Nitrogen Management for Grain and Protein

MABA Convention

January 29, 2016

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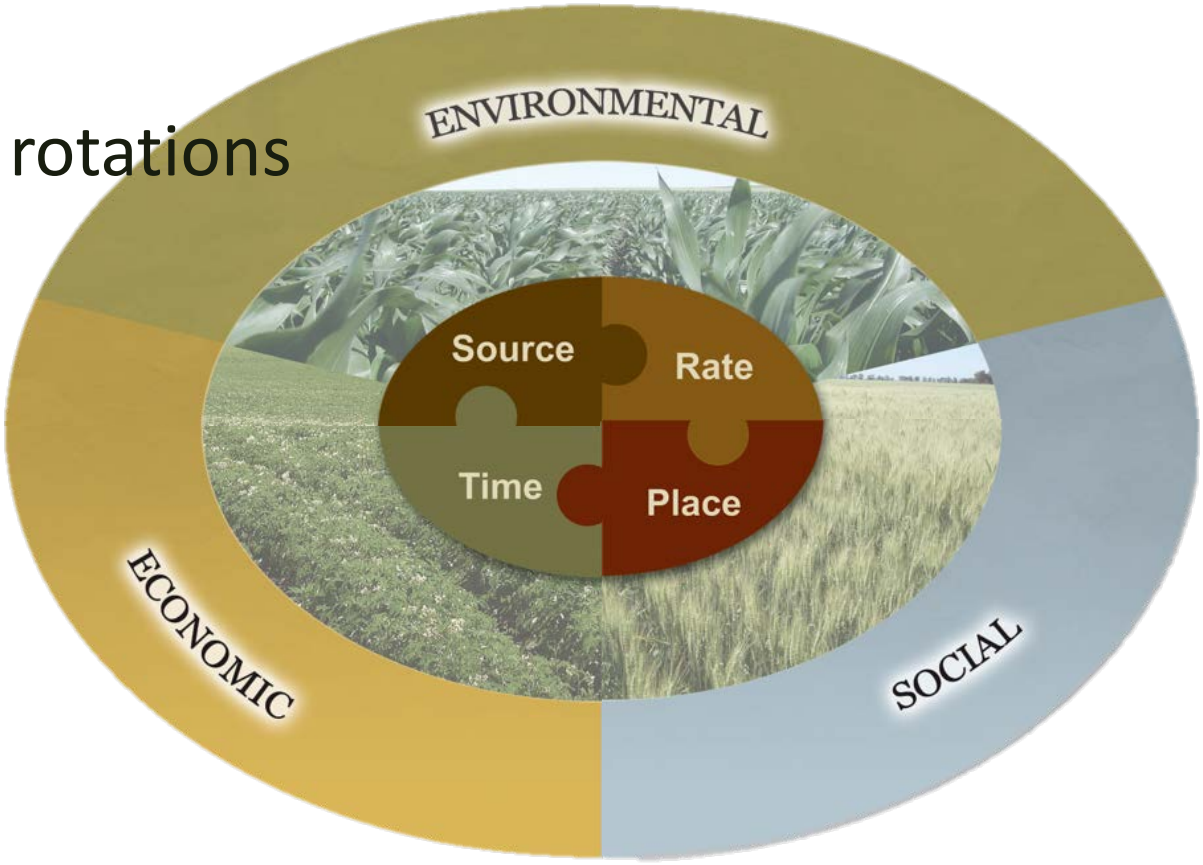
MONTANA STATE UNIVERSITY

MSU Soil Fertility Extension

Todays objectives – 4Rs of nitrogen

- Steps towards calculating an N rate
- Timing
- Source & legume rotations
- Placement



Realistic yield goal

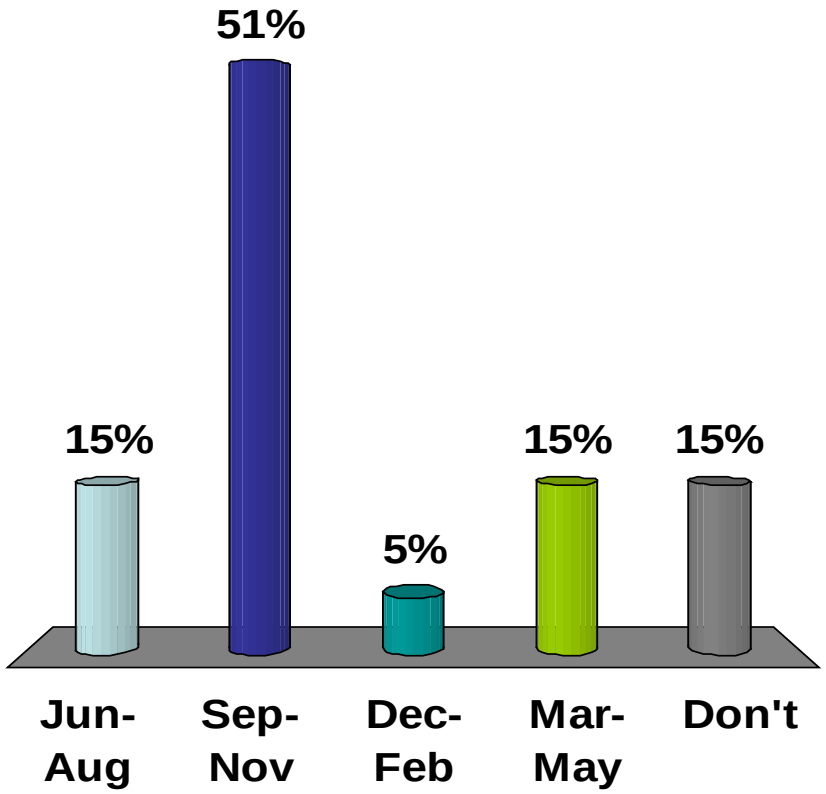
- Use variety selection tools
- Past yields indication of future performance
- Having ability for in-season N application allows conservative yield estimate for pre-plant rate

Residual soil N: Timing of soil sampling

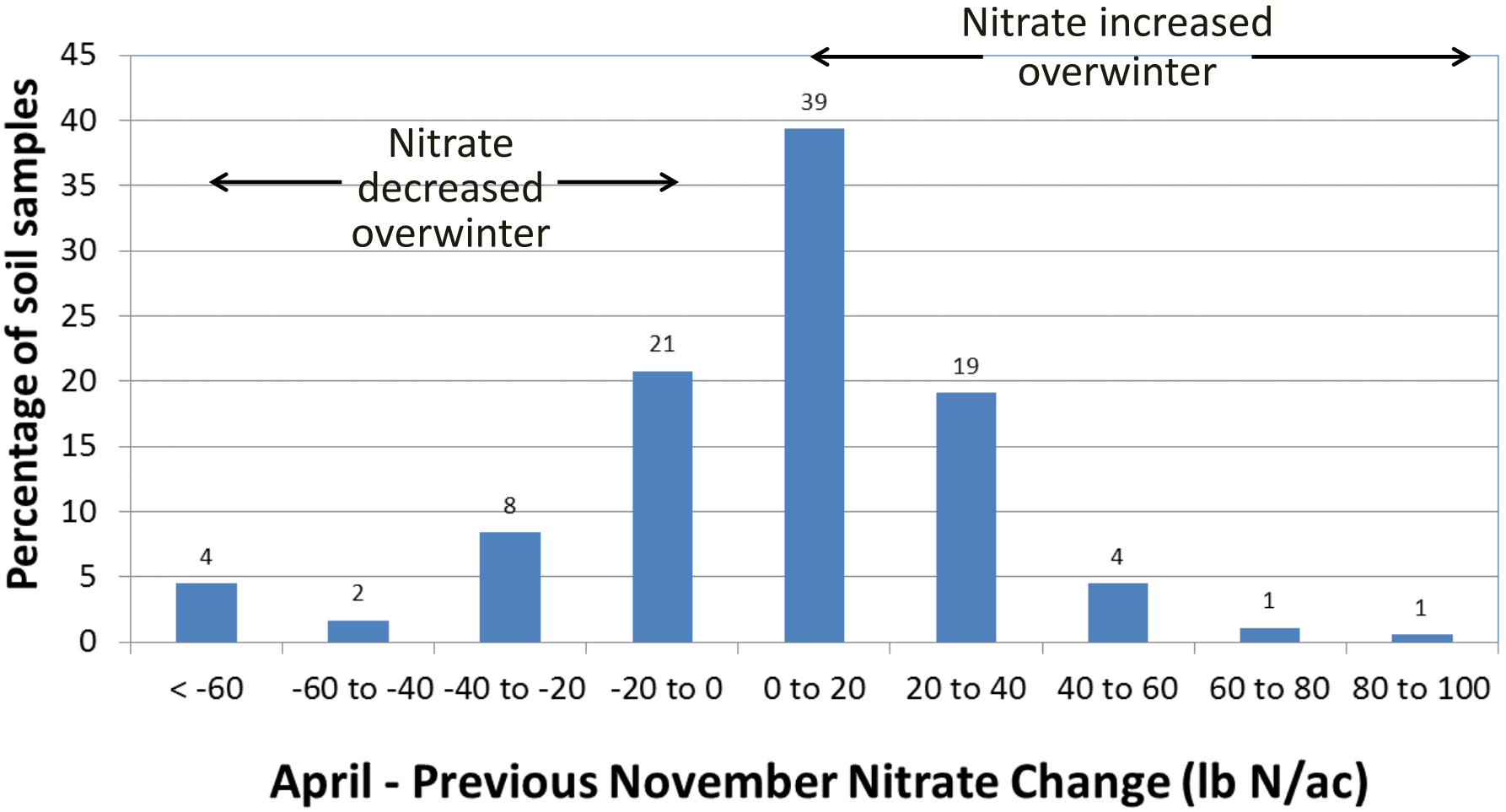
- Nitrogen fertilizer guidelines are based on spring soil samples for nitrate in Montana
- BUT, most sampling in MT occurs from late summer to late fall

Based on 35 'clicker' responses at MABA 2010 Convention, when asked when crop advisers do most of their soil sampling:

Why is this a potential problem?



Soil nitrate can increase or decrease from November to April, Montana data based on 180 samples (Jones et al. 2011)



Fall soil tests can lead to over or under-fertilized fields

High N crop residue and/or high O.M.

Mineralization

Over fertilized

Over winter

High Precip

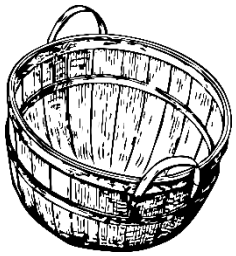
High N on shallow or coarse soil

N leaching (or N_2 gas losses?)

Under fertilized

Compare fall with spring a few times to see patterns of loss or gain for given pastures/rotation

Historical average AVAILABLE N rate guideline: when soil organic matter = 2%



- Dryland winter wheat
  2.6 lb N/bu @ 12.5% protein

- Spring wheat
  3.3 lb N/bu @ 14% protein

- MSU N rate calculation tool takes into account fertilizer costs, grain prices, and protein discounts to optimize net revenue.
  http://www.msuextension.org/econtools/nitrogen/index.html

Evaluate N management

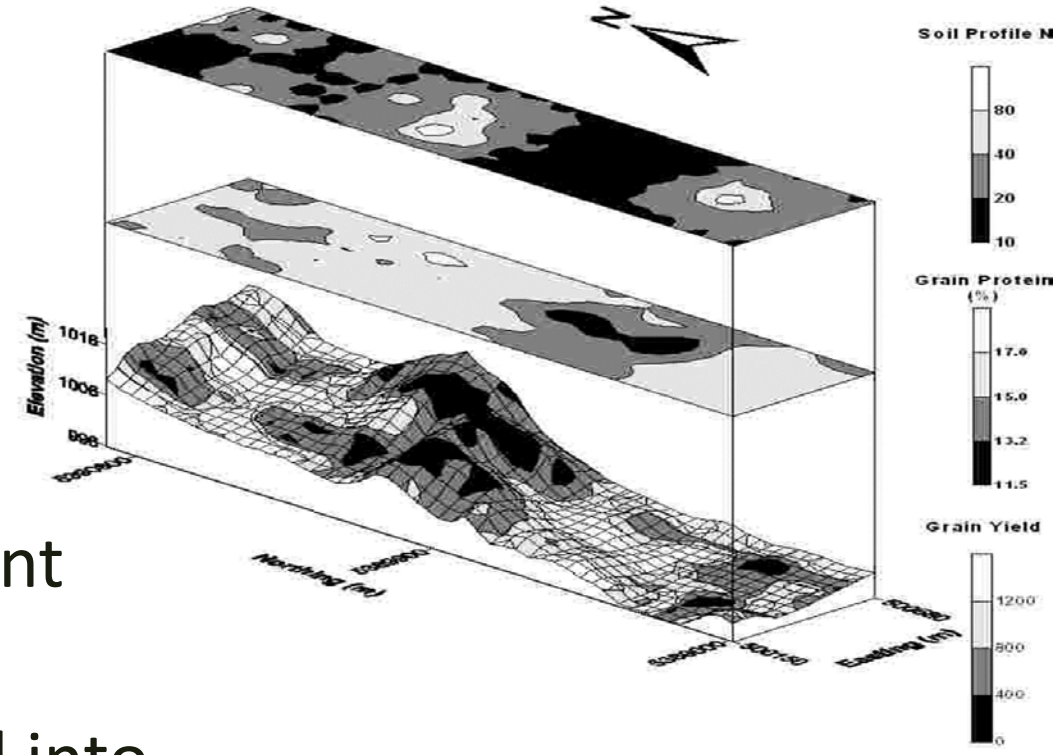
- If winter wheat protein < 12.5%, likely yield limited by lack of N
- If spring wheat protein < 13.2%, likely yield limited by lack of N
- To increase wheat protein by 1 point, apply

  ~0.75 lb N/bu before flower for dryland

  ~ 0.5 lb N/bu for irrigated

For more detail, see "*Practices to increase wheat grain protein*" EB0206.

Variable rate N application (Zone or site specific farming)



- At this time economic advantage is inconsistent (and hard to study)
- At simplest, divide field into zones of low, med, high productivity
- NDSU has bulletin series on Zone farming SF1176 series at www.ag.ndsu. edu/publications

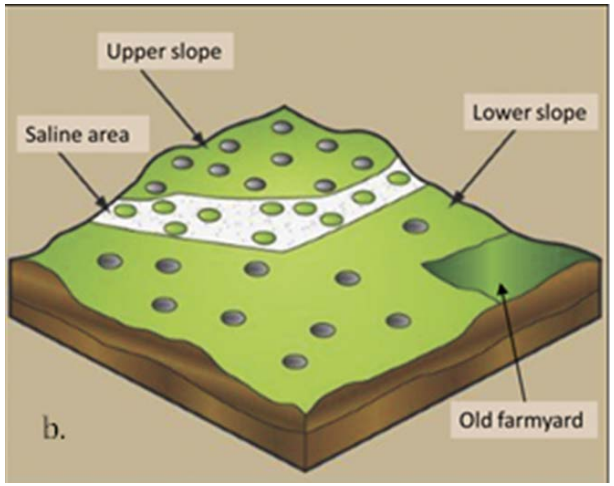


Image adapted from IPNI 2012

N rate adjustments

- Stubble: small grains stubble high carbon to N (C:N). Adjust fertilizer N up or down?

  10 lb N/1000 lb stubble up to 40 lb N

- Fallow: assume ½ of stubble has decomposed over previous year when adjusting

- After legume rotation:

  Adjust fert up or down?

  Legumes credit (add) N

Crop	N credit (lb N/acre)
Alfalfa	40
Annual legume 1 x	~10
Annual legume >3 x	~20

N rate adjustments (cont)

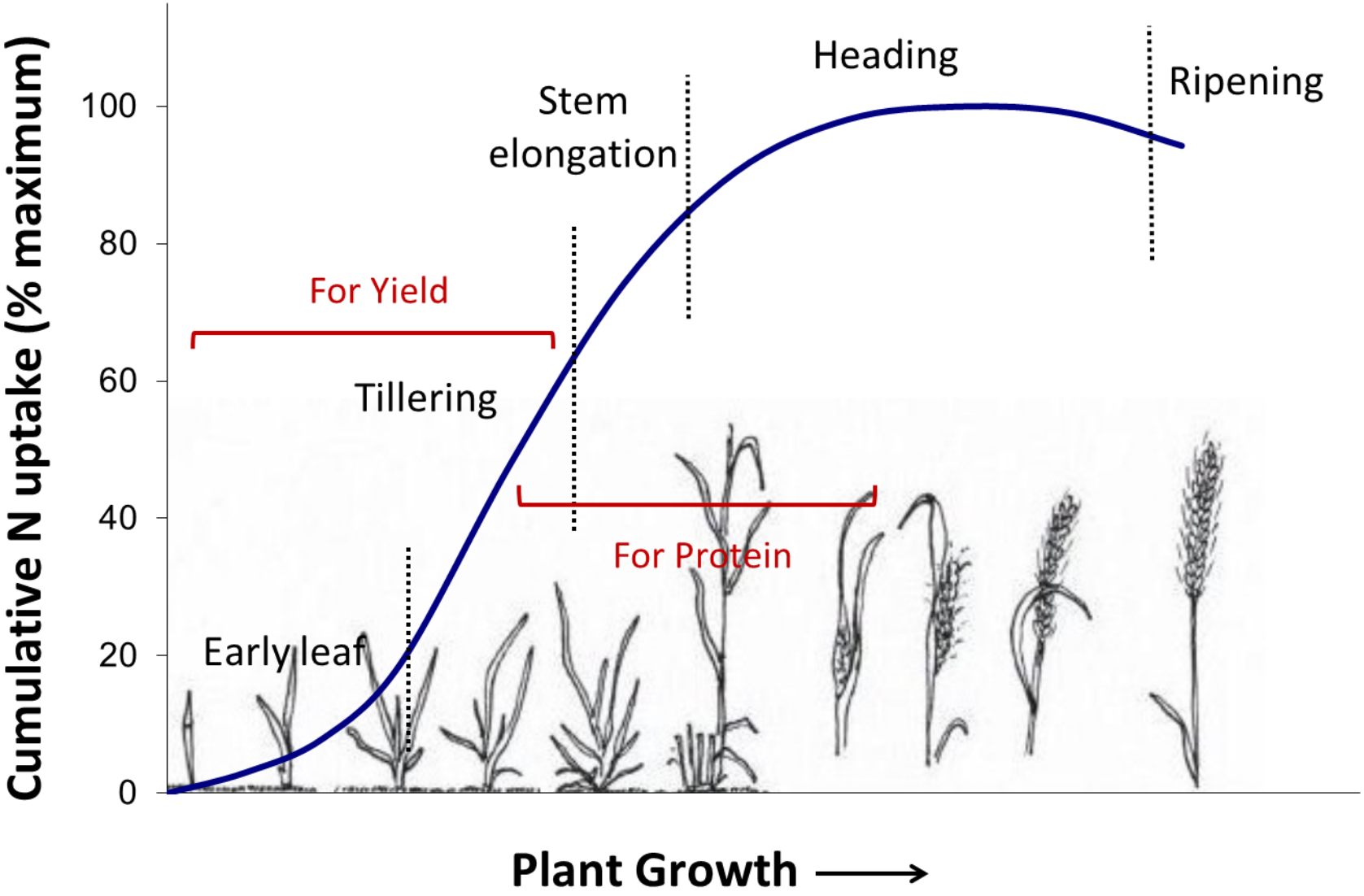
- SOM
  - <1% SOM, add 15-20 lb N/acre
  - >3% SOM, reduce 15-20 lb N/acre

- Tillage – No-till may require extra N for 6 to 15 years. Finer soils require longer end.

Questions?

On to *Timing*

N uptake by wheat for yield and protein

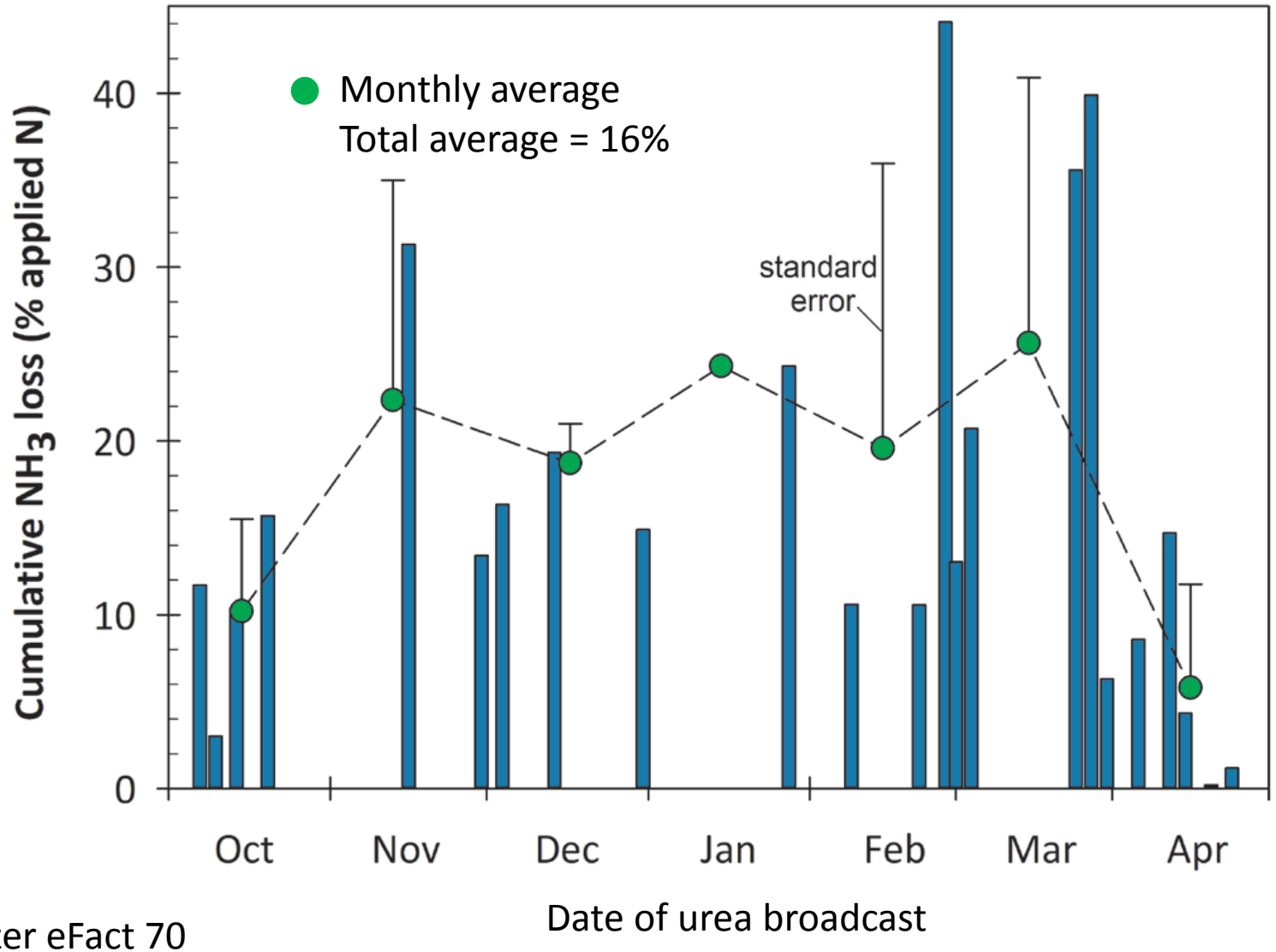


Timing depends on source

- Readily available [urea (46–0–0), urea ammonium nitrate (28–0–0)]
  - shortly before seeding up to mid-tillering
- Slowly available (Manure, slow-release N)
  - take time to become available
  - apply well before needed – e.g., fall

Timing can affect volatilization loss from urea

Worst case: broadcast on moist surface followed by light scattered precipitation



Fertilizer eFact 70

Use Nutrient Uptake figure to time top-dress

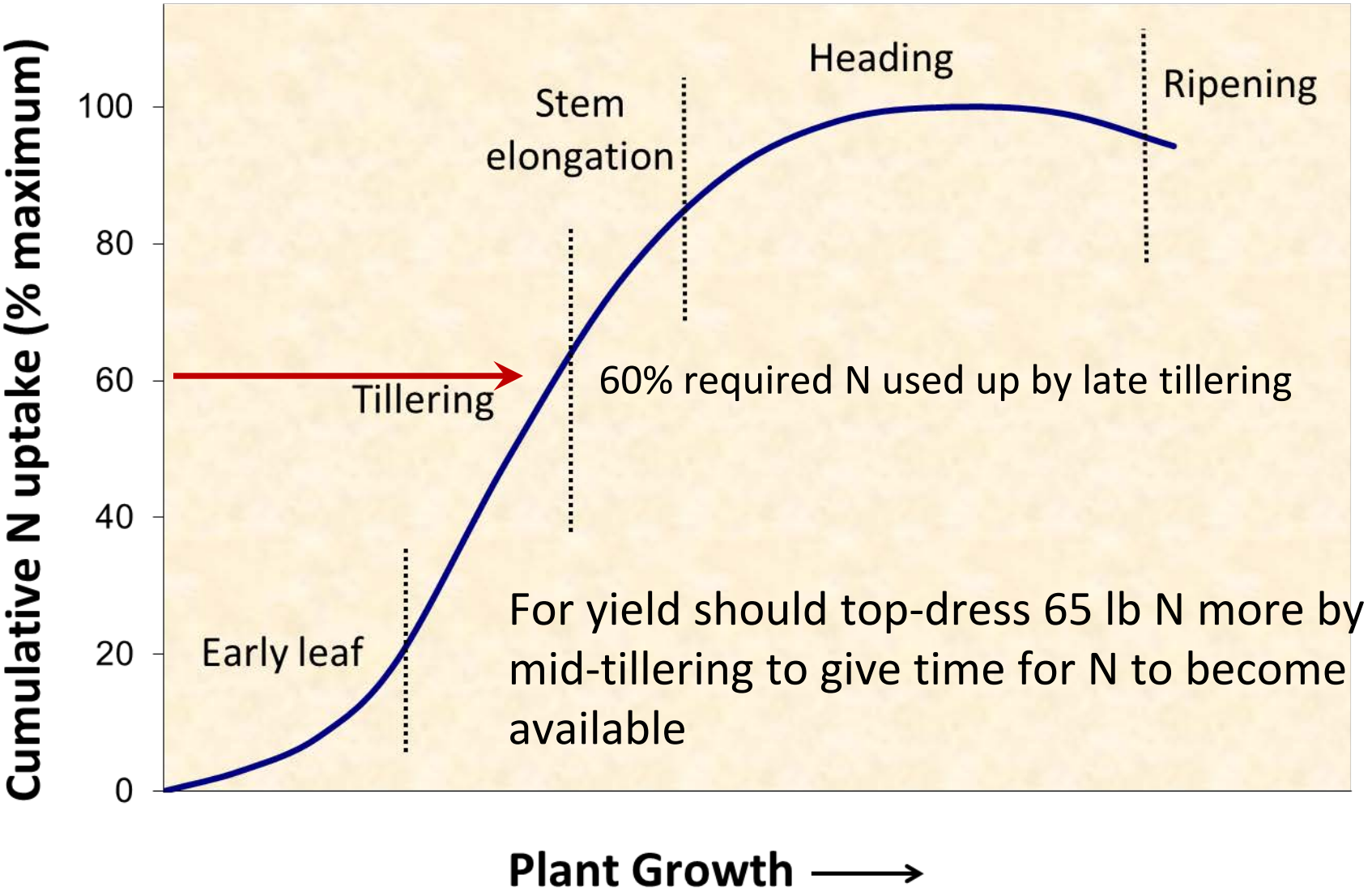
Example on per acre basis:

- 165 lb N total need
- 40 lb N in soil + 60 lb preplant N = 100 lb N = 60% total N required (100/165)
- (165 – 100) = 65 lb N needed to top-dress

Nutrient uptake figures are available at

http://landresources.montana.edu/soilfertility/nutuptake.html

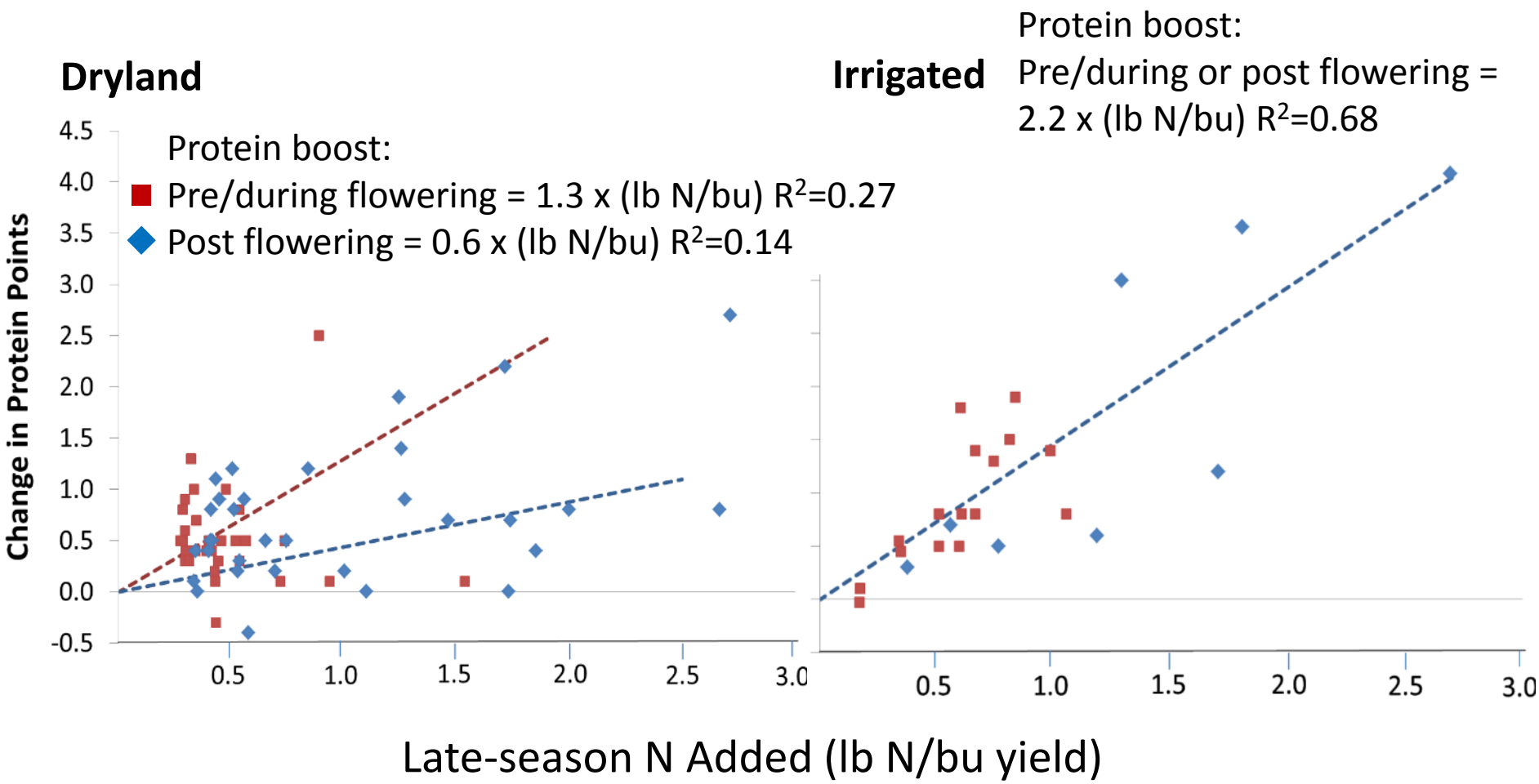
Top-dress amount and timing based on wheat growth stage



Split/In-season N Applications

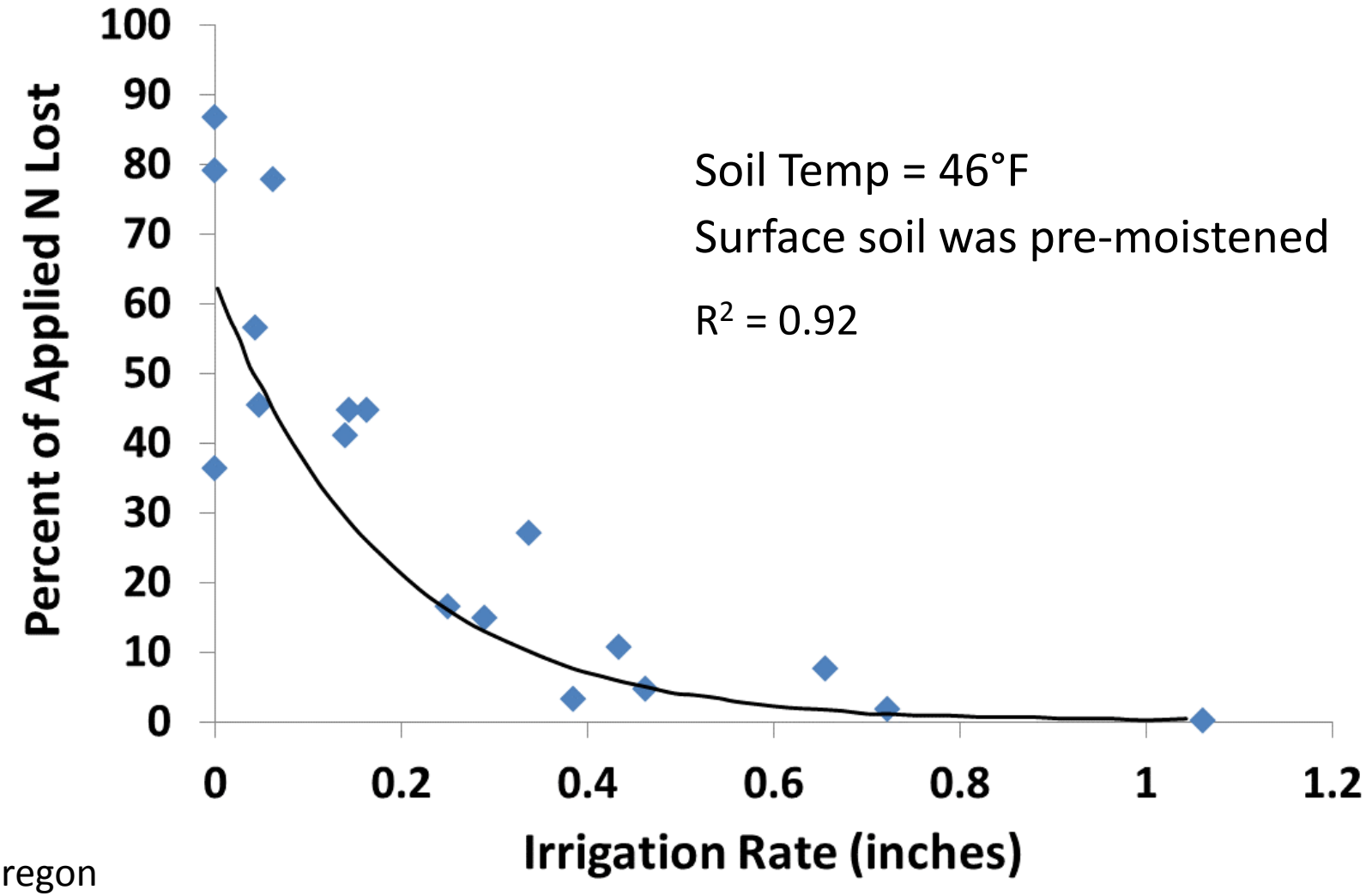
- Fall broadcast supplies early growth needs
- In-season adjustment for estimated yield potential based on precip to date
  - Don't apply 2nd application if dry
  - Apply large 2nd application if wet
  - Use chlorophyll meters (e.g., SPAD, GreenSeeker, and Crop Circle) and remote-sensing technologies to guide in-season N adjustments
- Later applications:
  - Potential to increase protein rather than yield

In-season N rate, timing, and dryland vs. irrigation affects protein boost



Ability to incorporate with rain or irrigation more important than exact timing at flowering

Broadcast before rain or irrigation to minimize volatilization loss



Echo, Oregon
Holcomb et al. 2011

Late season N cautions

- High late season N on irrigated wheat – lodging
- After stem elongation less chance of lodging
- If risk of scab avoid within 5 days of flowering if irrigated or expected rainfall

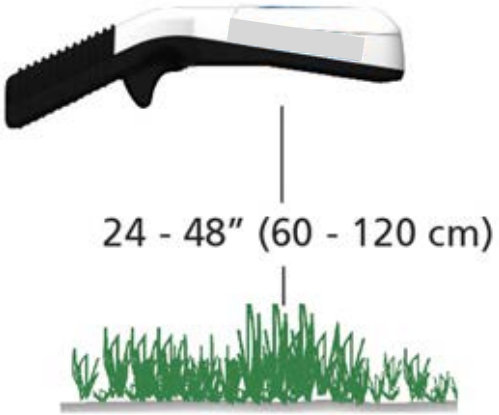
Image from MT200806

To apply late season or not?

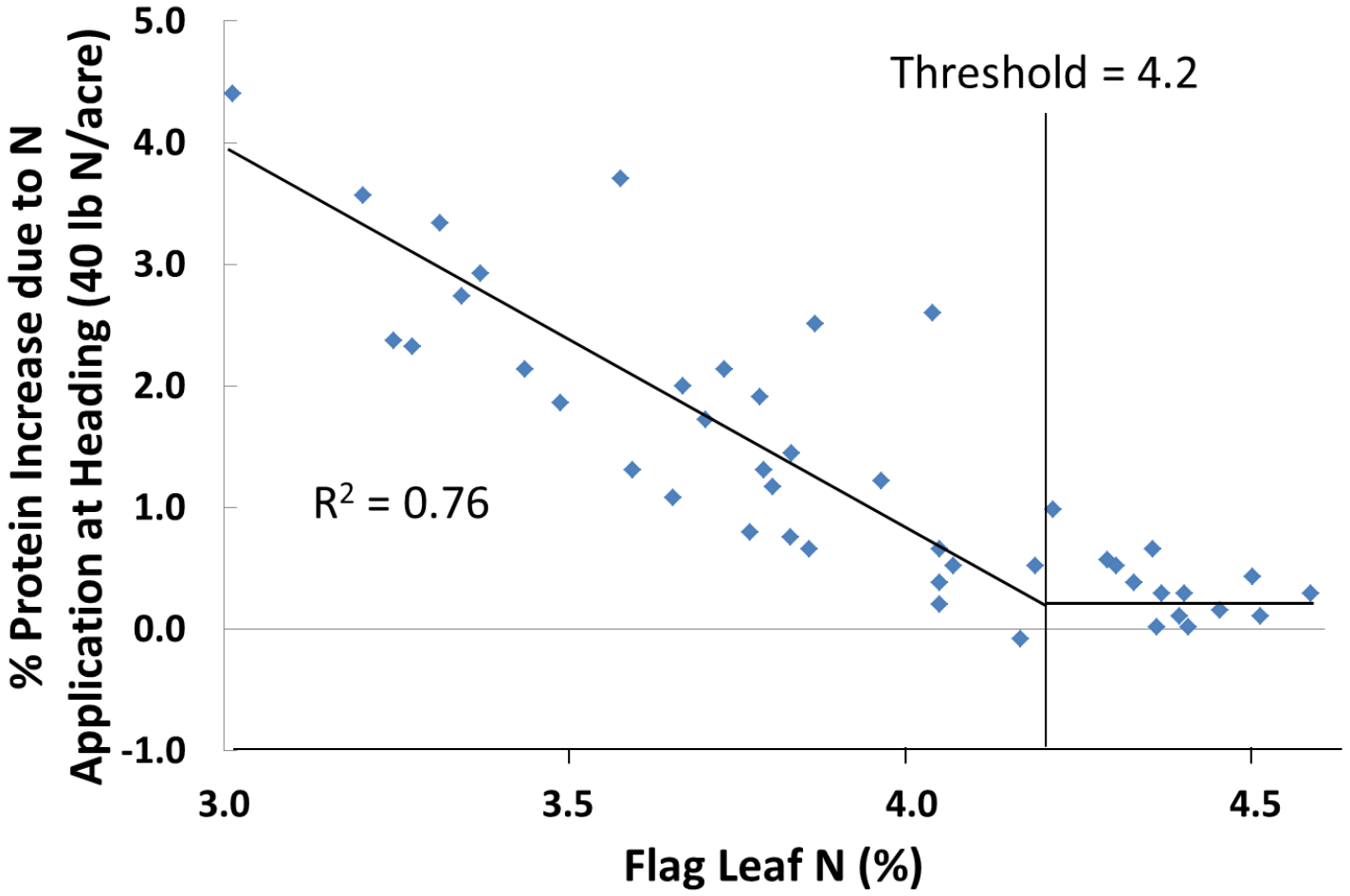
- Flag leaf N concentration

  (sampled at heading) < 4.2%

- Chlorophyll readings
  - Irrigated spring wheat at heading < 93 to 95% of well-fertilized reference plot
  - Not a reliable tool in dryland winter wheat in our region



Protein increase gained by top-dressing 40 lb N/acre at heading on SW increases at lower flag leaf N



Relationship between protein response to N topdressed and flag leaf N in irrigated sw. Fertilizer Fact 12

What is the ‘critical flag leaf N’?

- Critical FLN = FLN below which should top-dress N to maximize profit (and above which should result in a loss).
- Critical FLN = 4.2 – 0.18(N cost in $/lb N)/(protein discount per point)
  - -0.18 is application rate from study (40 lb N/ac) divided by yield in the study (73 bu/ac) divided by slope of response on previous figure (-3)
  - Example 1: If ratio of N cost to discount = 1.5 (May 2012), critical FLN = 3.9%.
  - Example 2: If ratio of N cost to discount = 4 (current for ww), critical FLN = 3.2% (rarely this low).
- Bottom line: need far lower FLN to justify top-dressing for protein IF ratio of fertilizer cost to discount is high.

Flag leaf sampling

- When?
  Collect at first sign of flowering
- Numbers?
  Randomly select 50-75 flag leaves per field
- How and where send?
  Overnight to a lab w/ fast turnaround (e.g., 1 day turn-around)
- Is this a common way to determine whether to topdress or is it Clain's hair brain idea?
  Agvise analyzed ~15,000 flag leaf samples in 2009 and ~30,000 in 2010 (Dietrich, pers. comm.)

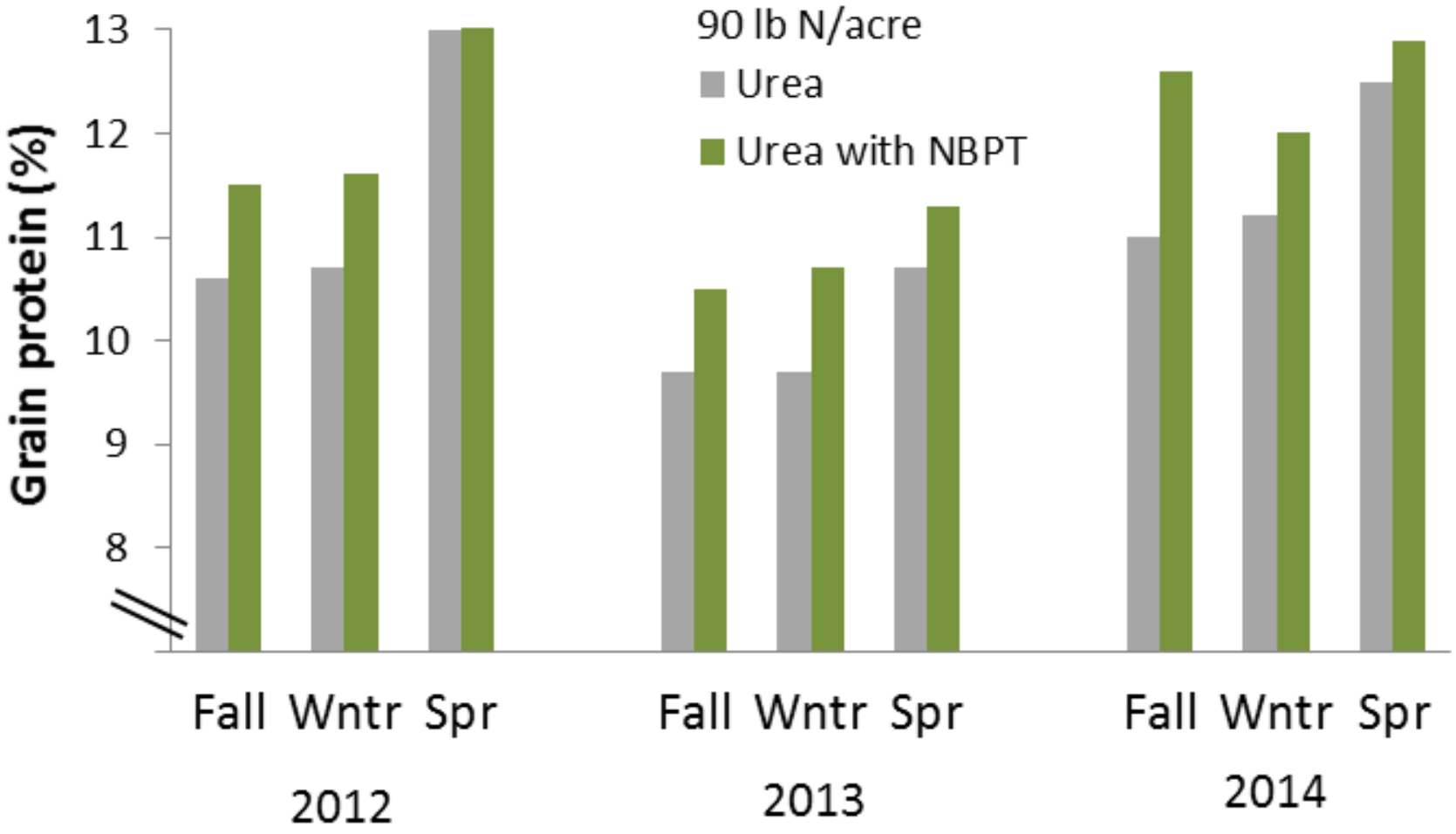
Questions?

On to *Source and Placement*

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?

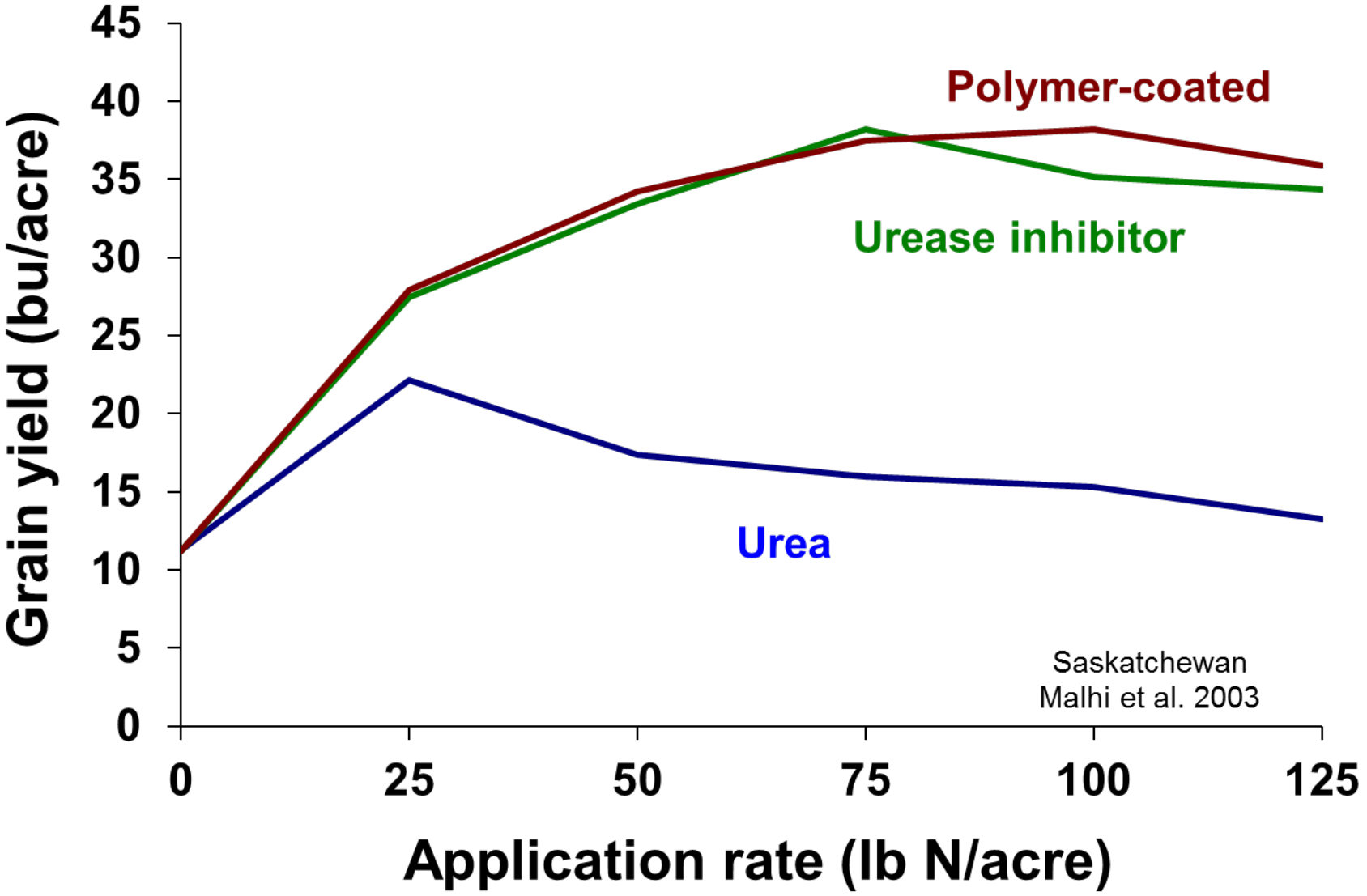
NBPT with broadcast urea can increase WW grain protein



Coffee Creek, MT
Engel unpub data

NBPT sig increased protein by 0.4 to 1.6 % points.
NBPT only increased yield in Fall 2012.

EEFs increase safe rate with seed

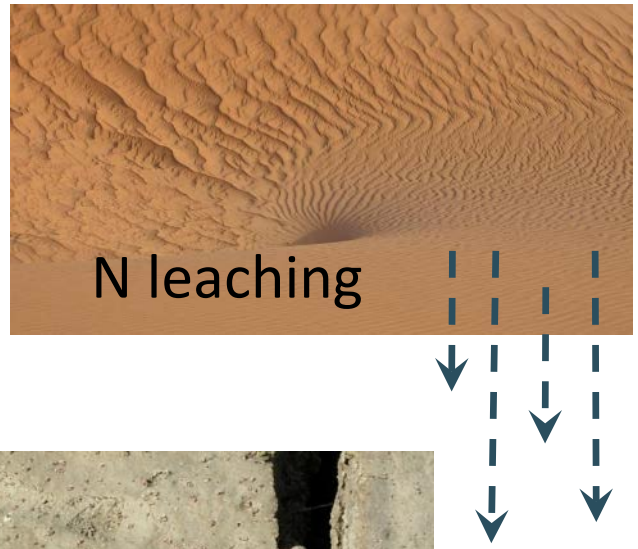


Slow- and controlled-release for the northern Great Plains

- 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 stress is important, then extra cost might be worth it
- Release tends to be too slow with late winter early-spring application
- Consider blending with urea

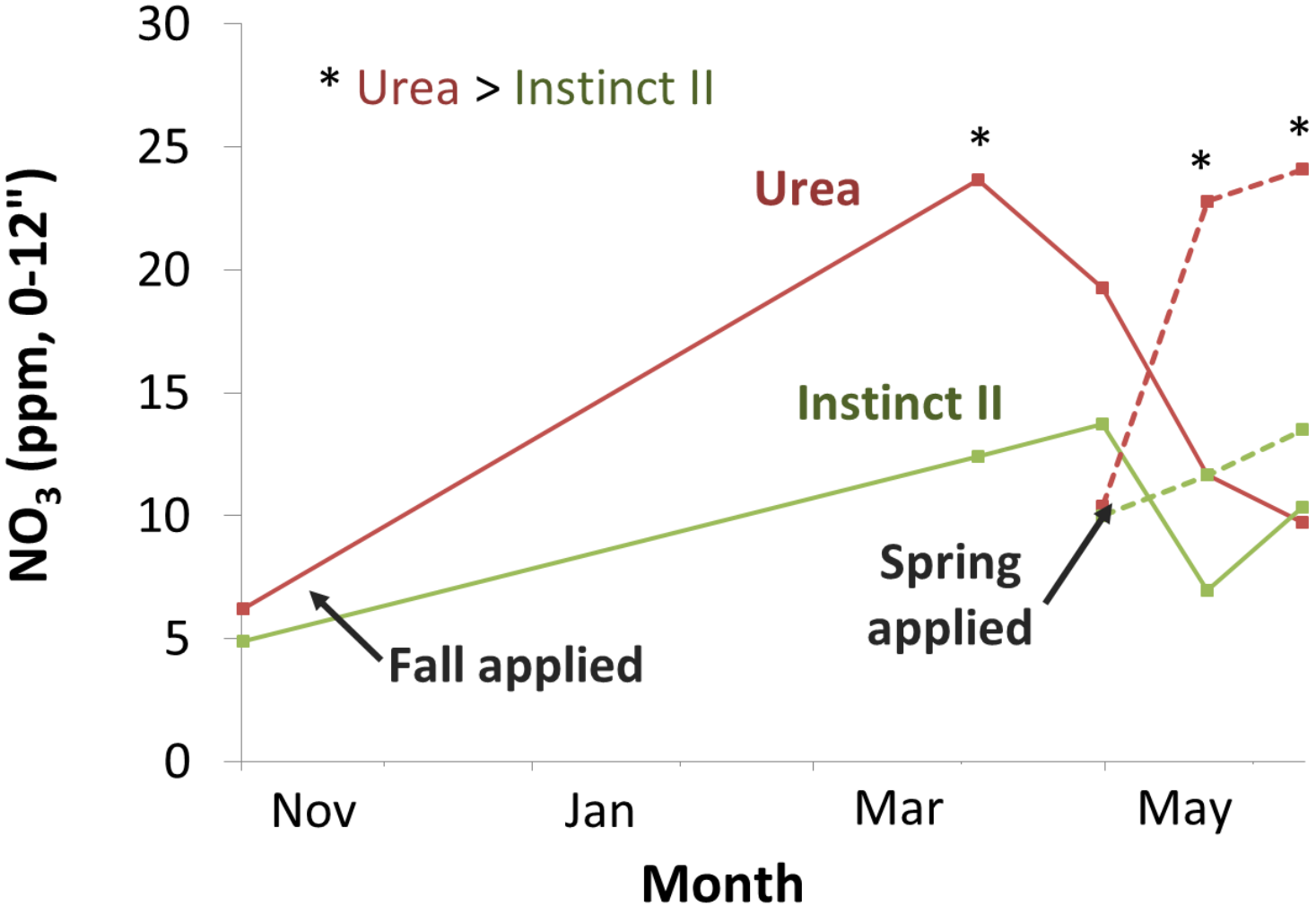
Nitrification inhibitors

- Potential benefit with fall-banded urea where:
  - high precip with leaching in sandy soils
  - denitrification (nitrate → N_2 gas) in water logged/clay soils



- Benefits less likely in dry or well drained soils
- An alternative is fall subsurface large urea granules

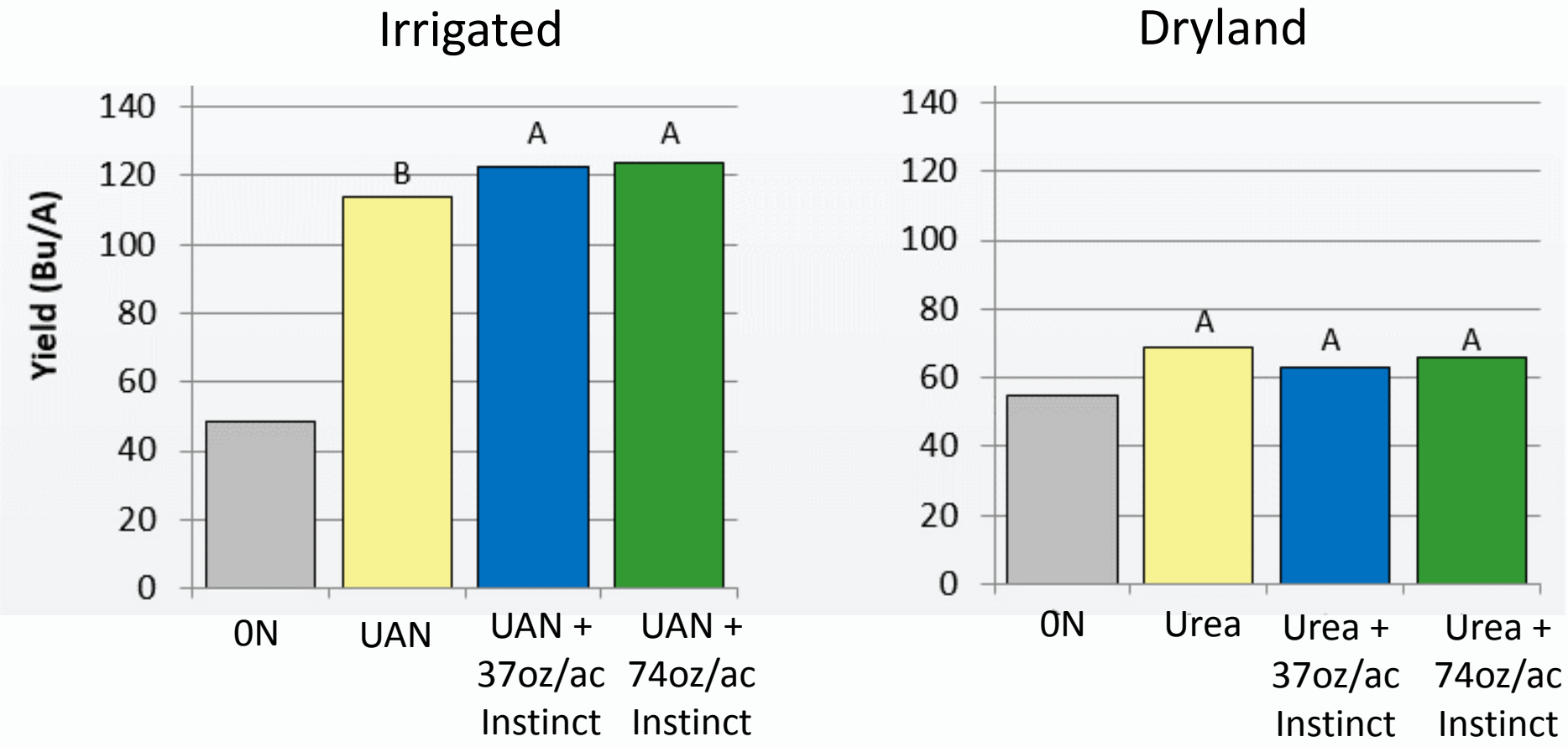
Instinct II (nitrification inhibitor) reduces fertilizer conversion in soil to nitrate



P. Miller, unpub data, 2015
MSU Post Farm, 16” rainfall zone

N banded 2” below surface

Winter wheat grain yield increased with Instinct II® under irrigation (but not dryland)



Scherder et al., 2015, inland Pacific NW
UAN sidedress dribble stream bar, urea preplant incorporated

Species diversity: does it increase benefits?

Nitrogen Fixers

Spring Pea
Common Vetch
Lentil

→ *Increase nitrogen*

→ *Add soil carbon*

Fibrous Root

Oats
Italian ryegrass
Proso millet

→ *Reduce compaction, move nutrients upward*

→ *Potential disease control*

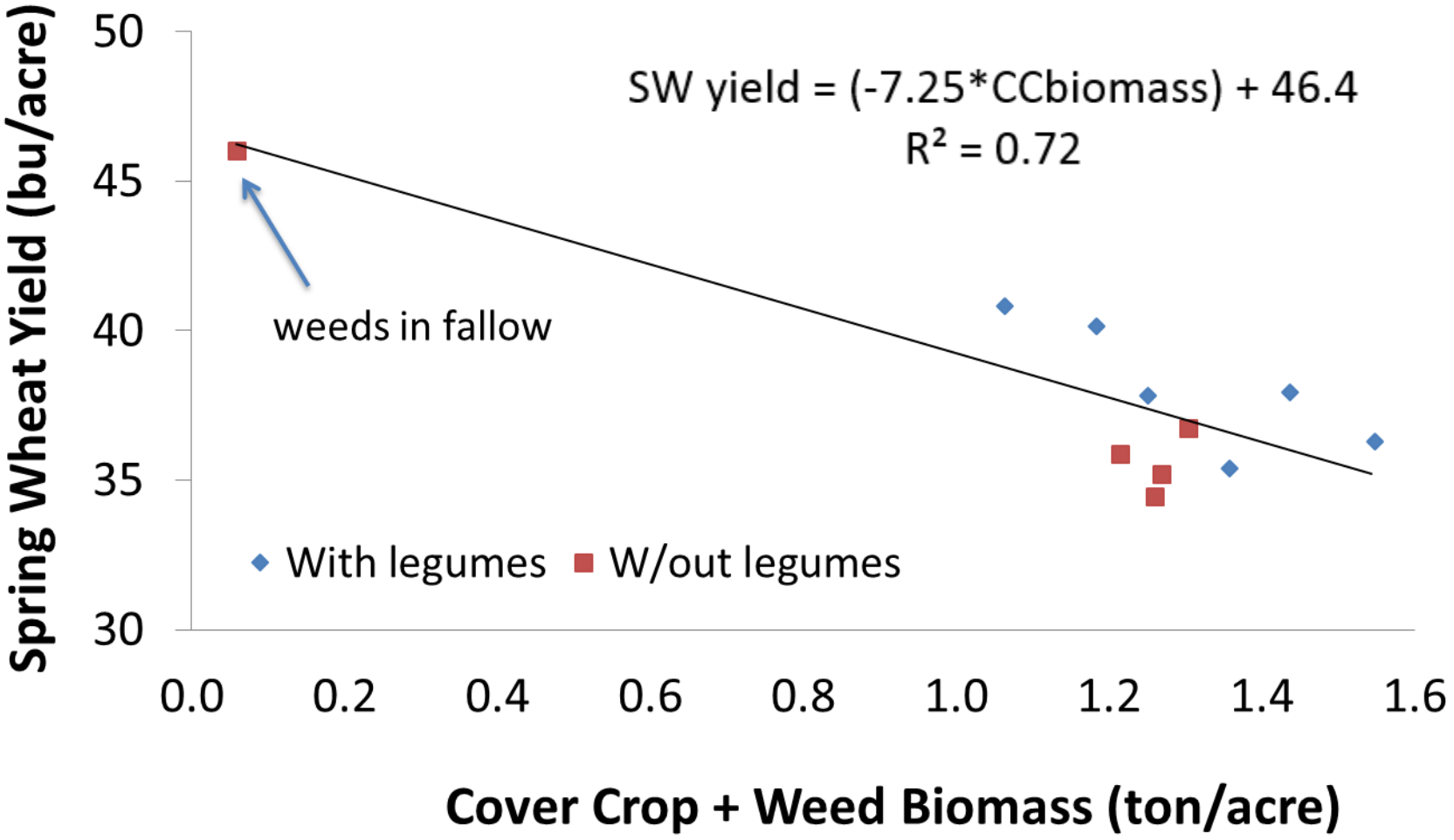
Tap Root

Purple top turnip
Safflower

Brassica

Daikon radish
Winter canola
Camelina

Spring wheat yield at Dutton vs previous year total biomass (cc + weed)

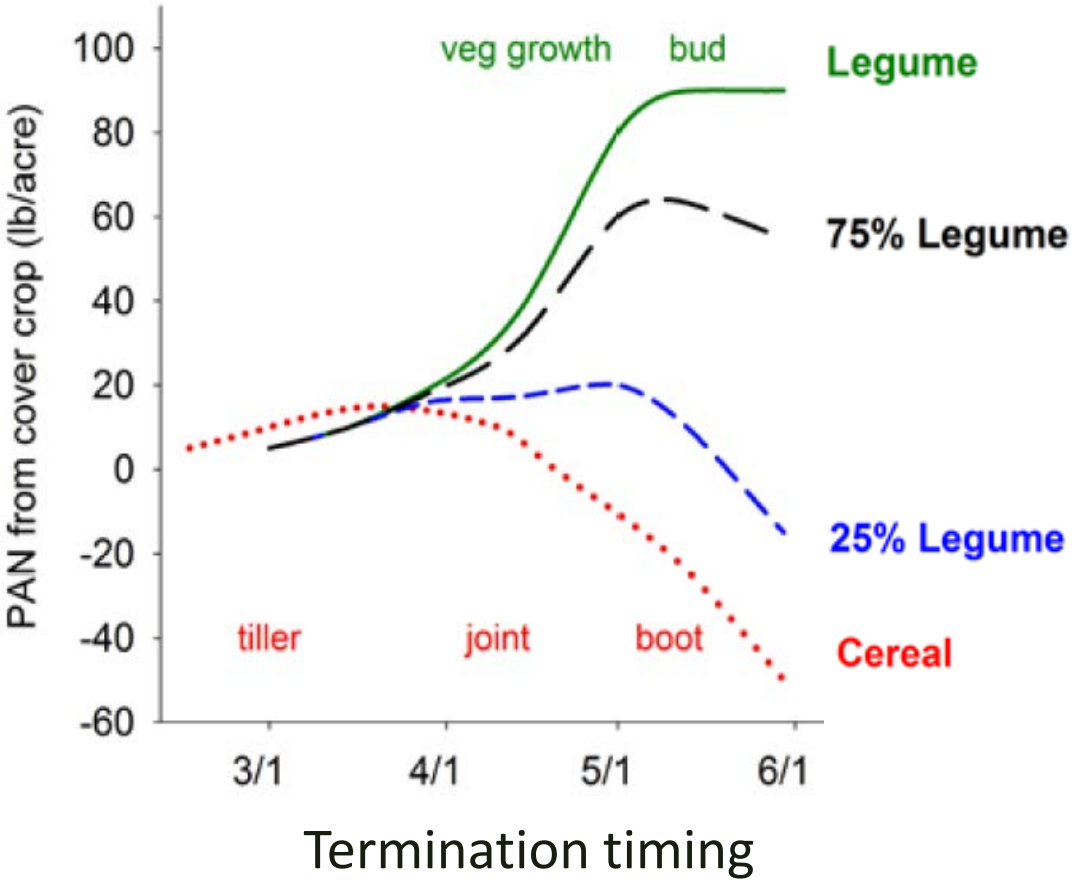


Housman, Tallman, et al., unpub data, Dutton

What about soil health?

Legume cover crops

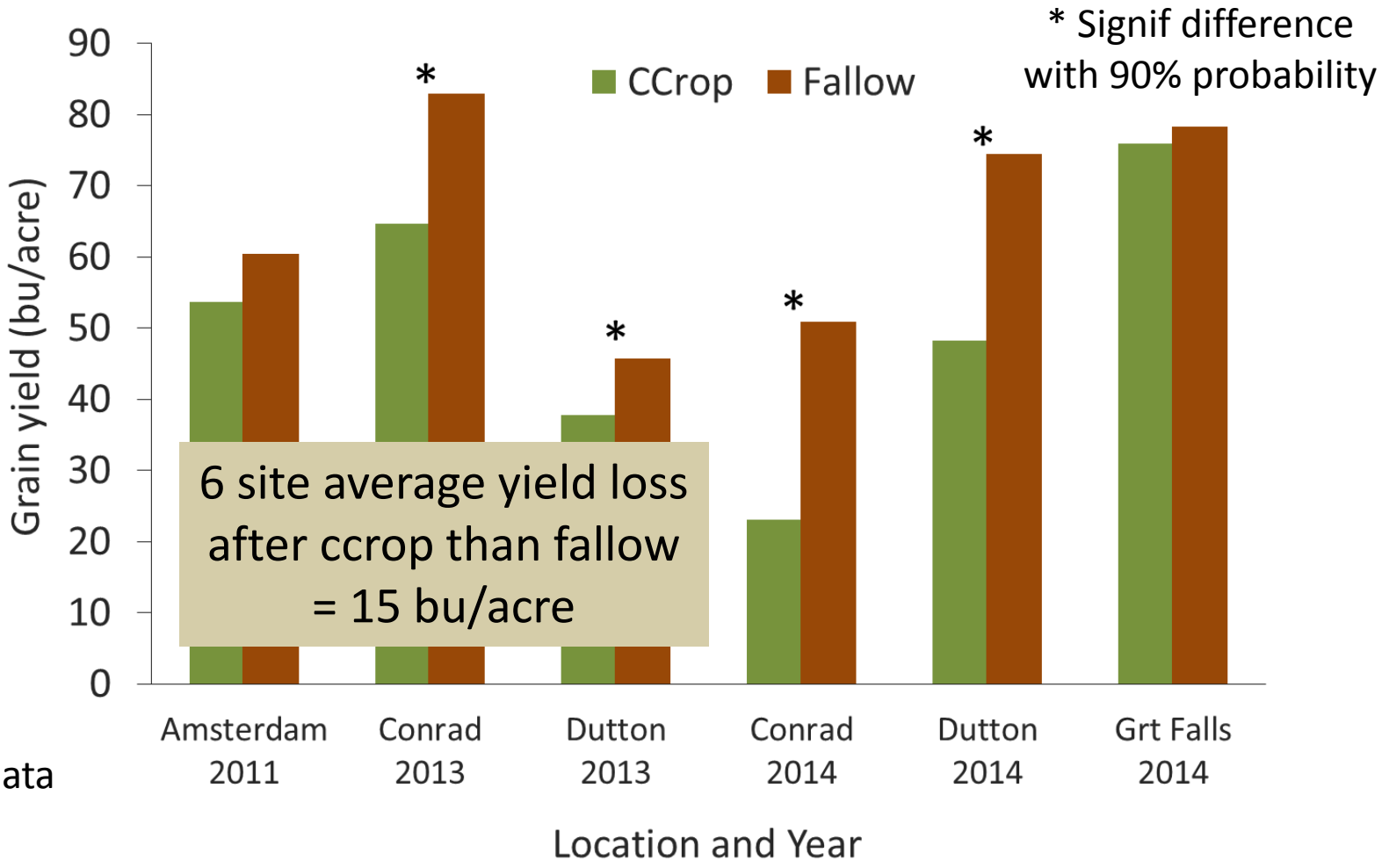
- Terminate by first bloom



- Comprise 50% of ccrop to provide plant available N (PAN), especially if terminated late

Willamette Valley, Oregon
Sullivan and Andrews, 2012

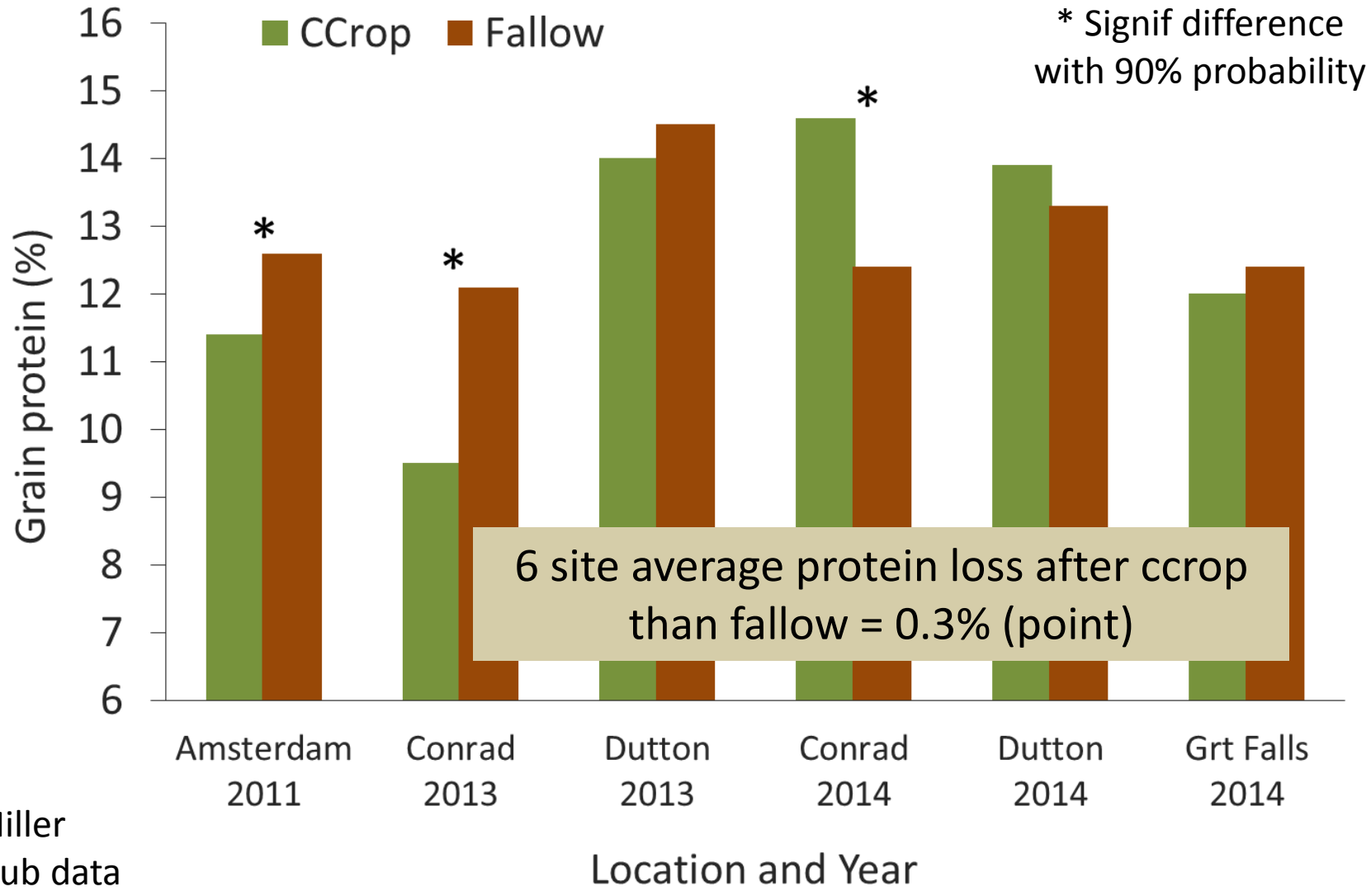
Cover Crop Cocktail Farm Study: 1 rotation of mixed CC reduced grain yield in 4 of 6 production years



P. Miller unpub data

Yield less after mixed cover crops on farmers' fields, likely due to late termination and high water & N use by CCrop

Cover Crop Cocktail Farm Study: 1 rotation of mixed CC produced varied grain protein results

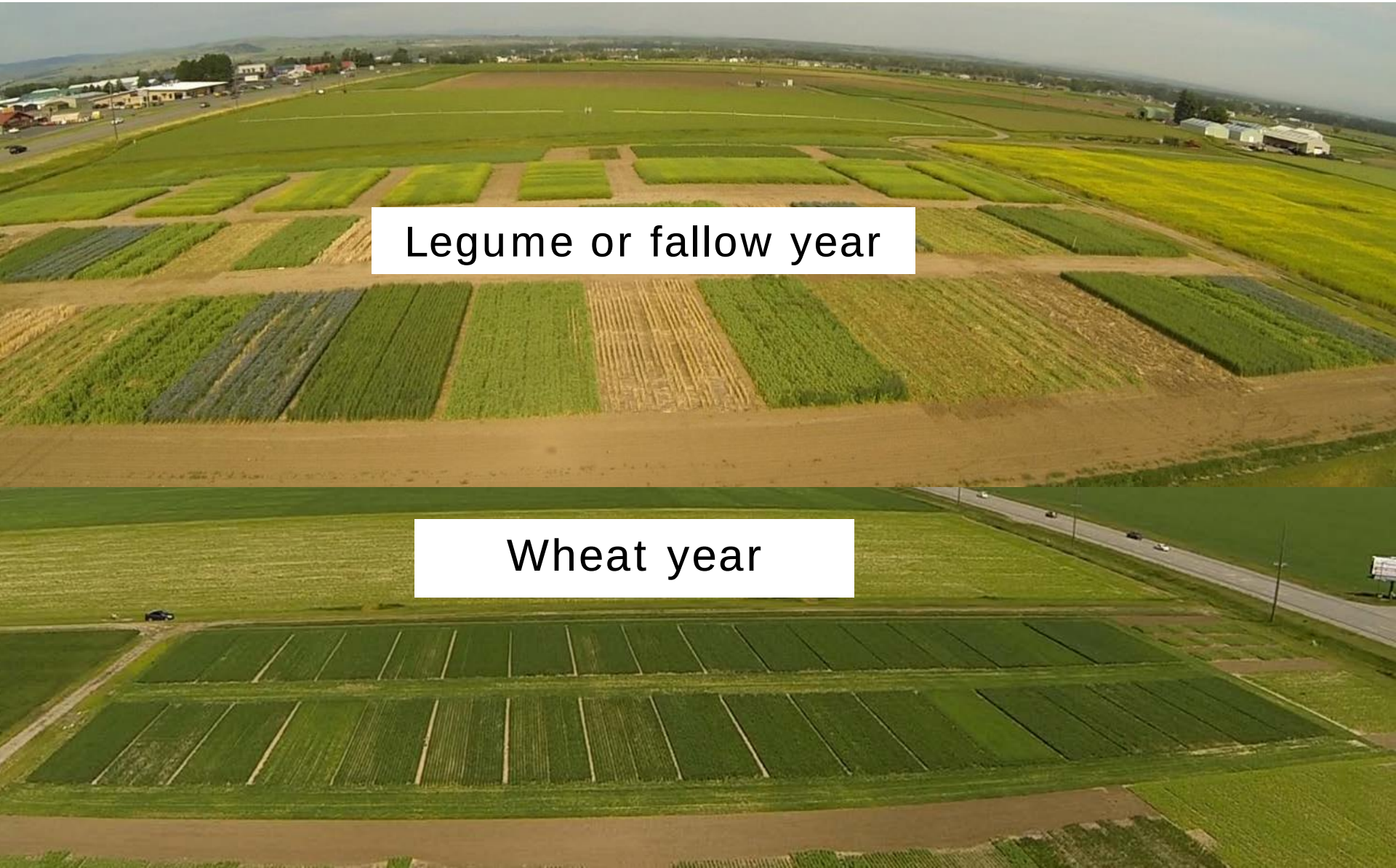


P. Miller unpub data

Cover Crop Cocktails Farm Study: Take home messages on yield and protein

- Spring wheat grain yield was lower after CC than fallow in four of six field-scale studies, and protein results were mixed.
- High water use from late termination was likely cause of yield differences.

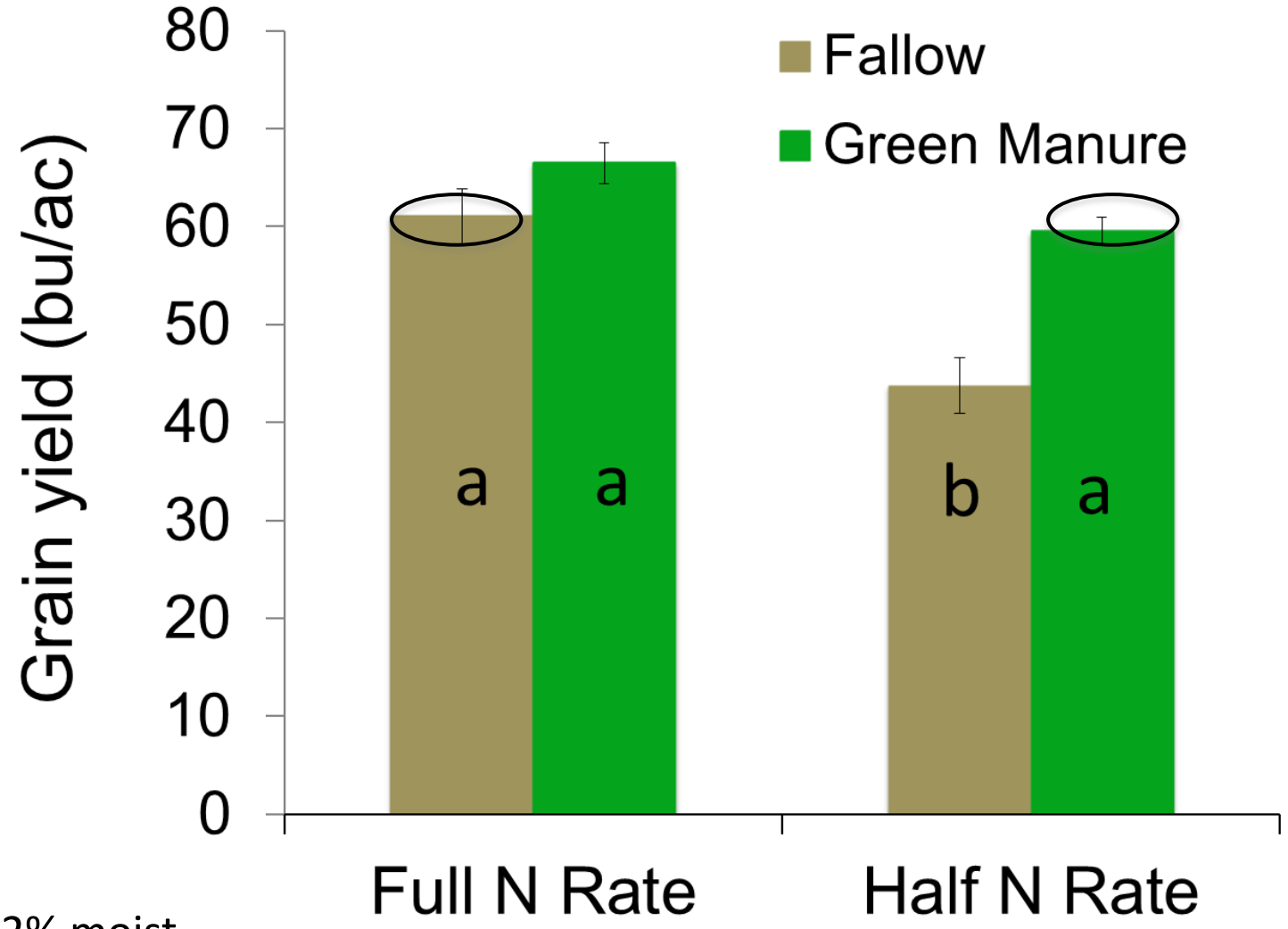
Not a stellar outlook for cover crops in short term, what about long term? 8-year plot study



8-year Plot Study

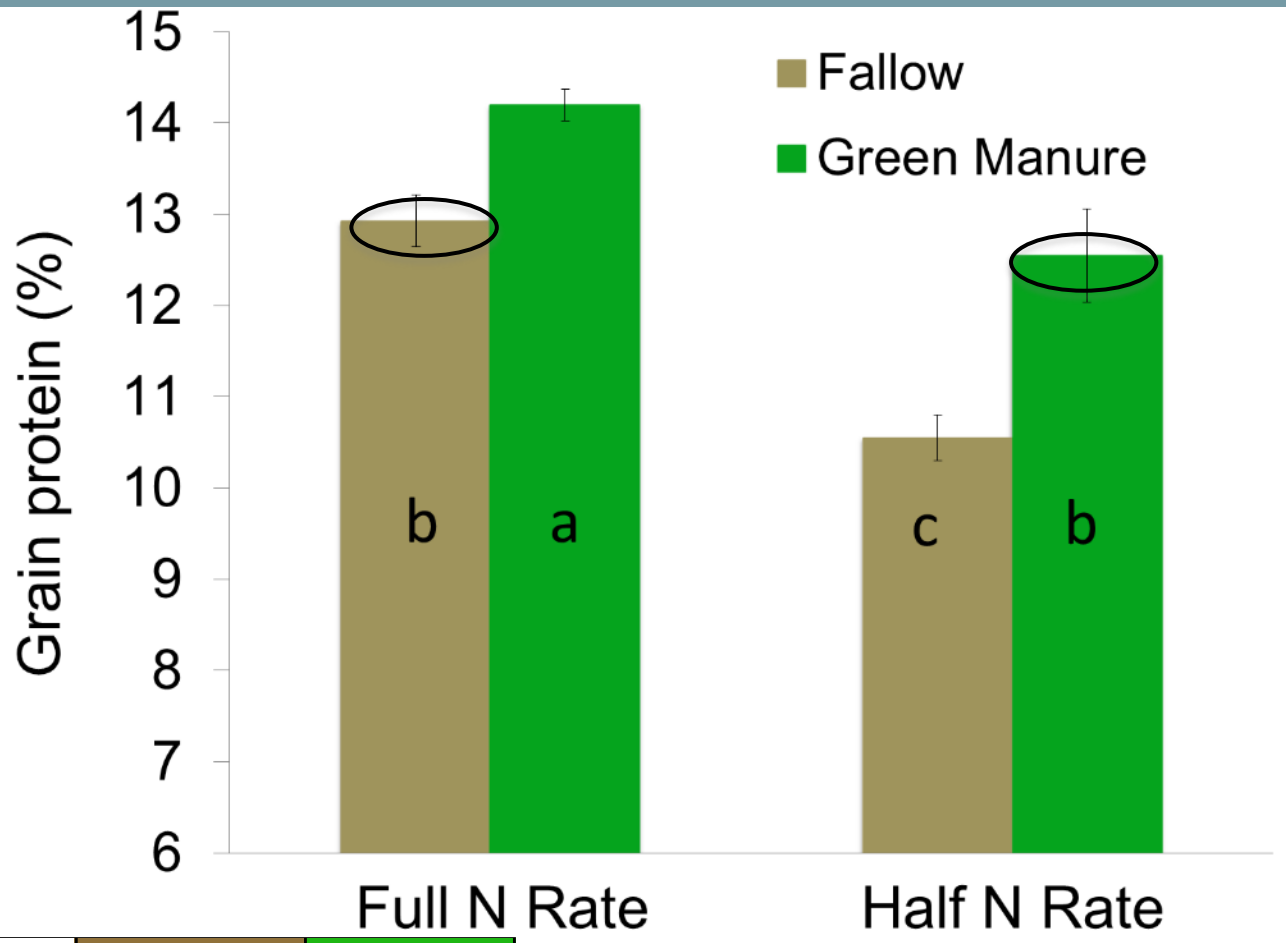
- Long-term effects of no-till pea forage/legume cover crop-wheat vs. fallow-wheat
- ~16” annual precip on deep soils & ability to recharge soils
- Pea forage grown in 2003, 05, 07 and pea CC grown in 2009, terminated at full pod
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years, 2012 record drought.
- 2 N rates: Full (3 lb available N/bu) and ½ N
- *NO differences in wheat yield following CC and following fallow in 2004, 2006, 2008, and 2012, and large benefit of CC in 2010*

8 Year Plot Study: Grain yield in 8th year (2010)



@ 12% moist

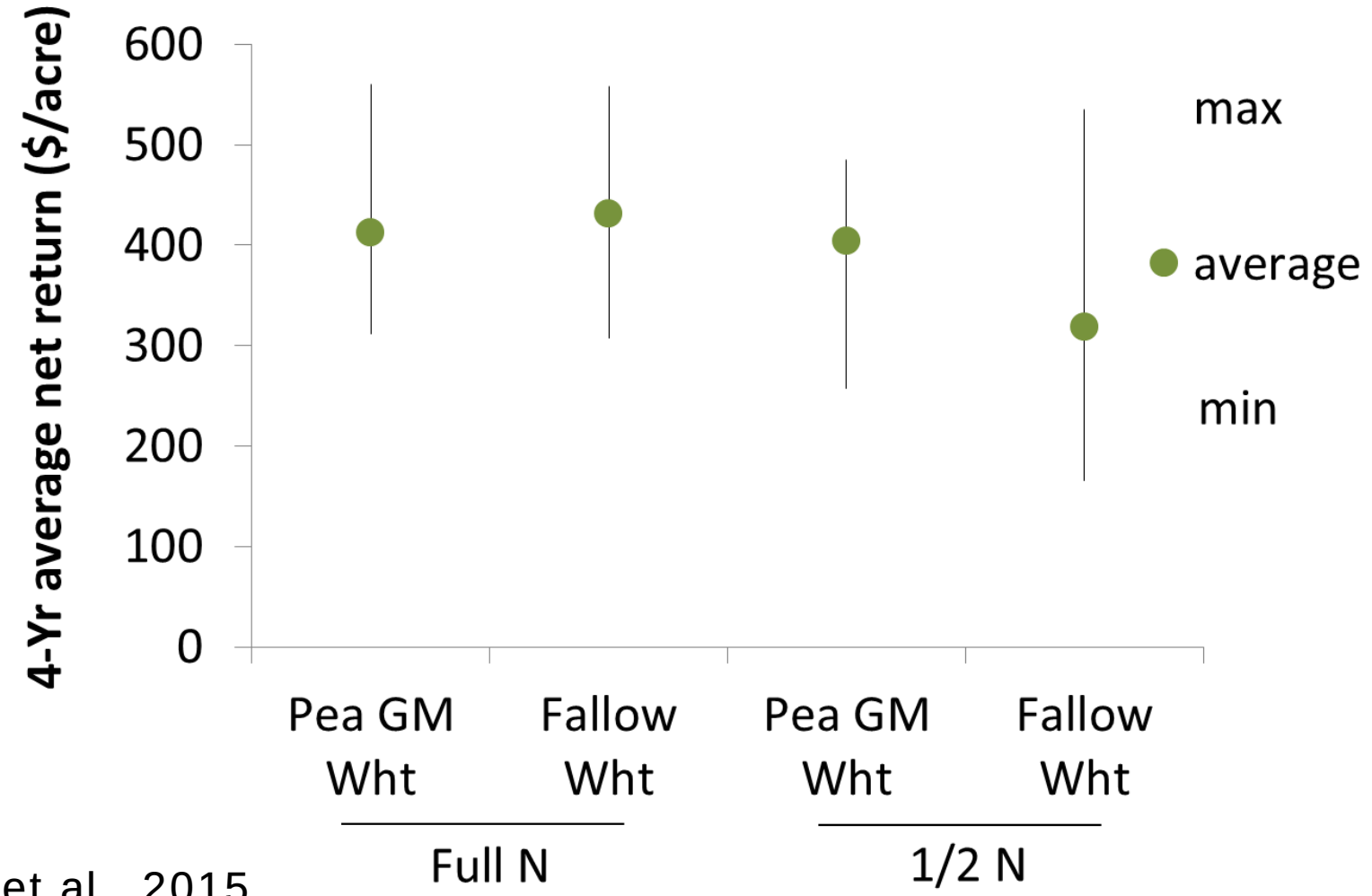
8 Year Plot Study: Grain protein in 8th year



* 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.

After 4 rotations pea GM provides same net return as fallow, with less N

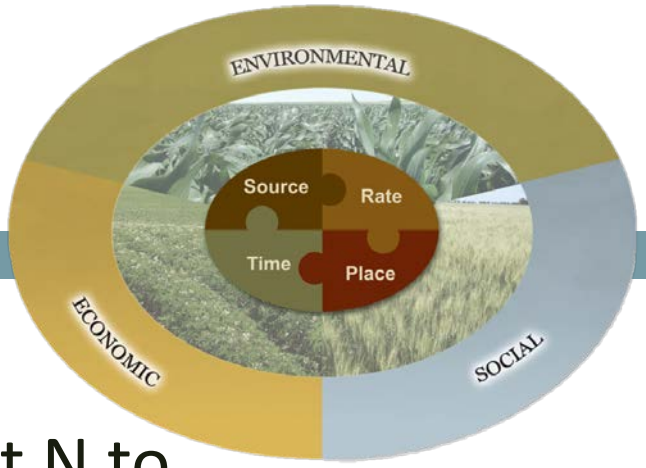


Miller et al., 2015

Placement

- Urea and ammonium based fertilizers – best subsurface placed
- Safe rates for seed placed
  - On-line resources to calculate
  - 50% higher with NBPT
  - 2-4 x higher with polymer coated
- Foliar application
  - Use practices to min leaf burn
  - < 30 lb N/ac of UAN
  - < 45 lb N/ac of liquid urea
  - Use less with herbicide, surfactant, sulfur, NBPT

Summary



- Use realistic yield goals and soil test N to calculate pre-plant N rate
- Adjust in-season for given year
- Apply early for yield, later for protein
- Select the source appropriate for conditions
- Use on-line tools for variety selection, optimal N rate, safe seed-placed rates

Resources

- Variety selection tool www.sarc.montana.edu/php/varieties/
- N rate calculation tool http://www.msuextension.org/econtools/nitrogen/index.html
- On soil fertility website http://landresources.montana.edu/soilfertility/
  - Safe rates for seed-placed – under *Agriculture Links*
- Under *Extension Publications*
  - *Nutrient Management in No-Till* (EB0182)
  - *Enhanced Efficiency Fertilizers* (EB0188)
  - *Nutrient Uptake and Timing by Crops* (EB0191)
  - *Practices to Increase Wheat Grain Protein* (EB0206)

QUESTIONS?

This presentation and additional information on soil fertility topics is available at http://landresources.montana.edu/soilfertility

Photo by Andrew John