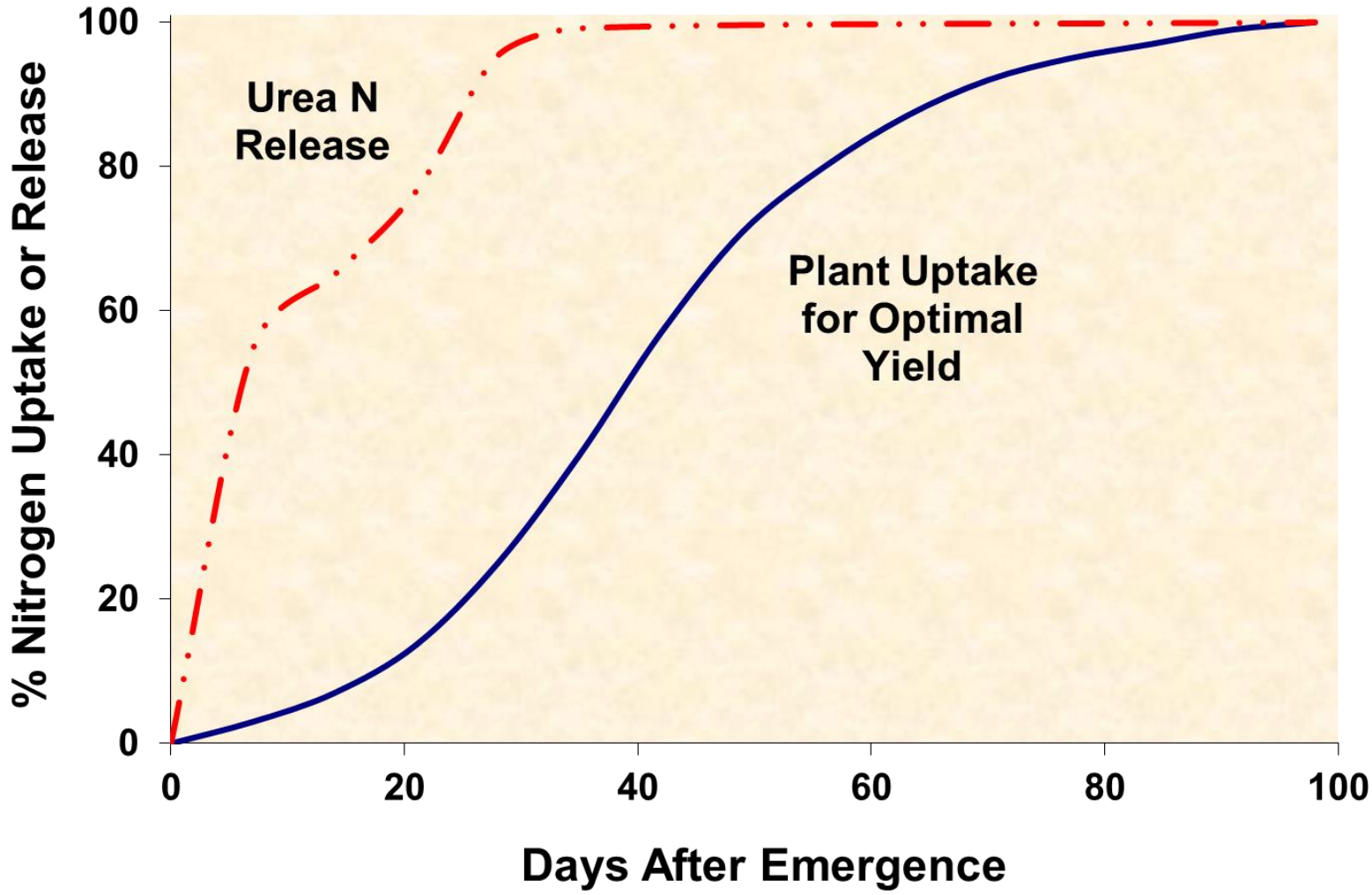
NBPT with broadcast urea can increase WW grain protein



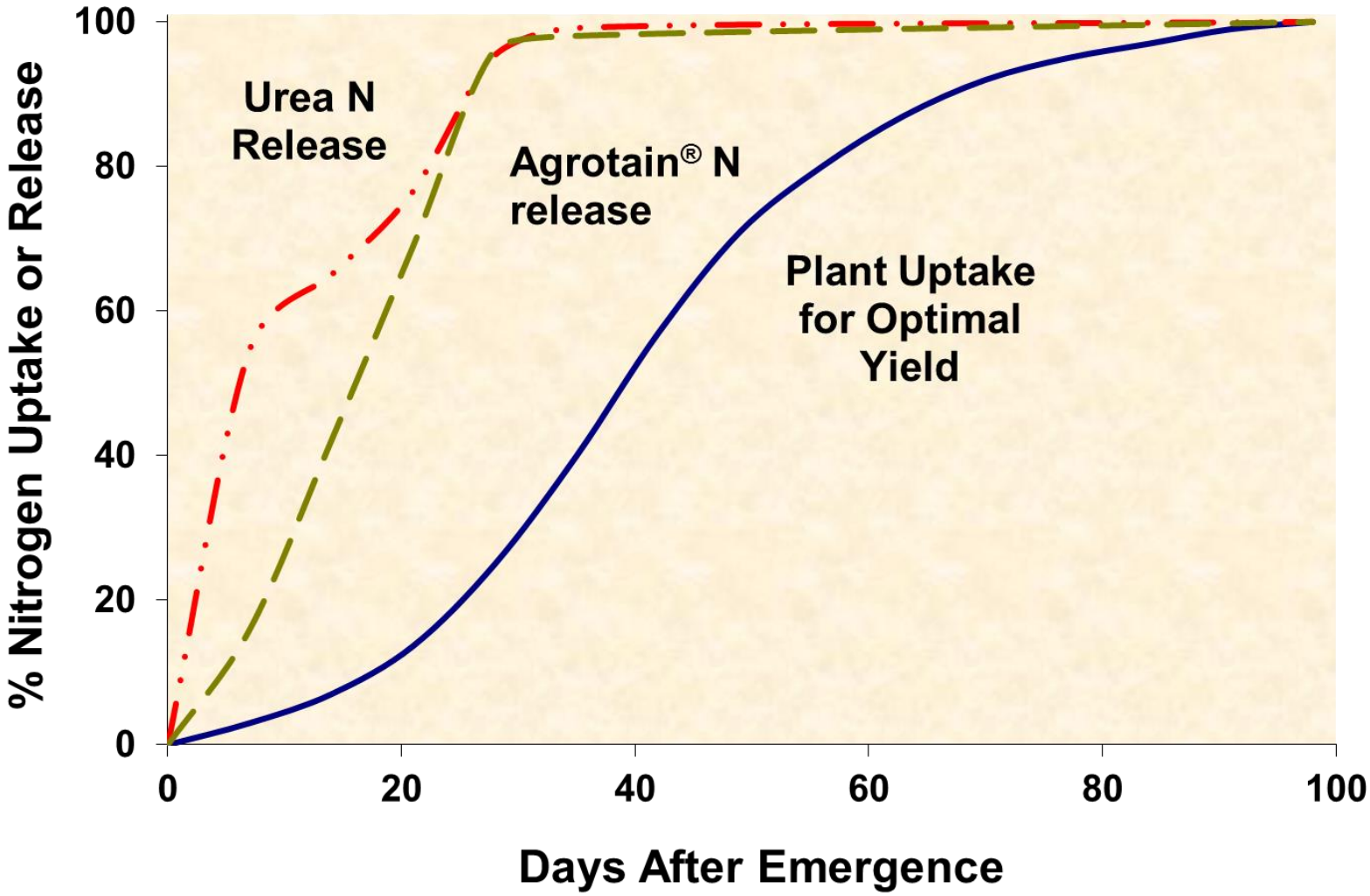
NBPT sig increased protein by about 0.4 to 0.8% points for both years. NBPT only increased yield in Fall 2012.

Coffee Creek, MT
Engel unpub data

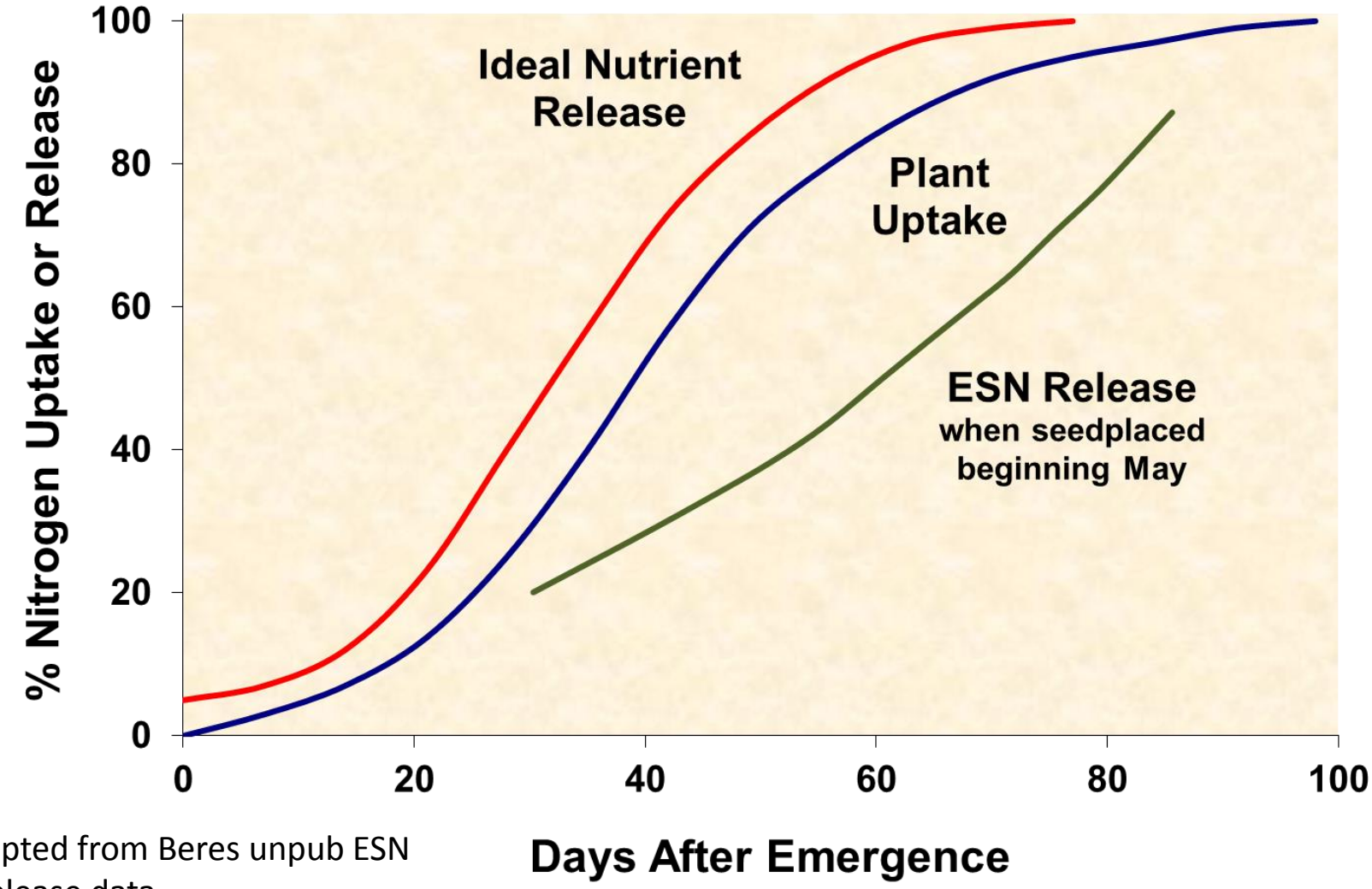
Controlled release sources strive to supply N closer to plant uptake



Urease inhibitor helps



Ideal controlled N release curve

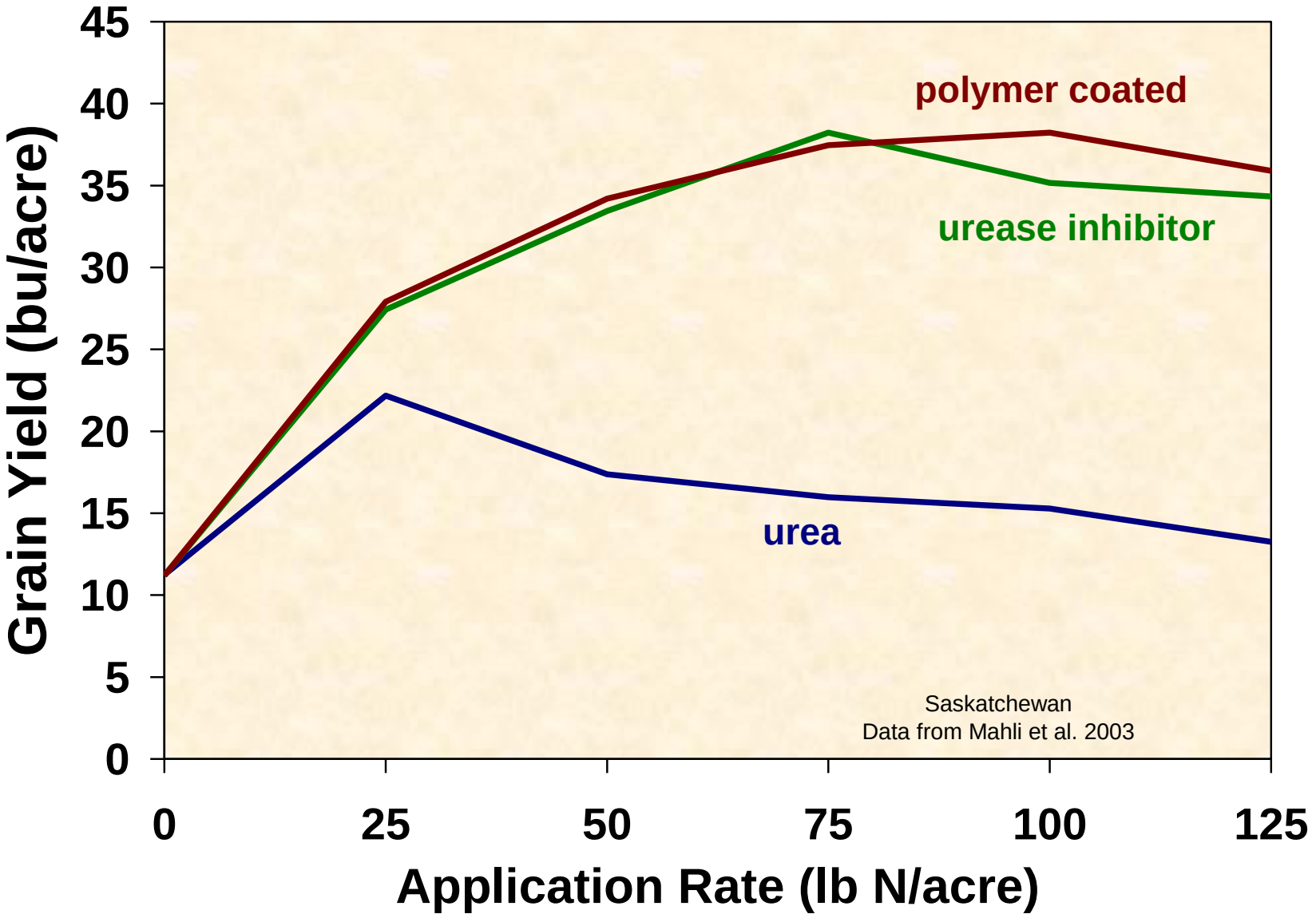


Adapted from Beres unpub ESN N release data

Slow- and controlled-release for the northern Great Plains

- No consistent benefit shown
- Fall broadcast may increase yield over broadcast urea, especially in a wet year when urea may leach overwinter
- If fall application to reduce spring work load (and save the marriage) is important, then extra cost might be worth it
- Release tends to be too slow with late winter early-spring application
- Allow for higher rate seed-placed

EEFs increase safe rate with seed



Dry vs. liquid N: Foliar N as an in-season boost to yield and grain protein (timing to be discussed later)

How much foliar liquid urea is taken up via leaves at flowering?

1. <10%
2. 10-20%
3. 20-30%
4. 30-40%
5. 40-50%
6. 50-75%
7. >75%
8. Depends on how hungry the plants are

13%
13%
13%
13%
13%
13%
13%

- 8-11% is taken up by leaves, vs. 37-67% of soil applied N taken up by plant in same study (Rawluk et al. 2000)
- ½ inch rain (have you been living right?) or irrigation needed to soak N into soil
- If scab risk, do not irrigate within 5 days of flower

Response Counter

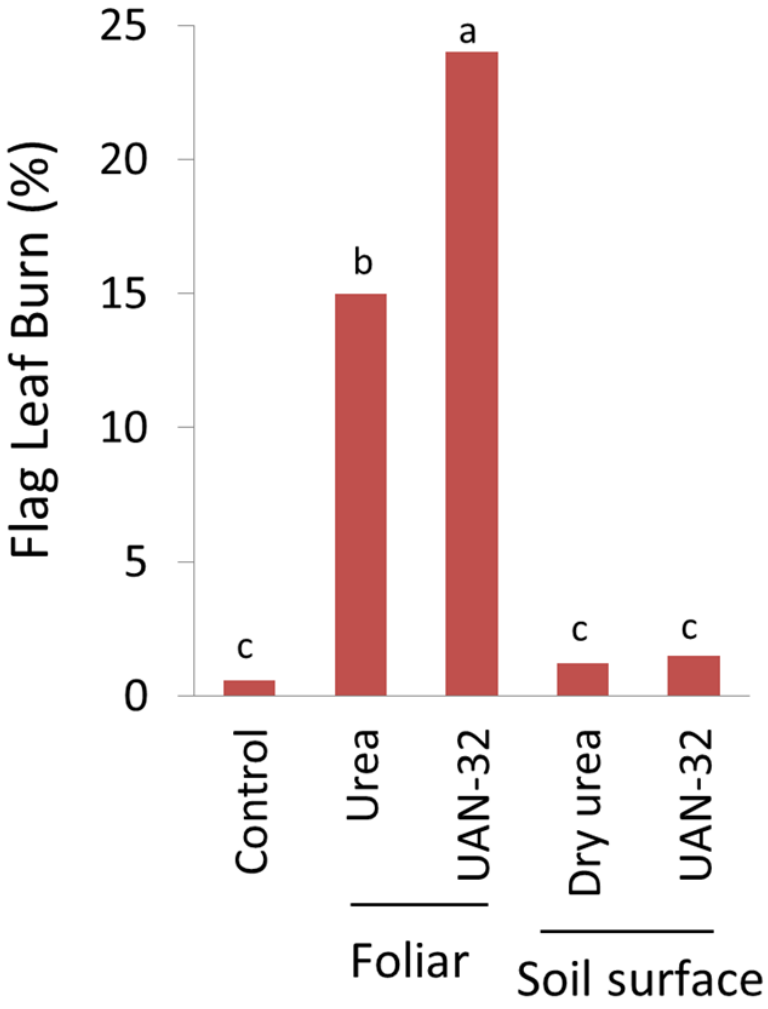
Source and rate of N affect leaf burn

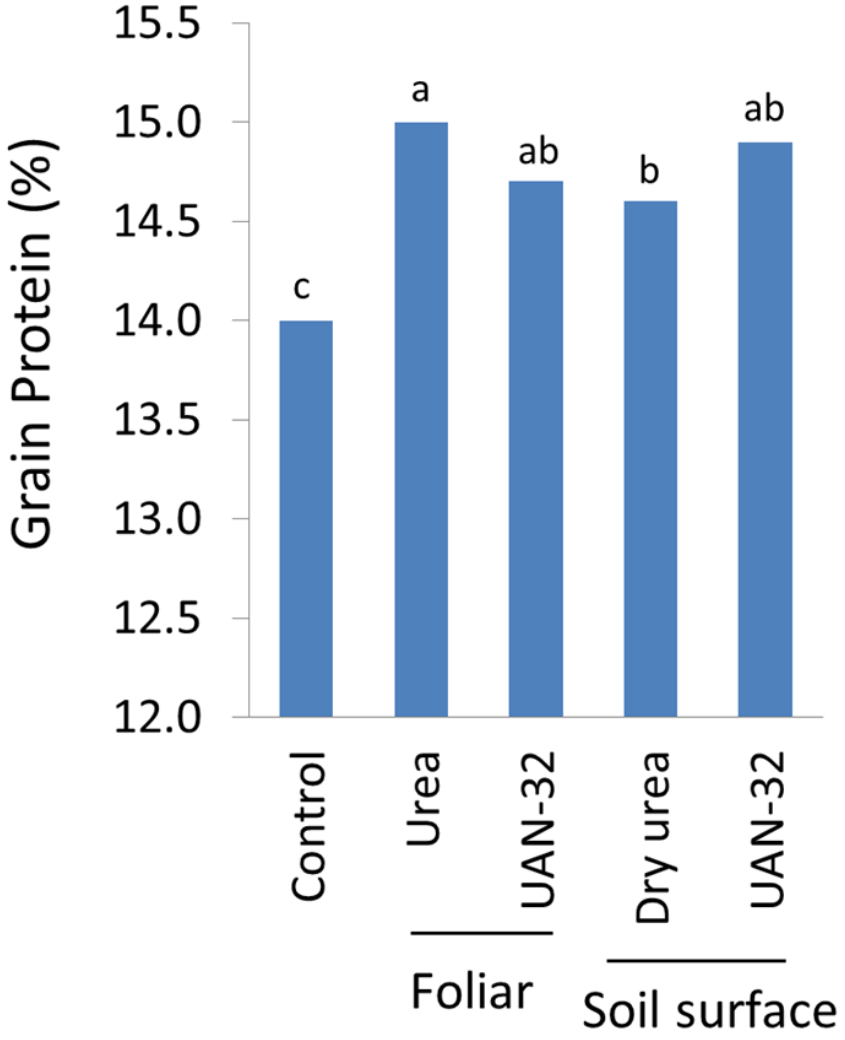
32% UAN causes more flag leaf burn and reduced grain yield than equal amount of N from foliar urea

- UAN max suggested rate 30 lb N/ac
- Foliar urea max suggested rate 45 lb N/ac

Brown & Long 1988, Parma, ID, irrigated winter wheat

Source and placement effect on irrigated spring wheat leaf burn and grain protein





Brown 1995, Idaho, Irrigated SW

All received 135 lb N/ac dry urea at tillering to produce 120 bu/ac, **Yield was not sig different among**

Fertilizer leaf burn – added caution

- Reduce to 20 lb N/ac max if combined with herbicide
- Leaf damage increased with:
  - Surfactant + more than 20 lb N/ac of 28-0-0 UAN
  - Urea + Agrotain®
  - Sulfur

http://fieldcrop.msu.edu/sites/fieldcrop/files/E2602.pdf

http://www.msuweeds.com/assets/Annual-Results/2010-Results/Wheat/2010ResultsWT02-10.pdf

- Less leaf burn at beginning of stem elongation than at 2nd node visible, and with added S, but may not translate to increased yields (Phillips 2004)

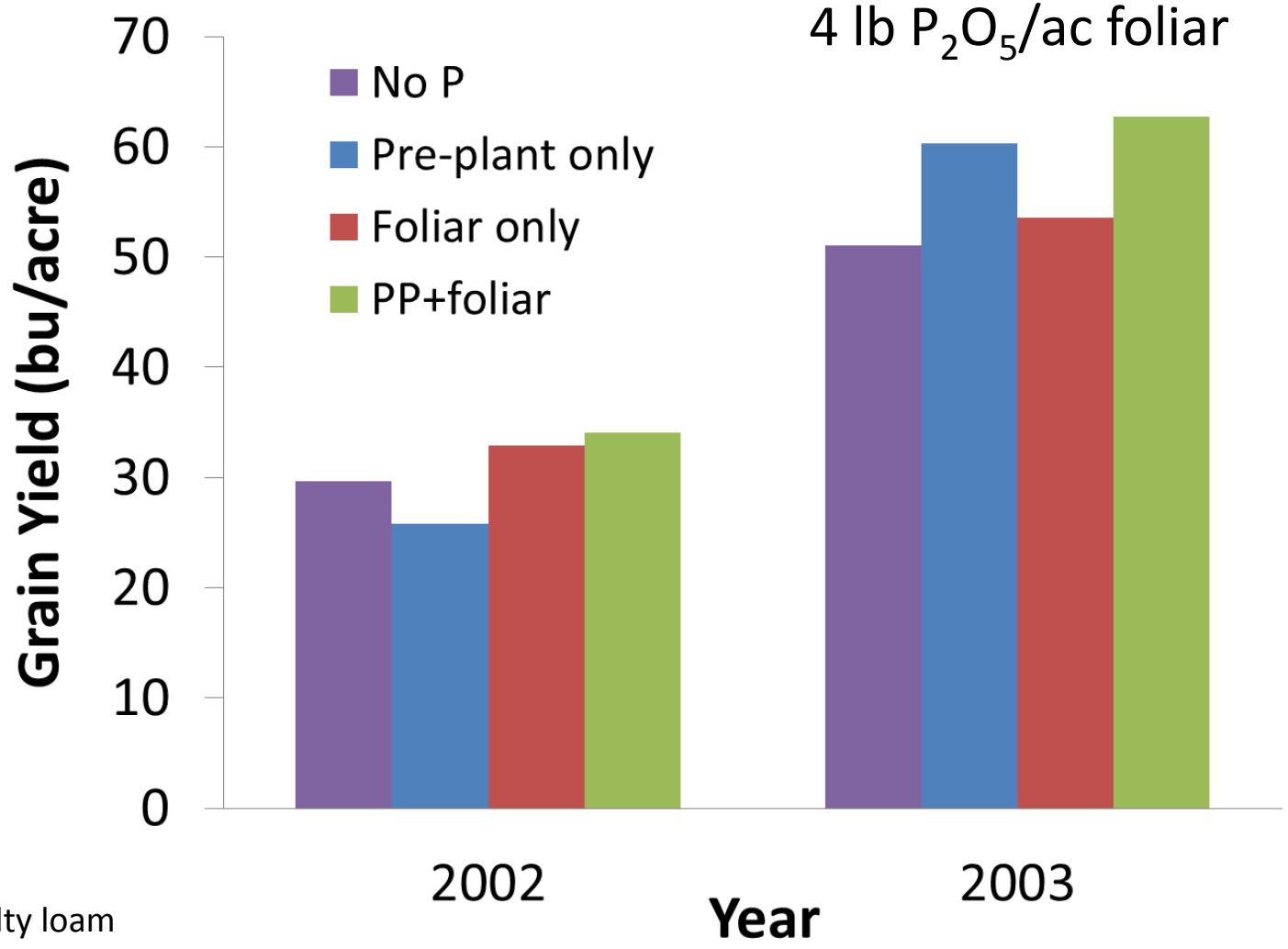
Questions?

Phosphorus

- Phosphate P is equally ‘available’ to the plant, whether in dry granular or liquid form
- Soil chemistry determines how much gets taken up by plant
  - Alkaline soils with high Ca bind P to create mineral form unavailable to plants – liquids can produce higher yields on highly calcareous soils (> 20% $CaCO_3$)
  - Limited independent replicated work done on specialty product Avail® for cereals in Montana and the western U.S.

Pre-plant plus foliar P offers most consistent yield benefit

60 lb P_2O_5/ac preplant
4 lb P_2O_5/ac foliar



Oklahoma, fine silty loam
Olsen P 6 ppm, TSP incorporated preplant
Mosali 2006

K and Micronutrients

Every article we found on foliar K was conducted on K sufficient soils w/ no to minimal benefits, as expected.

IF apply foliar K, should be by late tillering given very rapid uptake during stem elongation.

How about micronutrients?

Foliar application of micronutrients

Micronutrients should not be applied unless deficiency is identified through:

- soil analysis (see *Fertilizer Guidelines for MT Crops* for soil applied fertilizer guidelines)
- tissue sampling
- visual deficiency symptoms (see *Plant nutrient functions and deficiency and toxicity symptoms*)

So many choices

- Lack of independent replicated studies make it difficult to provide recommendations
- There are more new products coming out than resources to test them
- If it seems too good to be true, it probably is
- Use test strips to test a product for given production systems
- See *Enhanced Efficiency Fertilizers* for partial list of those available and mechanism (http://landresources.montana.edu/soilfertility/publications.html)

Questions?

How should a grower choose between 2 products with similar benefits? Determine cost per lb N

ex. Ammonium sulfate (21-0-0-24) at 100 lb N/acre

- $\frac{\text{100 lb N/acre}}{\text{0.21 lb N/lb AS}}$ = 476 lb AS/acre

- $385/ton AS = $0.19/lb AS
- $0.19 x 476 = $90.5/acre for AS

Your turn. How much would 100 lb N/acre as urea cost, with $460/ton urea?

Urea (46-0-0) at 100 lb N/acre

- $\frac{\text{100 lb N/acre}}{\text{0.46 lb N/lb urea}} = 217$ lb urea/acre

- $460/ton urea = $0.23/lb urea
- $0.23 x 217 = $50/acre for urea

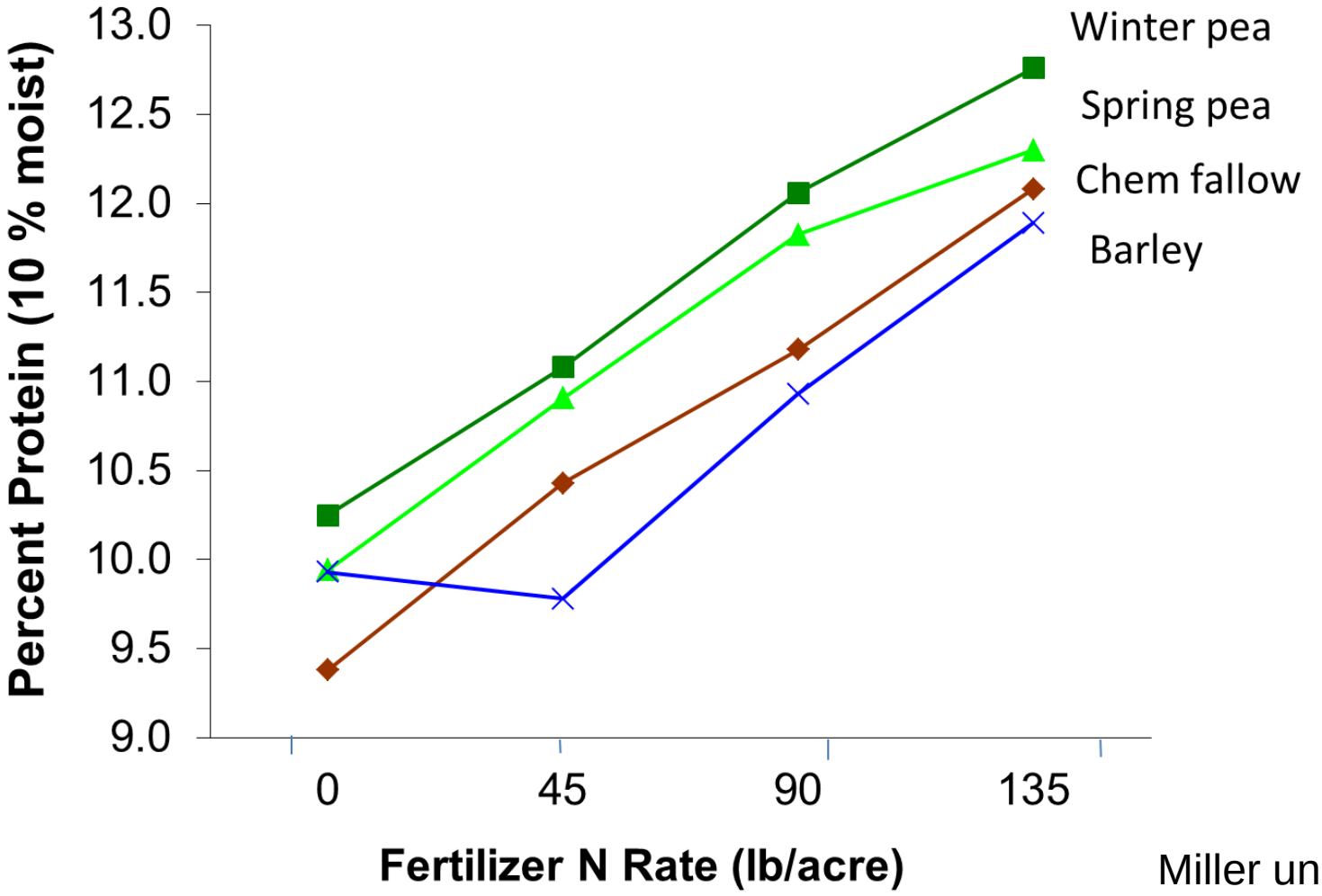
Other considerations, e.g.:

- Constraints on timing, placement, equipment

Rotations

A potentially very economical source, in the long run

Right rotation: Do legumes grown prior to winter wheat increase grain protein?

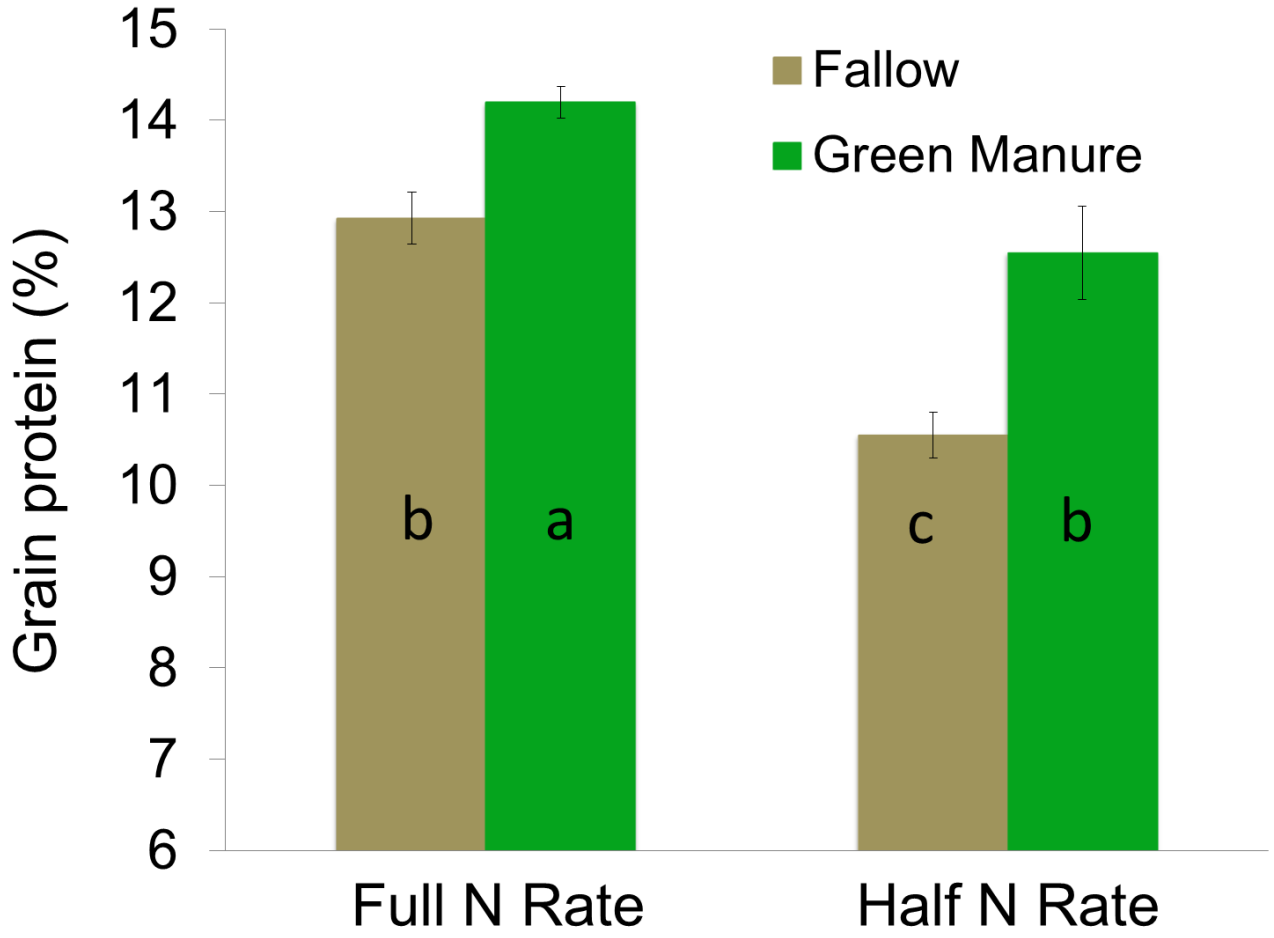


Miller unpub data

Legume green manure (LGM) study near Bozeman

- No-till pea forage/legume green manure-wheat vs. fallow-wheat
- Pea forage grown in 2003, 2005, 2007 and pea green manure grown in 2009, terminated at full pod
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years.
- 2 N rates: Full (3 lb available N/bu) and ½
- *No wheat yield or protein differences between after fallow and pea forage/pea manure in first 6 years of study (3 pea cycles)*

Spring wheat grain protein in 8th year



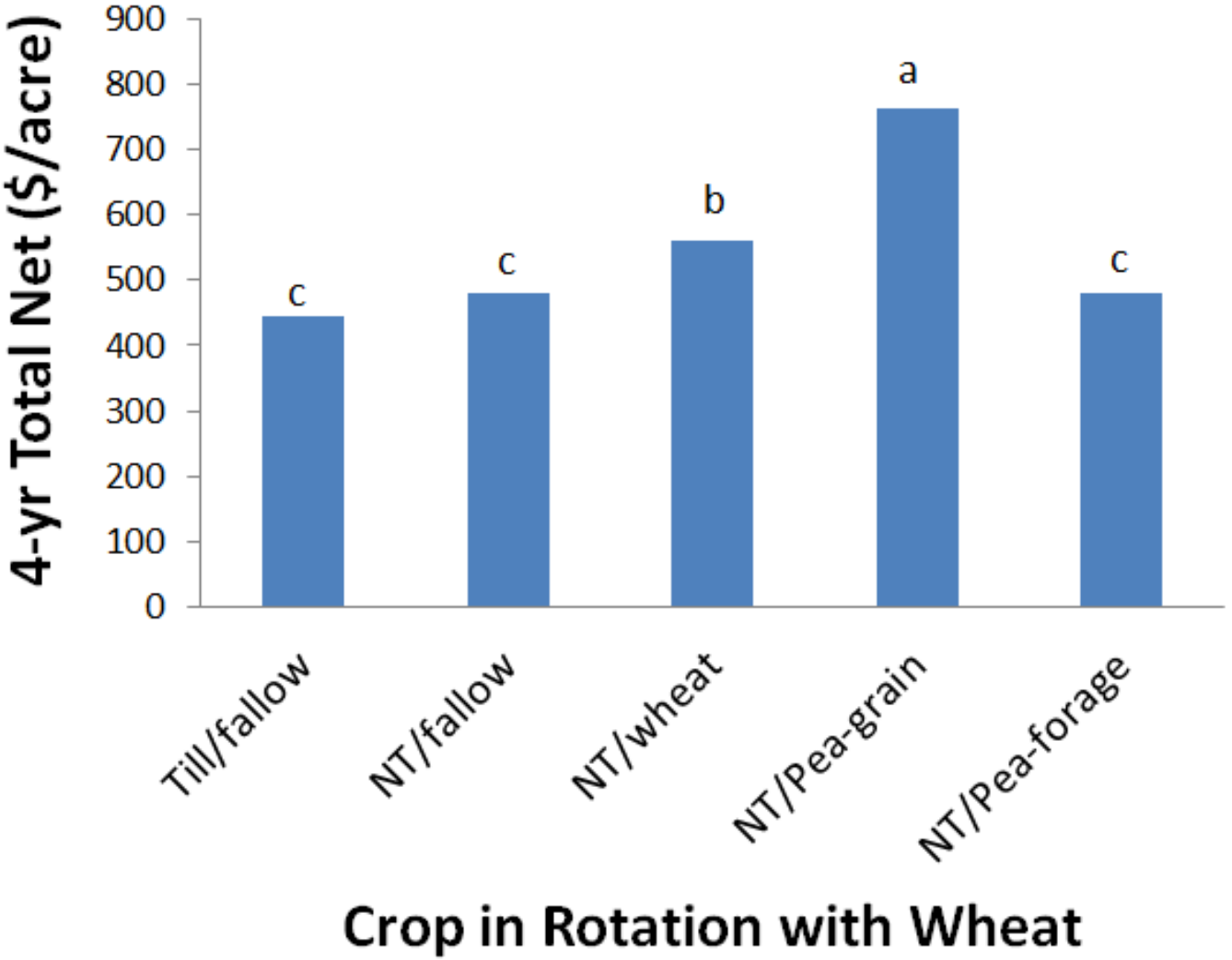
* N fertilizer rates	*Fallow-Wheat*	*LGM-Wheat*
Full N rate (lbs/ac)	124.00	83.00
Half N rate (lbs/ac)	39.00	0.00

Pea green manure after 4 LGM-wheat rotations saved **124 lb N/ac** compared to fallow.

Take home messages

- After 4 two-year cycles, wheat grain yield and protein were higher after LGM than after fallow.
- Over 100 lb N/ac was saved in the fourth cycle of LGM-wheat compared to fallow-wheat.

Economics of integrating pulse crops into wheat systems



Bozeman
Miller et al. in press

Summary

- NBPT (Agrotain®) helps reduce urea loss to volatilization and can increase grain protein
- Slow and controlled release fertilizers:
  - Tend to be more beneficial in wet than dry conditions
  - Release too slow when spring applied
  - Are safer than urea to seed place
- Foliar applications are useful for in-season adjustments, but best followed by rain or irrigation

Summary (cont.)

- All else being equal, select source based on cost per unit of nutrient (e.g. lb N)
- In the long run, legumes in rotation are an excellent economical source of N

Questions?

For more information on MT research on volatilization:

Fertilizer Facts 59 & 60
http://landresources.montana.edu/fertilizerfacts

Factors Affecting Nitrogen Fertilizer Volatilization (EB0208)

Management to Minimize Nitrogen Fertilizer Volatilization (EB0209)
http://landresources.montana.edu/soilfertility/

Urea volatilization research website
http://landresources.montana.edu/ureavolatilization