Agrotain

Avail

MESZ

Nitamin

ESN

FERTILIZER SOURCES

Cabin Fever - Agronomy Day

January 13, 2015

Legumes

SOM

Carbond

N-S

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Today's goals

- 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
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
Conventional	✓		✓
Enhanced efficiency		✓	
Foliar	depends		✓
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 (21-0-0-24) APS (16-20-0-13)		Elemental sulfur Ca-sulfate

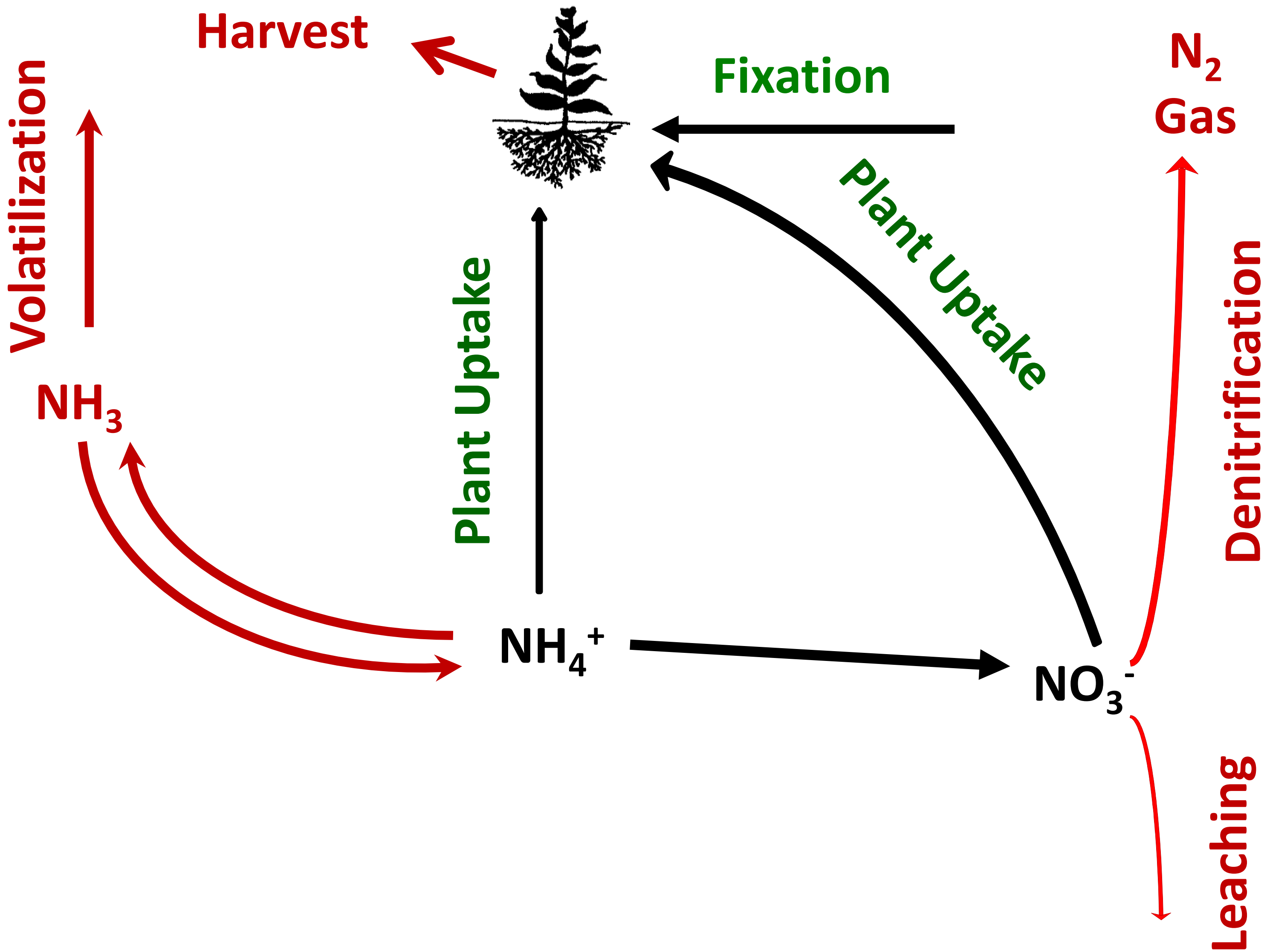
* Get tied up in mineral form making some unavailable to plants

Those more plant available are more easily lost

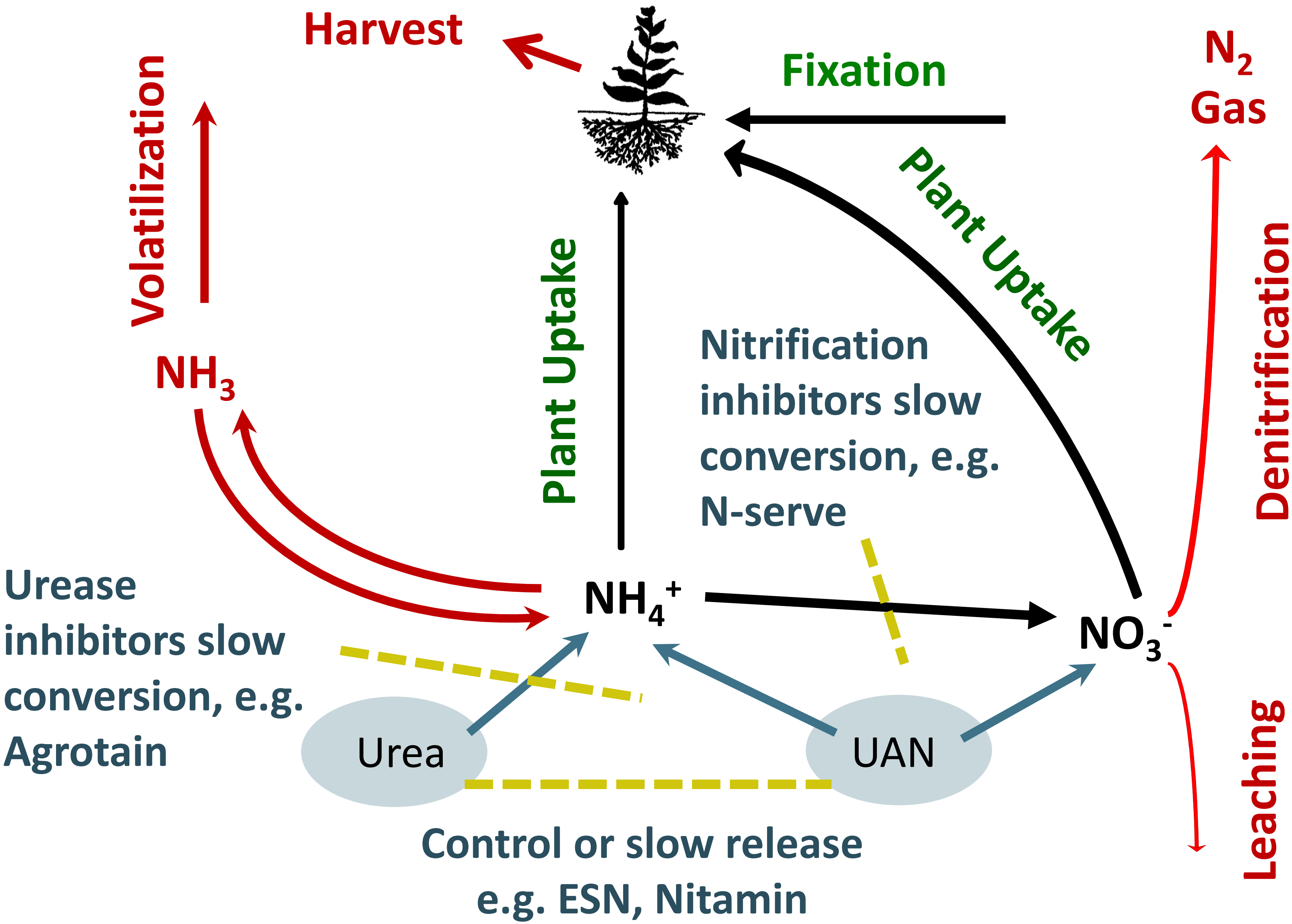
Plant availability affects timing and placement – discussed later

The basic N Cycle

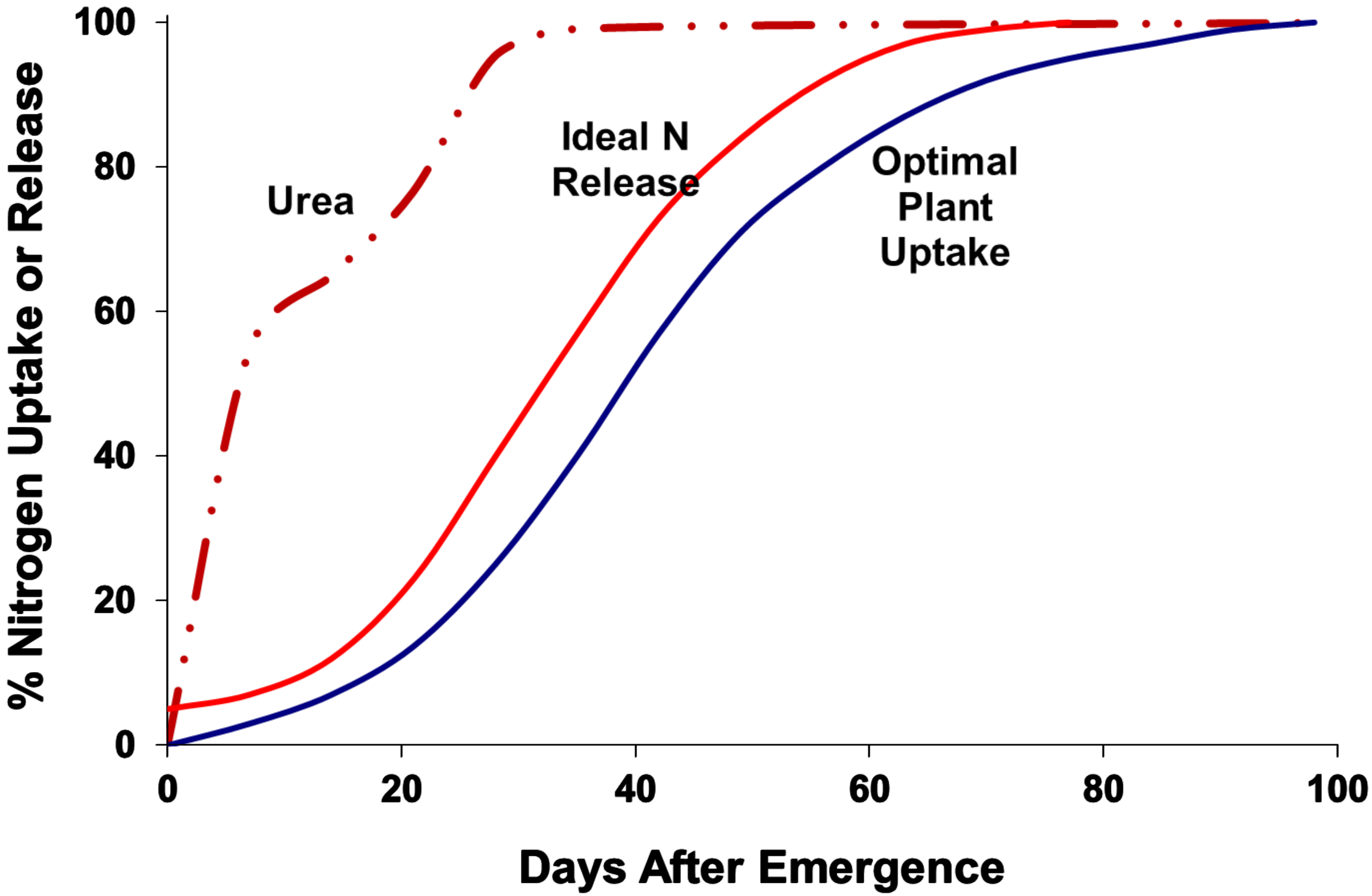
How N can leave a soil



Fertilizers and the basic N Cycle

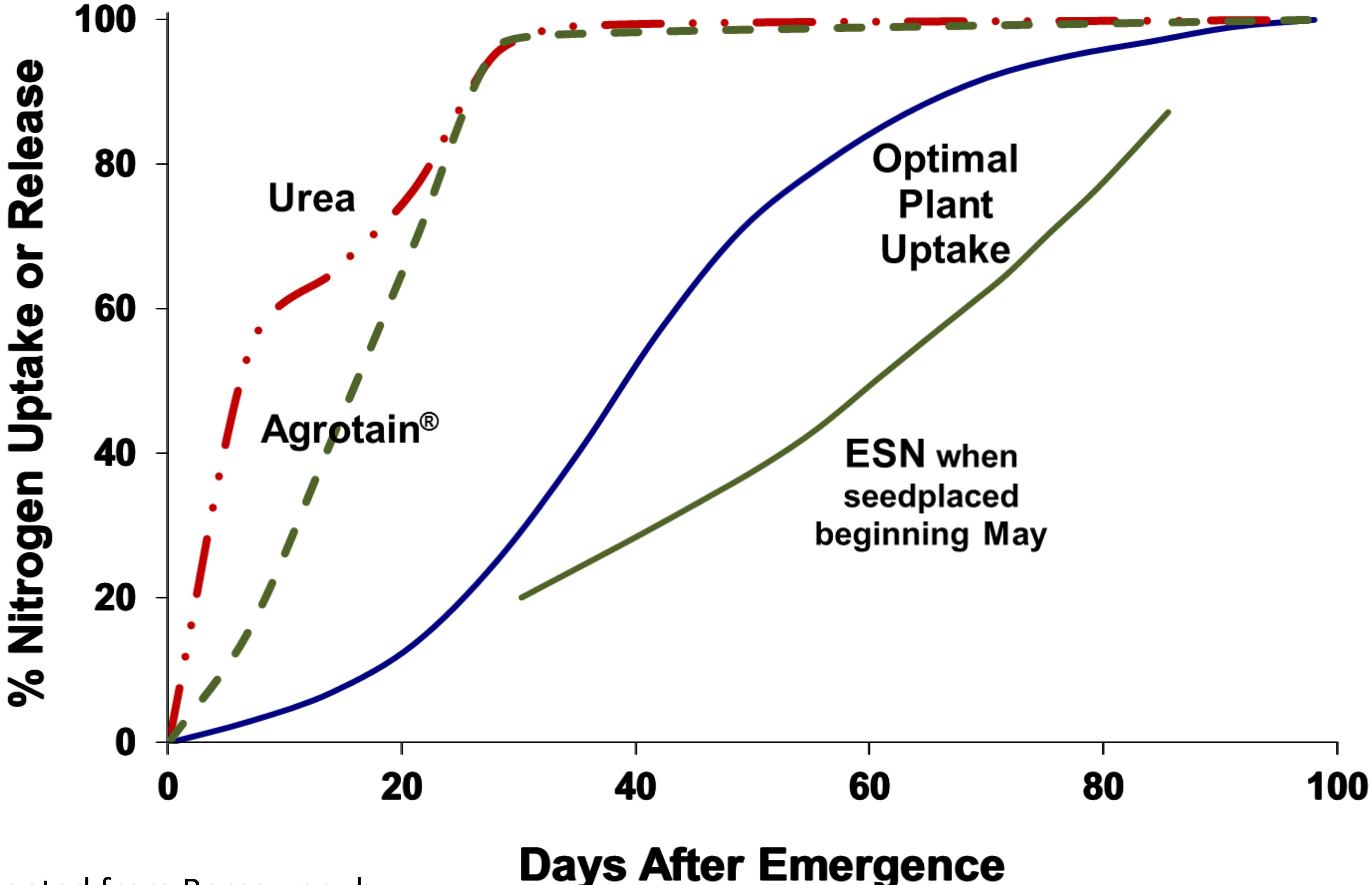


Plant N uptake, ideal N release, urea N release



Urea N release data from Engel, unpub.

EEFs strive to supply N closer to plant uptake curve



ESN adapted from Beres unpub
Agrotain N release from Engel, unpub

Different N sources have different volatilization and leaching loss potential

Source	*POTENTIAL* loss compared to urea: Volatilization	*POTENTIAL* loss compared to urea: 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)	≈	
Combinations (SuperU)	less	
Controlled release polymer coated (ESN)	less	
Slow release (Nitamin, N-Sure, N-Demand)	≈	

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	***POTENTIAL* loss compared to urea**	
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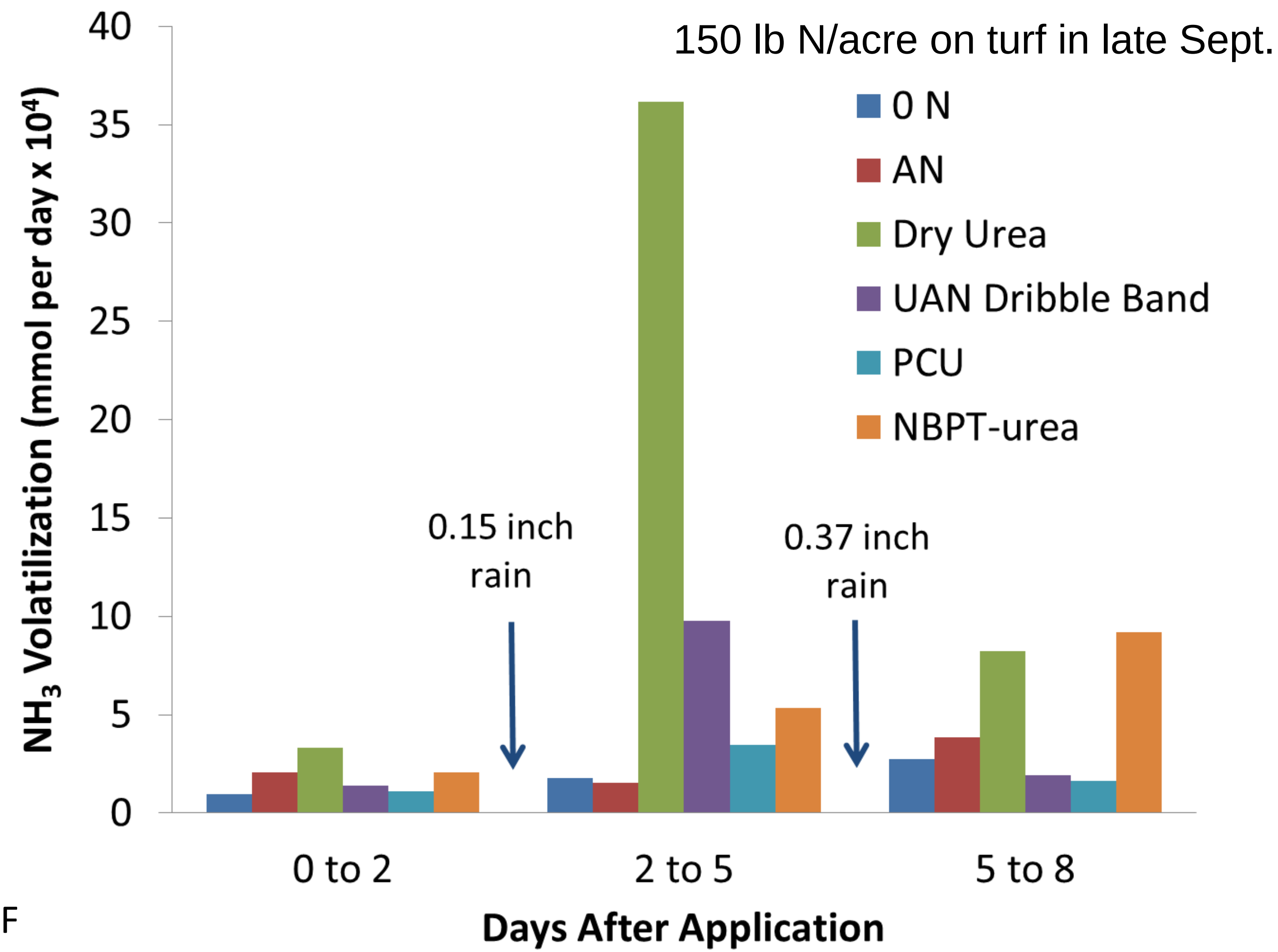
Effect of N source on volatilization



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

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

- Based on 17 studies:

  Average N lost from urea: 18.1%

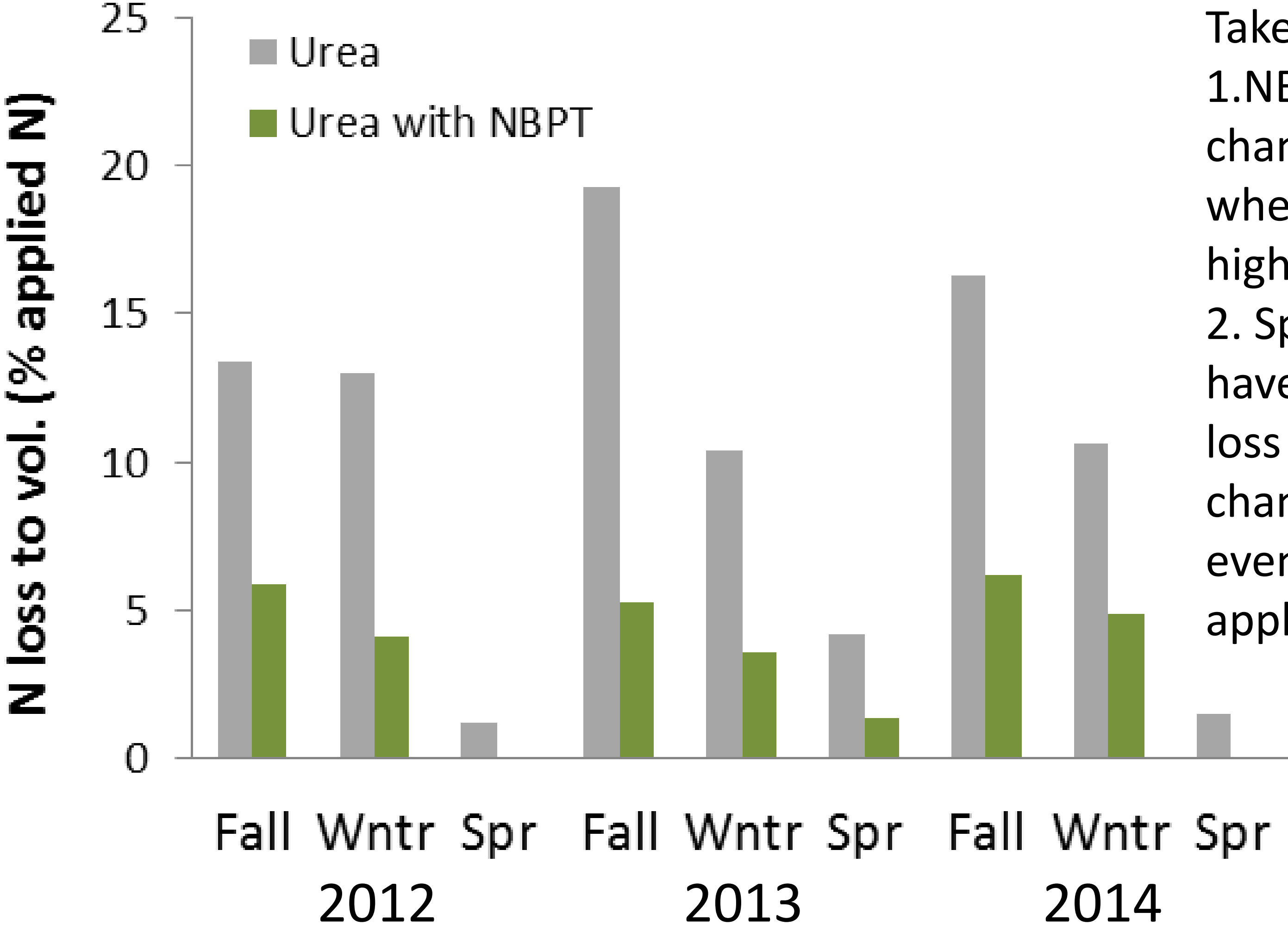
  Average N lost from NBPT-urea: 6.5%

- Worst case-conditions for loss:

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

  snow covered surface (Fertilizer Fact #60)

NBPT (Agrotain®) reduces N loss



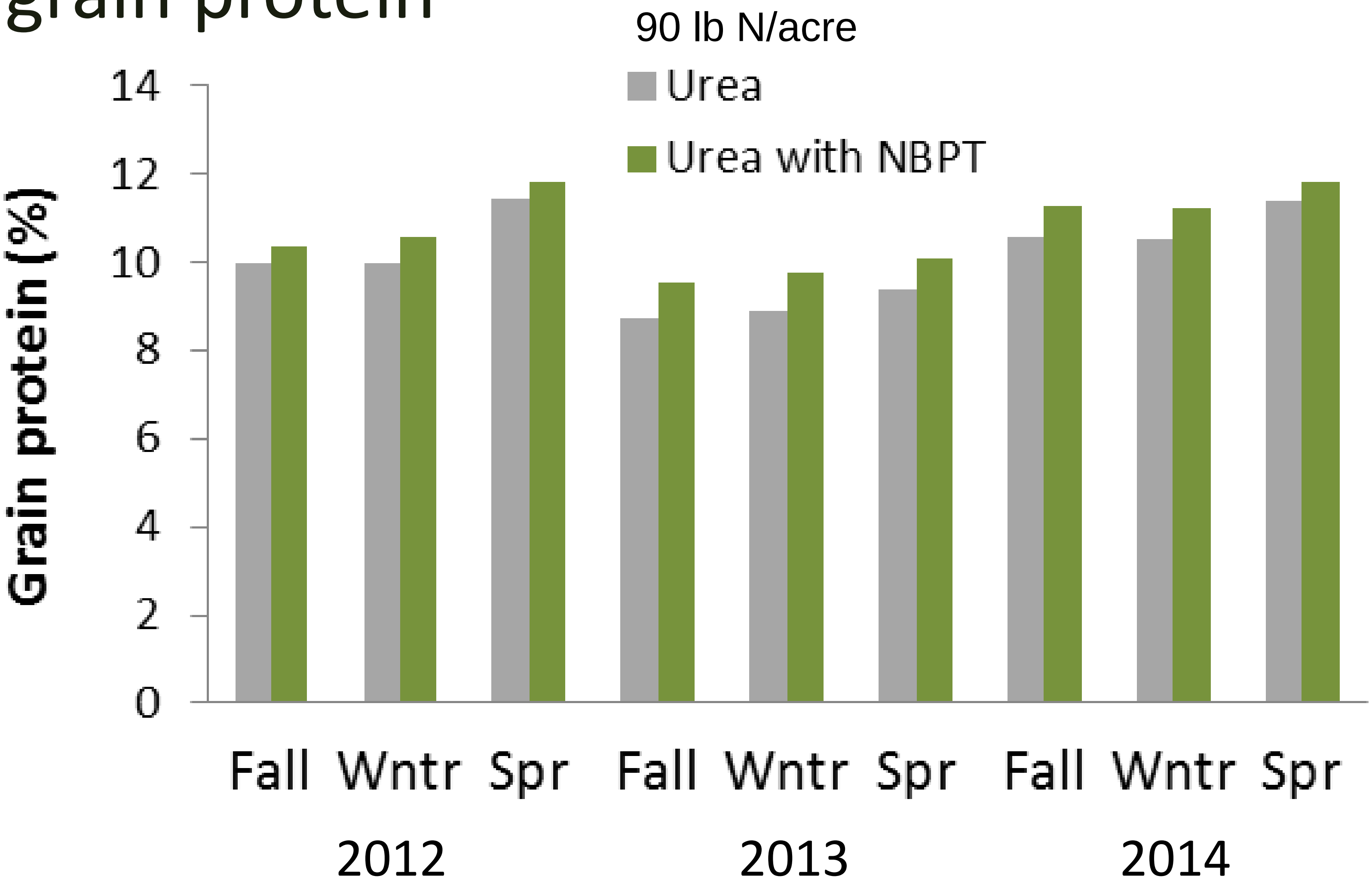
Take home:

1. NBPT has best chance of success when used during high risk conditions.
2. Spring applications have less potential for loss because higher chance for large rain event after application.

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 ≈ 63%

NBPT with broadcast urea can increase WW grain protein



NBPT sig increased protein from 0.4 to 0.8% points in all years.
NBPT only increased yield with fall broadcast in 2012.

Coffee Creek, MT
Engel unpub data

Source, placement and timing study at Moccasin

- Worst-case scenario for leaching – soils ~ 18” deep. 21.6 inches of precipitation from Oct 2010 to Sep 2011
- Placement: Broadcast, seed-placed
- Sources (selected, for all see Fertilizer Fact 62):

  Regular urea

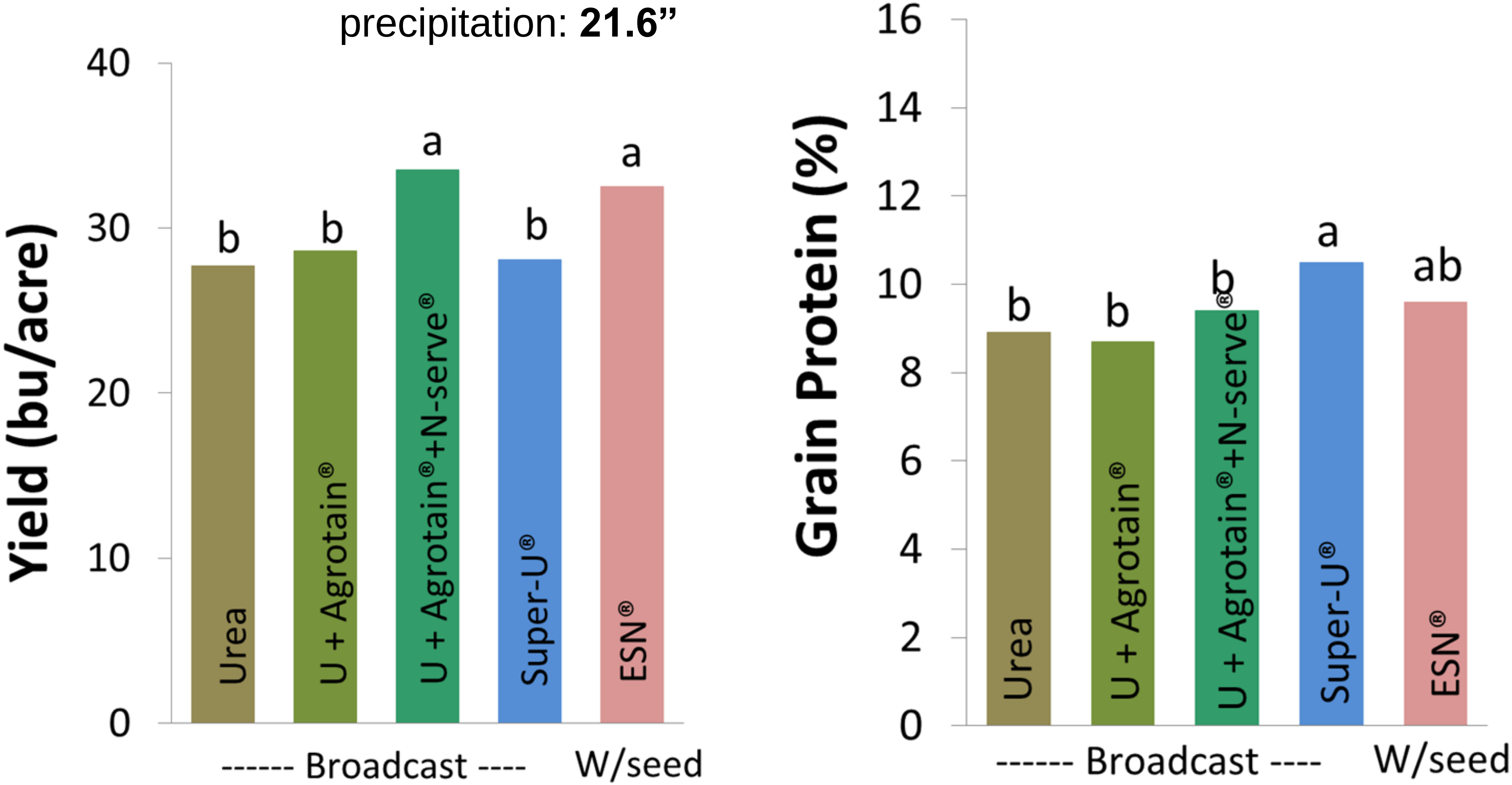
  Super U (w/ urease and nitrification inhibitors)

  Urea mixed with Agrotain and N-serve (nit inhib)

  ESN with seed (only in fall)

Effect of source and placement (fall applied) on WW grain yield under high risk leaching conditions

Oct 2010 through Sept 2011 precipitation: **21.6"**

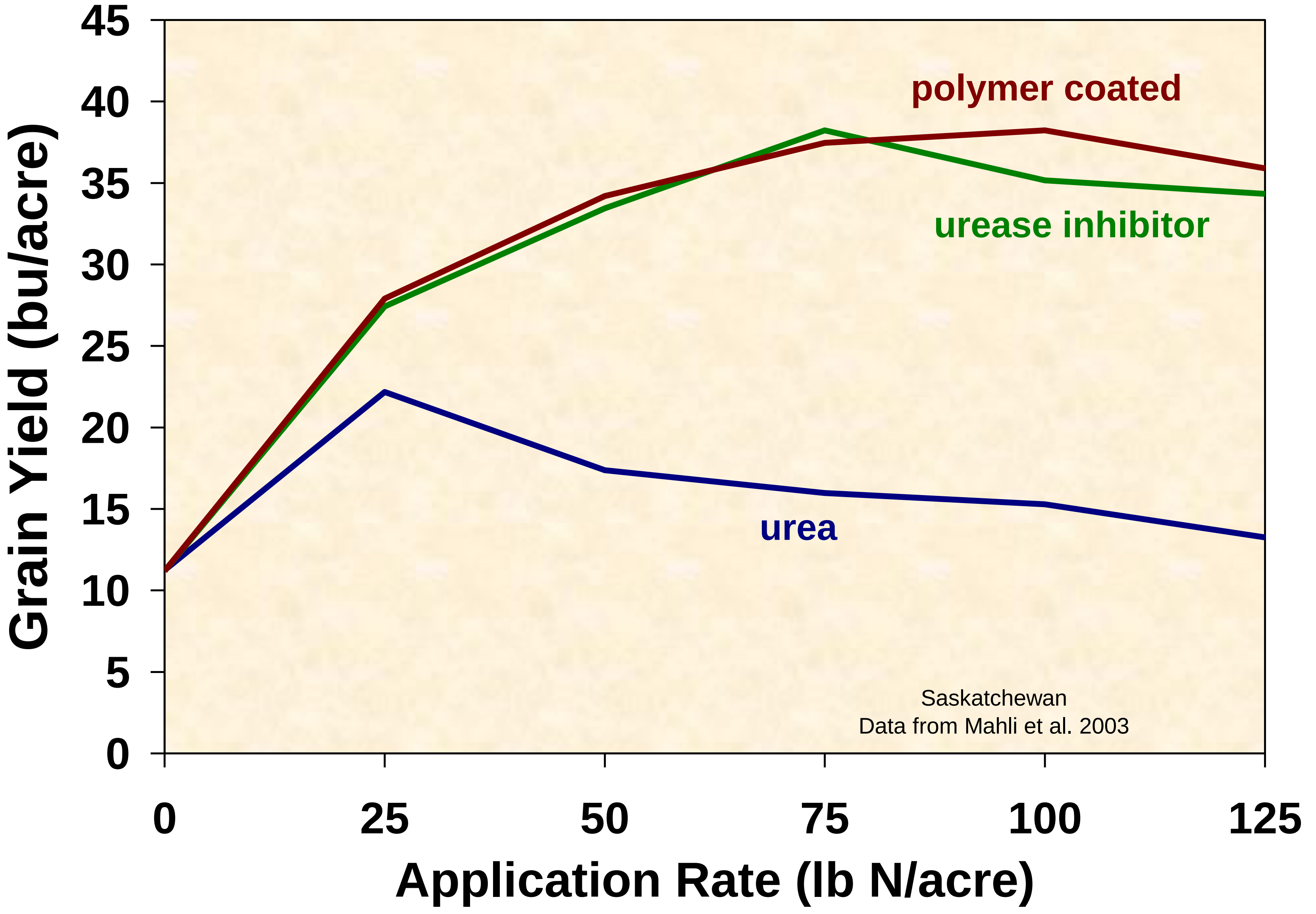


Fertilizer Fact 62, Moccasin, MT

Take home messages of Moccasin study

- In wet year, enhanced efficiency fertilizers produced similar or higher yields and protein than conventional urea
- In dry year, yields and protein were similar for EEFs and conventional urea (data not shown), so EEF net revenue would be worse.

EEFs increase safe rate with seed



Slow- and controlled-release fertilizers for the northern Great Plains

- No consistent benefit shown (Walsh et al 2013)
- Fall broadcast PCU may increase yield over fall broadcast conventional urea, especially in a wet year when urea may leach overwinter
- If apply in fall to reduce spring work load (and save the marriage), then extra cost might be worth it
- PCU release tends to be too slow in late winter early-spring applications
- PCU allow for higher rate seed-placed

Dry vs. liquid N: Foliar N as an in-season boost to yield and grain protein

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

- 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

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

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

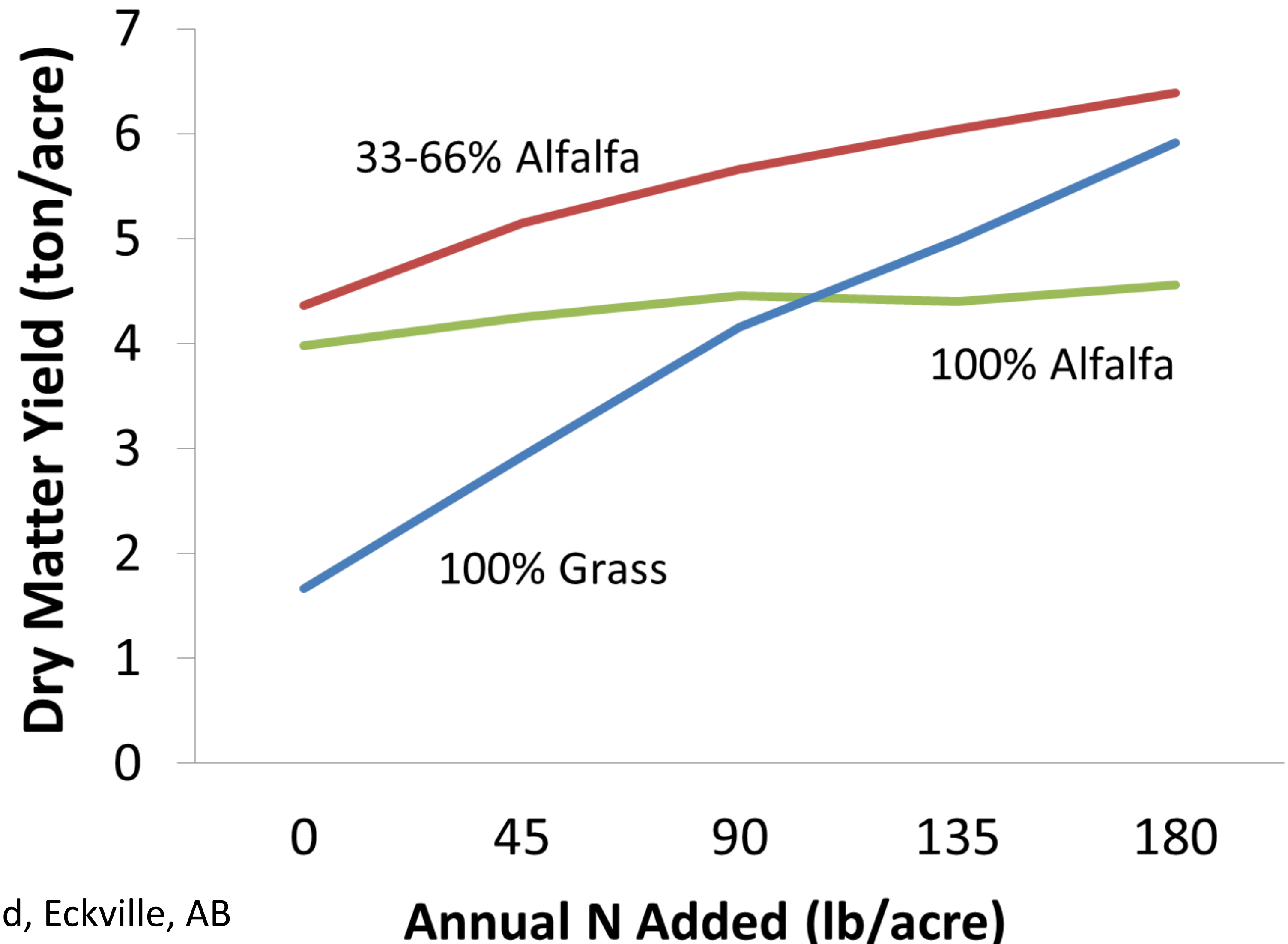
  http://fieldcrop.msu.edu/sites/fieldcrop/files/E2602.pdf

  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, but may not translate to increased yields (Phillips 2004)

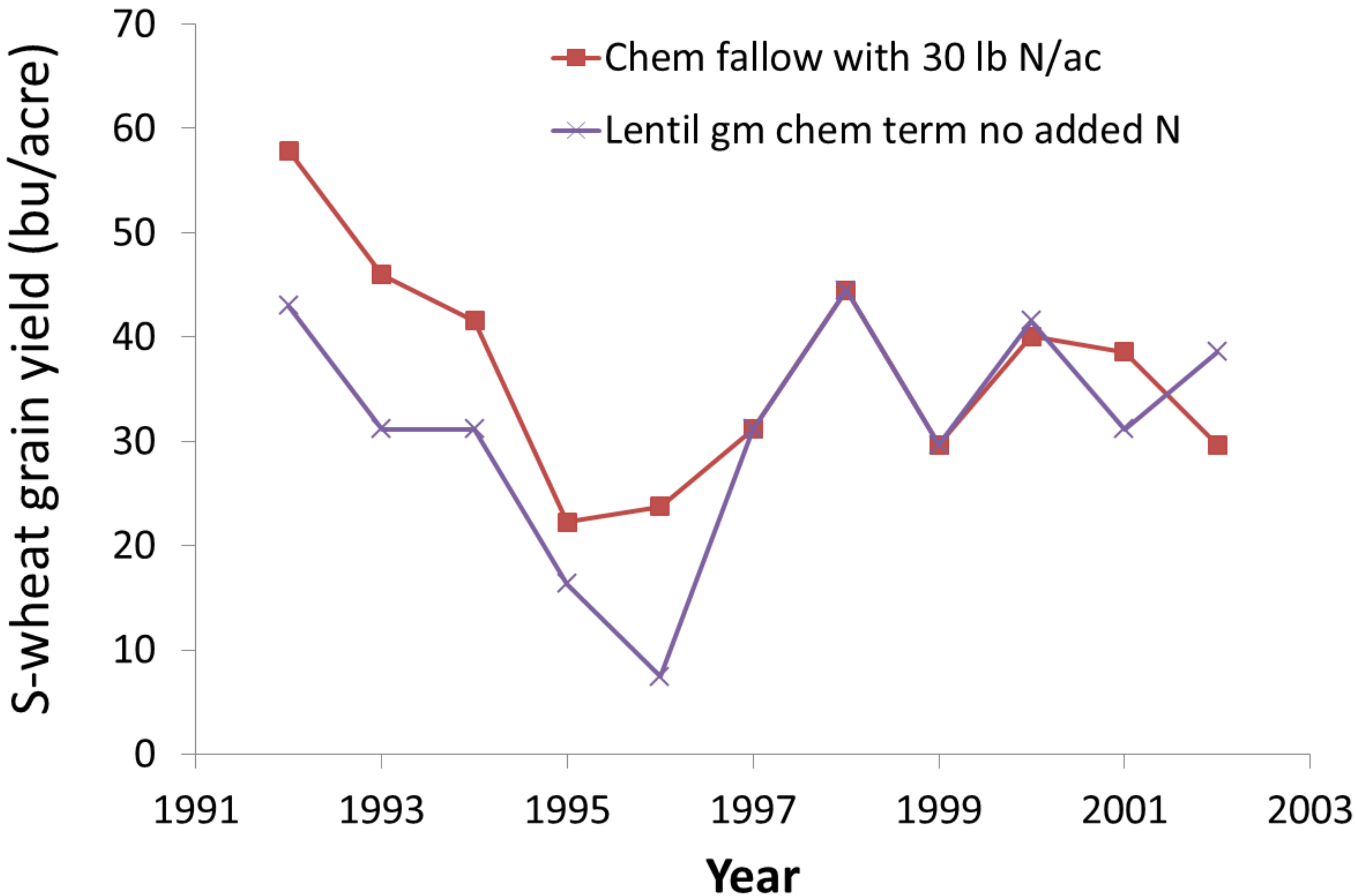
Questions?

Legumes benefit companion crop and total yield at all N rates



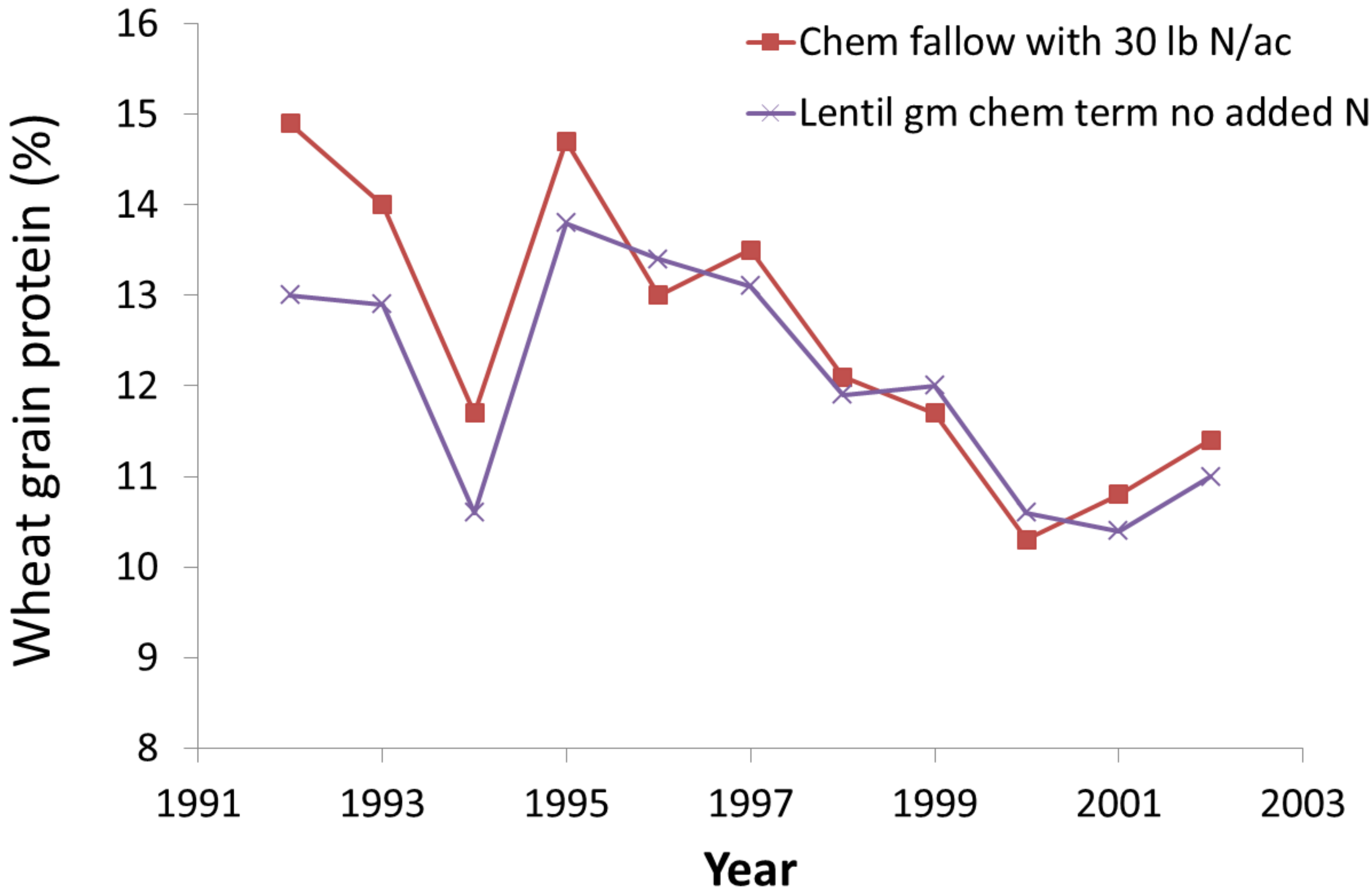
Dryland, Eckville, AB
Malhi et al. 2004

Pulse/legume rotations: A potentially very economical N source, in the long run.



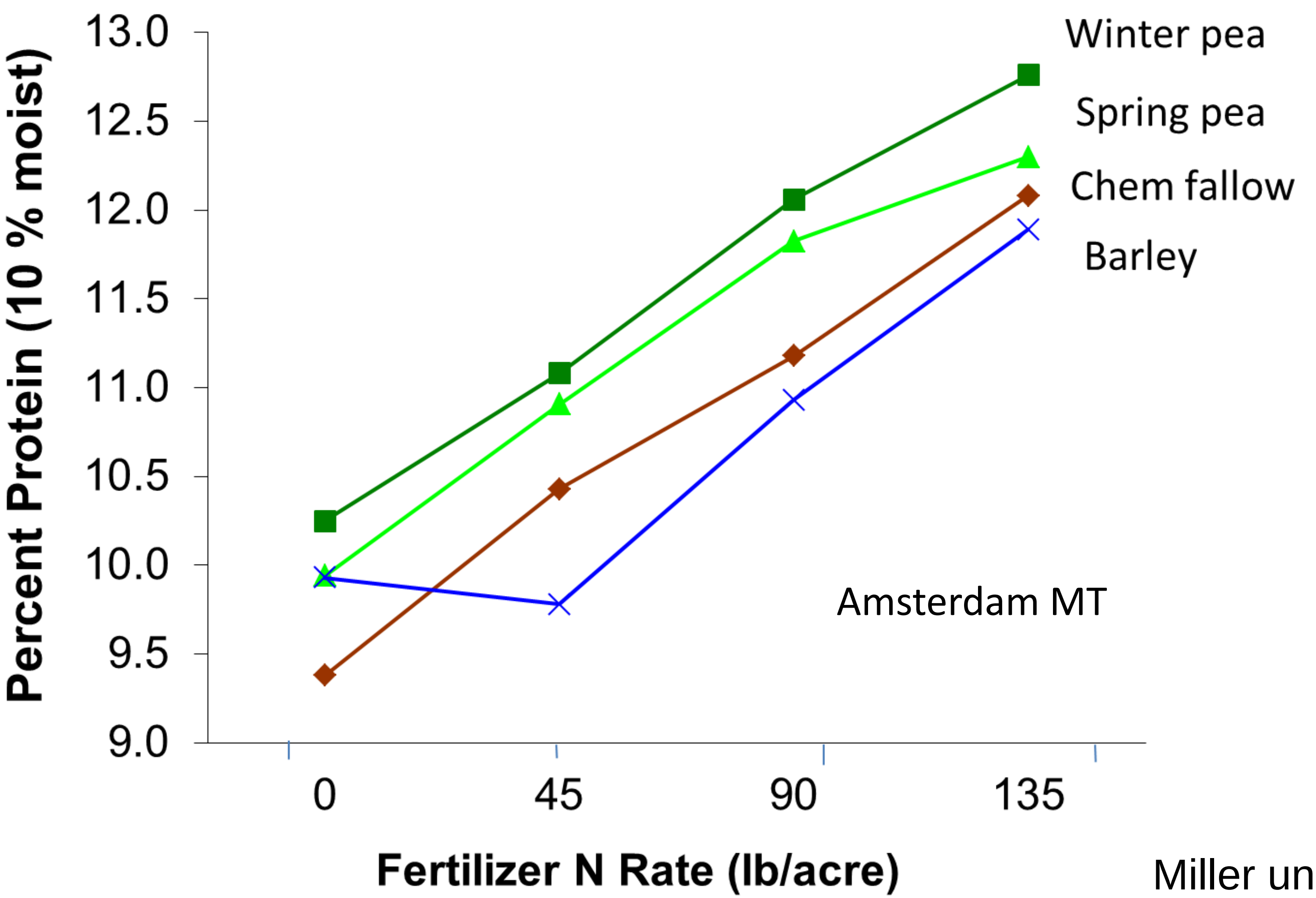
Allen et al., 2011, Culbertson

Pulse/legume rotations benefit protein before yields



Allen et al., 2011, Culbertson

Do legumes grown prior to winter wheat increase grain protein?

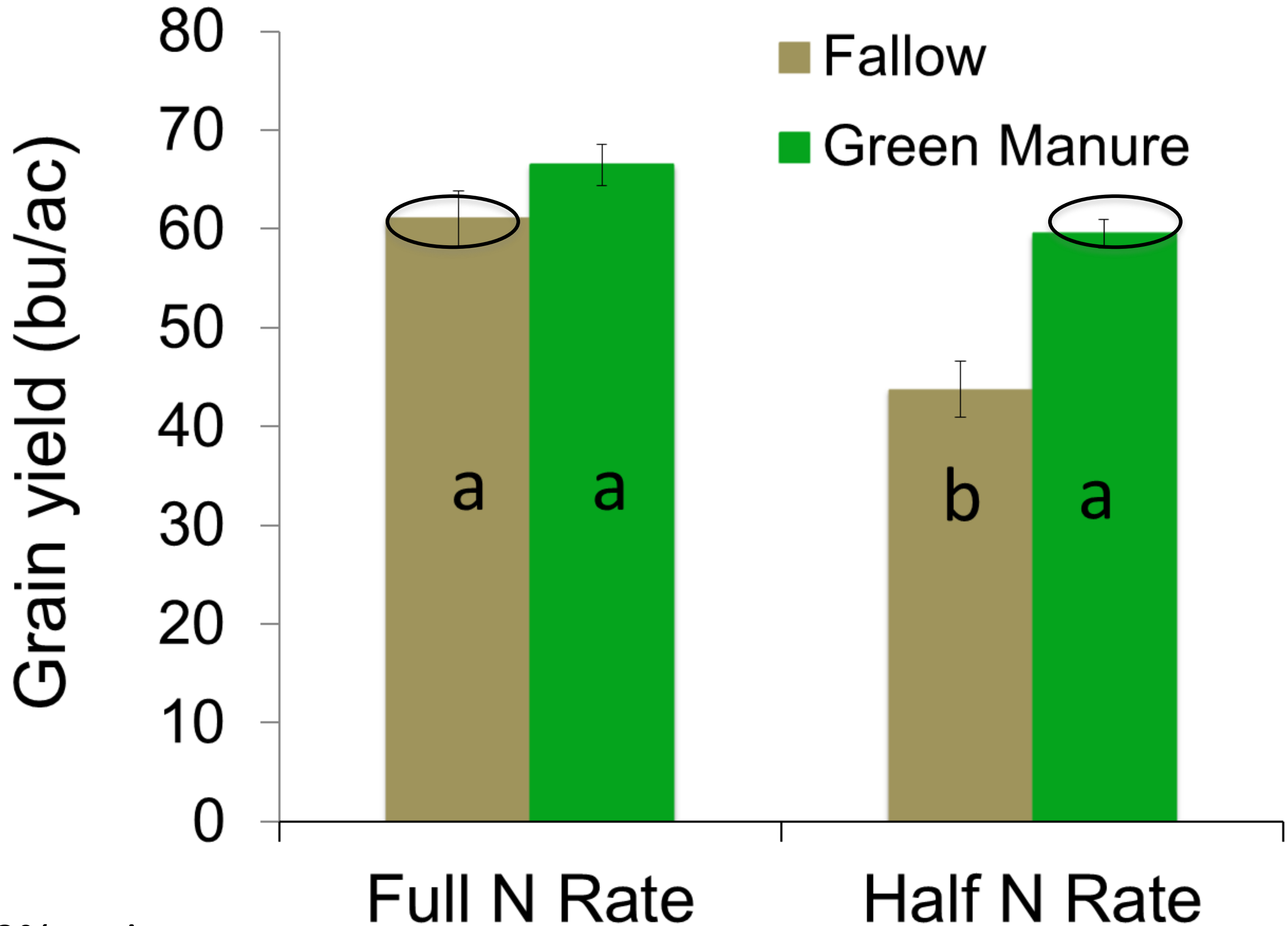


Miller unpub data

Legume green manure (LGM) study near Bozeman

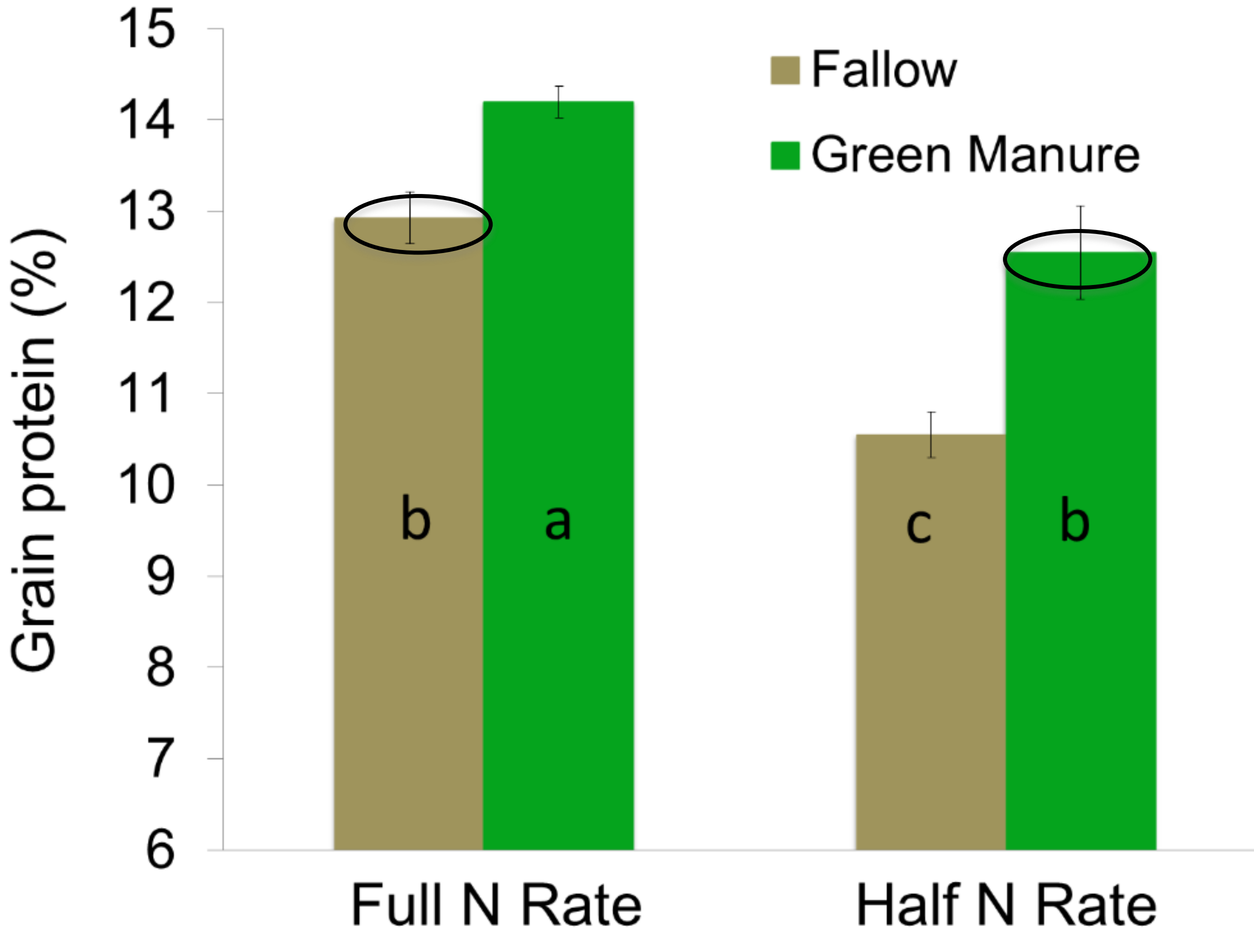
- No-till pea forage/legume green manure-wheat vs. fallow-wheat
- Pea forage grown in 2003, 2005, 2007 and pea green manure grown in 2009, terminated at full pod
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years.
- 2 N rates: Full (3 lb available N/bu) and ½
- *No wheat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

LGM study near Bozeman: Grain yield in 8th year (2010)



@ 12% moist

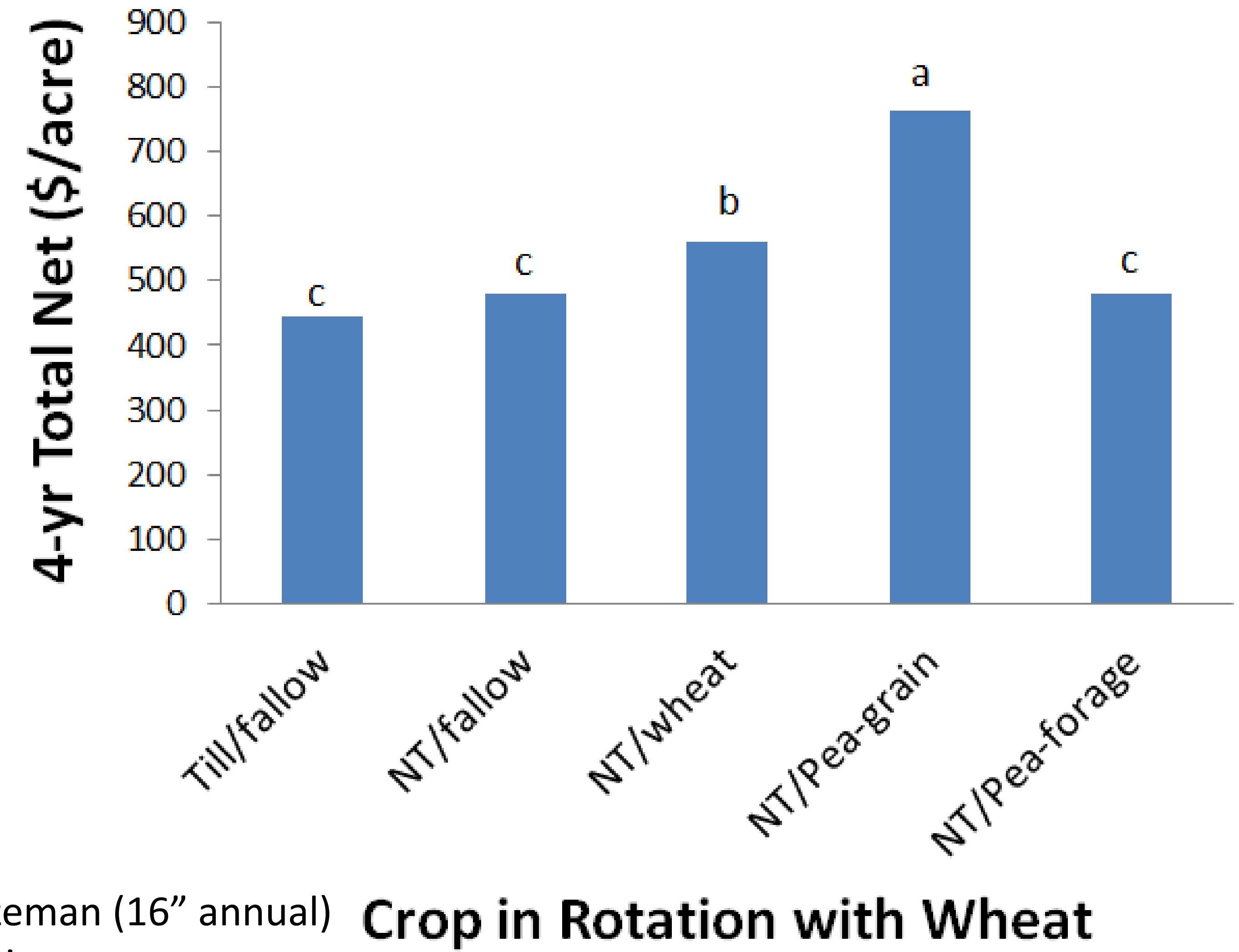
LGM study near Bozeman: Grain protein in 8th year



* 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

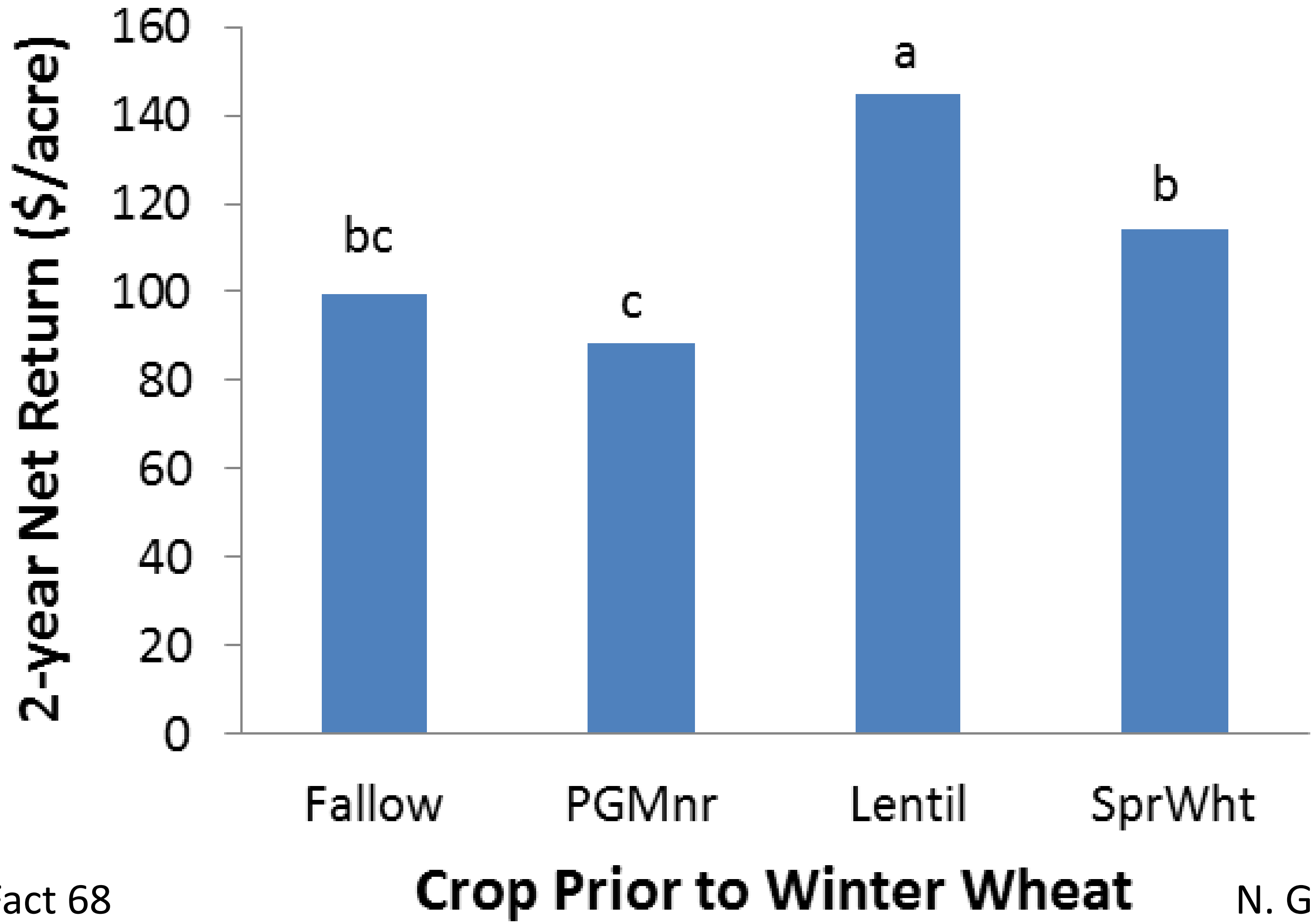
Pea cover crop after 4 CC-wheat rotations saved **124 lb N/ac** compared to fallow.

Economics of integrating pulse crops into wheat systems



West of Bozeman (16” annual)
Miller et al. in press

2-year net return (2012 – 2013) after 1 rotation at Big Sandy



Fertilizer Fact 68

N. Gray helped soil sample this!

N credit from pulse/legumes

- N Credit = The amount of fertilizer N to back off from a standard recommendation (e.g, lb N/bu of yield goal) when previous crop is a pulse grain, *based on spring soil sampling*.
- Adjust yield goal – will be lower after legumes than fallow due to water use, but higher than after small grain

Estimated N credit from pulse/legume

- Grain pulse grown once: 10 lb N/ac
- Grain pulse grown 3 or more times on same field in 10 year period: 20-30 lb N/ac
- Legume cover crop grown once: 20-30 lb N/ac (higher if moist)
- Legume cover crop grown 3 or more times: 30-50 lb N/ac
- If fall soil test (rather than spring), increase all of above by 10 lb N/ac (due to overwinter N mineralization)

Example N rate calculation (based on Big Sandy study results)

	Fallow	Grain pulse grown 1x	Legume cover crop grown 1x
WW yield goal (bu/ac)	45	35	45
Spring soil N (lb/ac)	80	55	65
Total soil N recommended (bu/ac x 2.6 lb/bu)	45 x 2.6 = 117	35 x 2.6 = 91	45 x 2.6 = 117
N credit (lb/ac)	0	10	25
Fertilizer N (lb/ac)	117-80-0=47	91-55-10=26	117-65-25=27

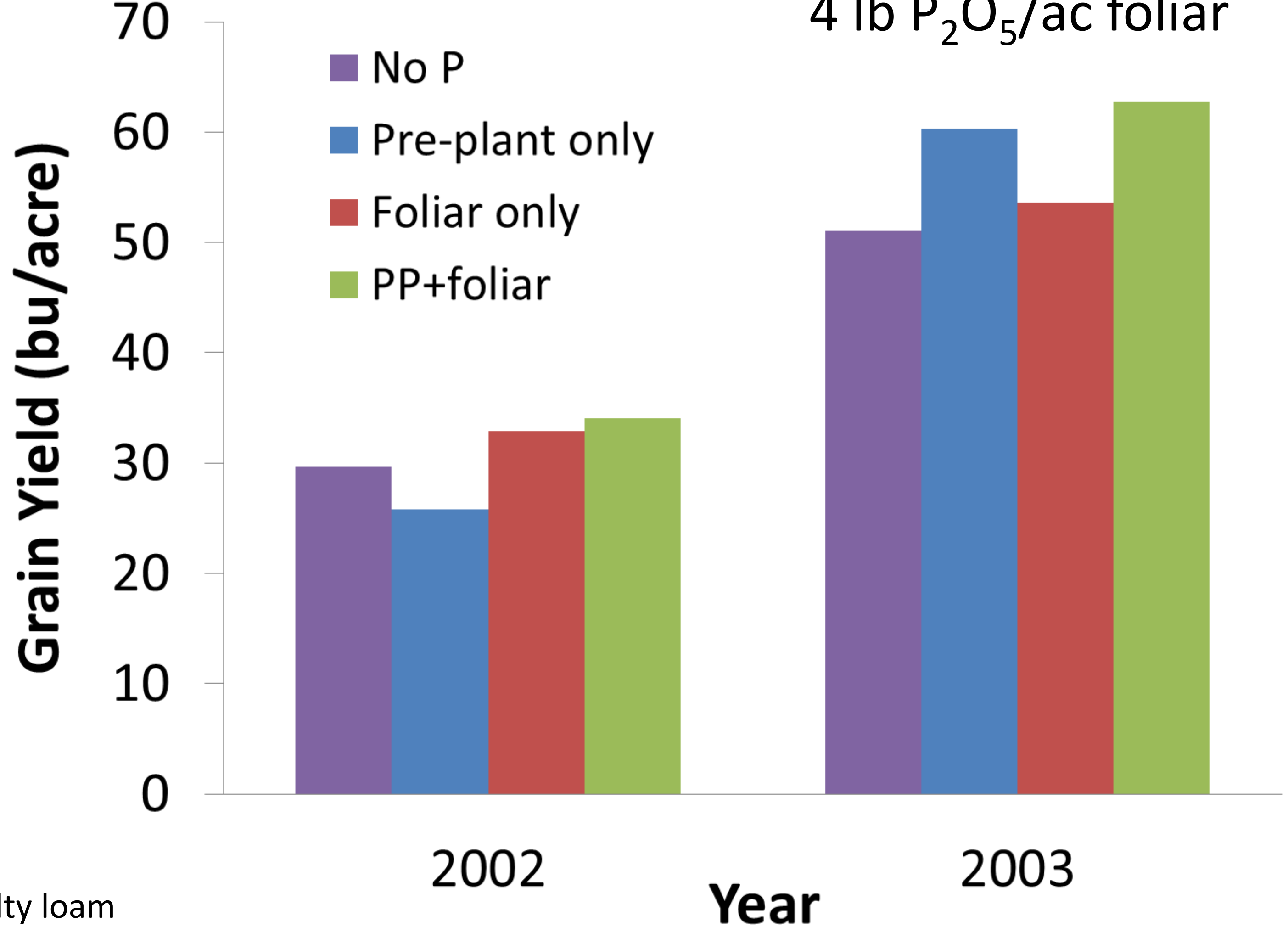
Questions?

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 products Avail® or Carbond® for cereals in Montana and the western U.S. Inconsistent results.

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

P with S and Zn

- MESZ – 12-40-0-10 plus Zn in a single granule
  - Half of S as sulfate, half as elemental-S
  - 1% Zn
  - Potential benefit of having more even distribution of nutrients and nutrient mix available to plant
  - Work in Ontario and Iowa on corn, potatoes in Minnesota found no benefit of MESZ as starter over using Urea+MAP+Zn. If S lacking, then add that too.
  - Producer needs to determine if convenience is worth the extra cost

Conventional/chemical vs. Plant/manure compost

<u>Conventional</u>

- No carbon
- Easy to store
- Higher nutrient concentration
- Custom formulated
- Easy to use
- Liquid or solid available

<u>Manure or Manure Compost</u>

- Bulkier
- Nutrient content low but diverse
- Nutrient content difficult to quantify
- Supplies organic matter

Both are available in forms that supply specific nutrients (e.g., bone/blood meal for P)

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
- Conduct strip trials to test a product on your farm.
- See *Enhanced Efficiency Fertilizers* for partial list of those available and mechanism (http://landresources.montana.edu/soilfertility/publications.html)

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

Ex: How much ammonium sulfate (21-0-0-24) is needed to supply 100 lb N/acre?

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

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

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 (recall \$90/acre for ammon sulfate)

Other considerations, e.g.:

- Constraints on timing, placement, equipment

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
  - Likely release too slow when spring applied to cereals
  - 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

For more information

Fertilizer Facts 45, 51, 59, 60, 62, 63 & 66:
http://landresources.montana.edu/fertilizerfacts

Extension Publications*:* http://landresources.montana.edu/soilfertility/

Factors Affecting Nitrogen Fertilizer Volatilization (EB0208)

Management to Minimize Nitrogen Fertilizer Volatilization (EB0209)

Enhanced Efficiency Fertilizers (EB0188)

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

Cover crops research website
http://landresources.montana.edu/soilfertility/covercrops.html

Questions?