Fertilizer Management in a Down Market

Central Region Ag Agent Update
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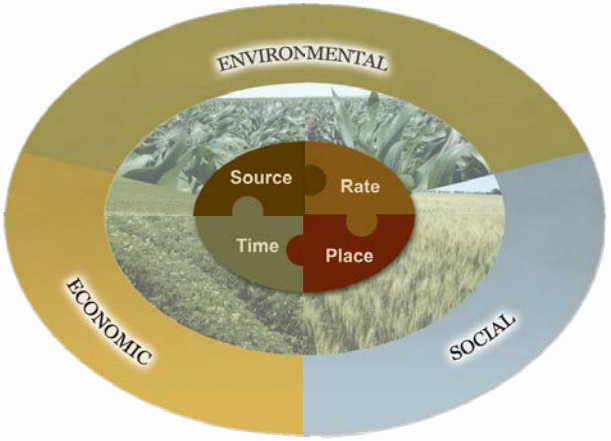
MSU Soil Fertility Extension

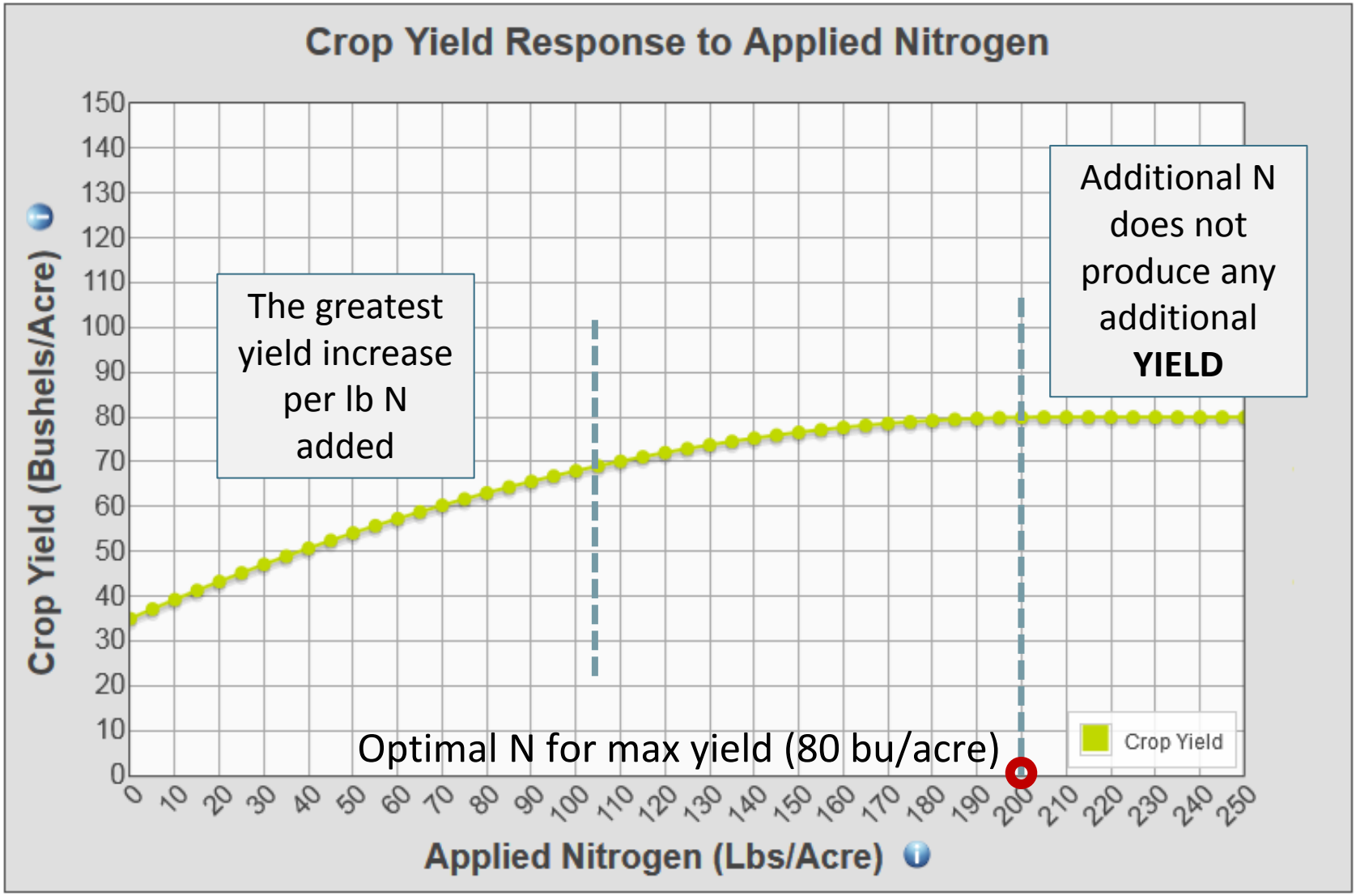
Primary objective today: Assist you in working with your producers to optimize profit from fertilizer management in era of low commodity prices

Specifically, I will discuss:

- The law of diminishing returns
- Steps towards calculating an optimum N rate
- Fertilization for optimal N use
  - Timing
  - Source & legume rotations
  - Placement
- P, K, S, and micro management

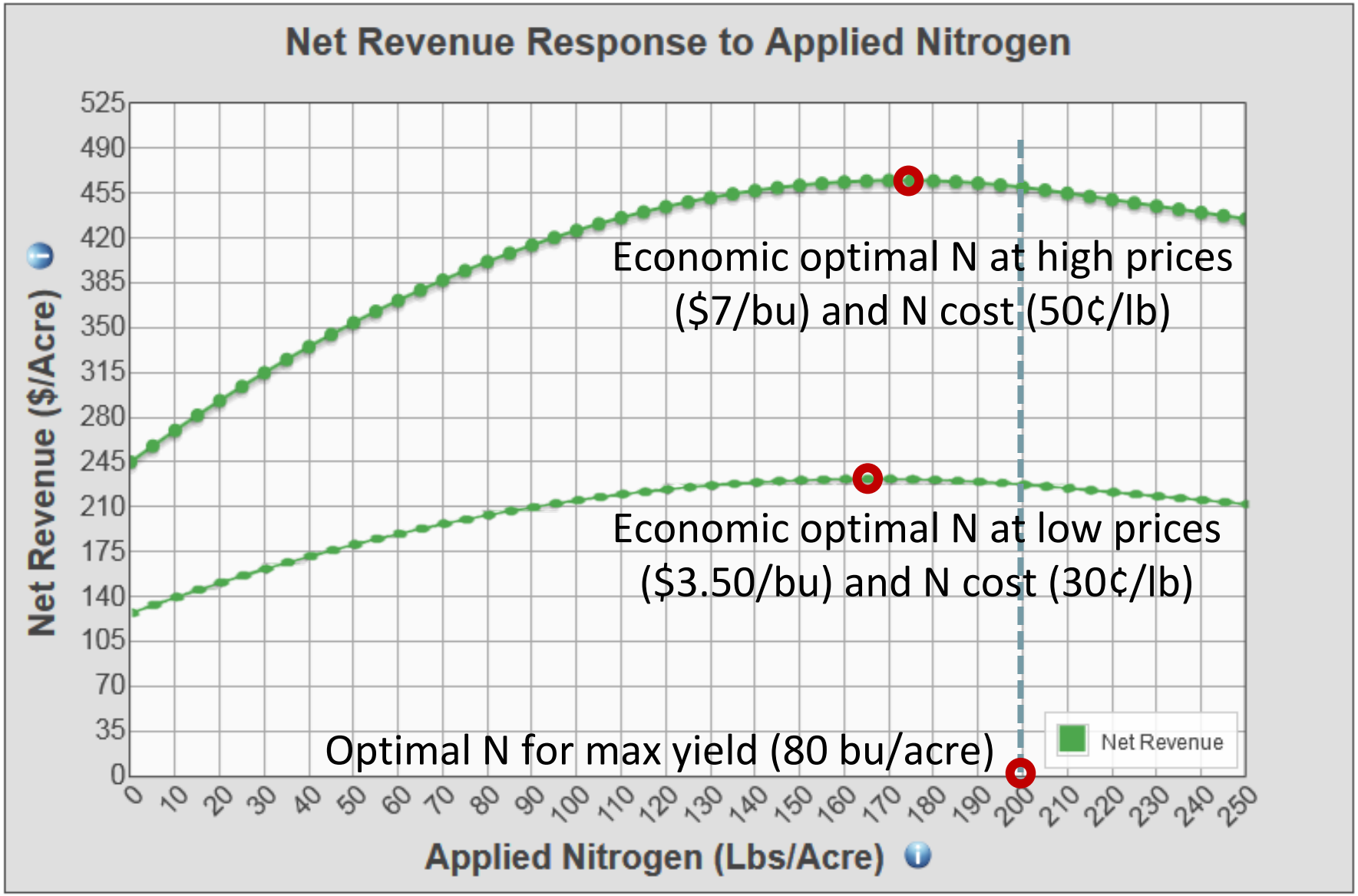


Law of diminishing returns



Soil N = 40 lb/acre, SOM = 2%

Economically optimal N (e.g. WW with 0 discounts/premiums)



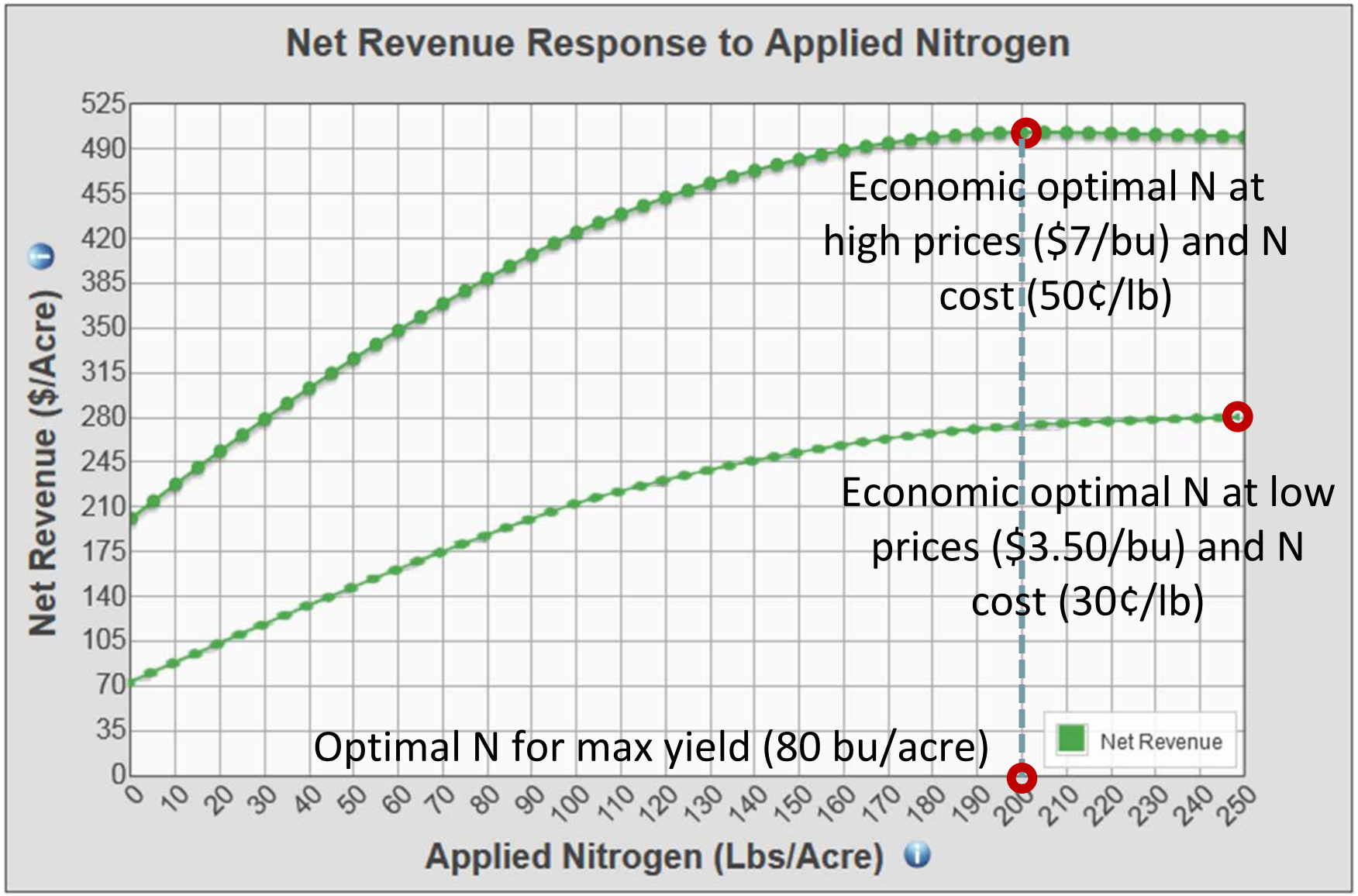
Soil N = 40 lb/acre, SOM = 2%

Because it's not that simple: MSU N Econ calculator

- Inputs
  - N fertilizer cost, grain price, protein discount/premiums
  - Yield goal – details on how to determine discussed later
  - These help calculate **TOTAL** available N for max net return
  - Residual soil N
  - SOM

Calculators online for barley, SW, and WW after fallow

Economically optimal N:
protein discounts (15¢/0.25%) & premiums (10¢/0.25%)



Soil N = 40 lb/acre, SOM = 2%

MSU N rate calculation tool takes into account fertilizer costs, grain prices, and protein discounts/premiums

http://www.msuextension.org/econtools/nitrogen/index.html

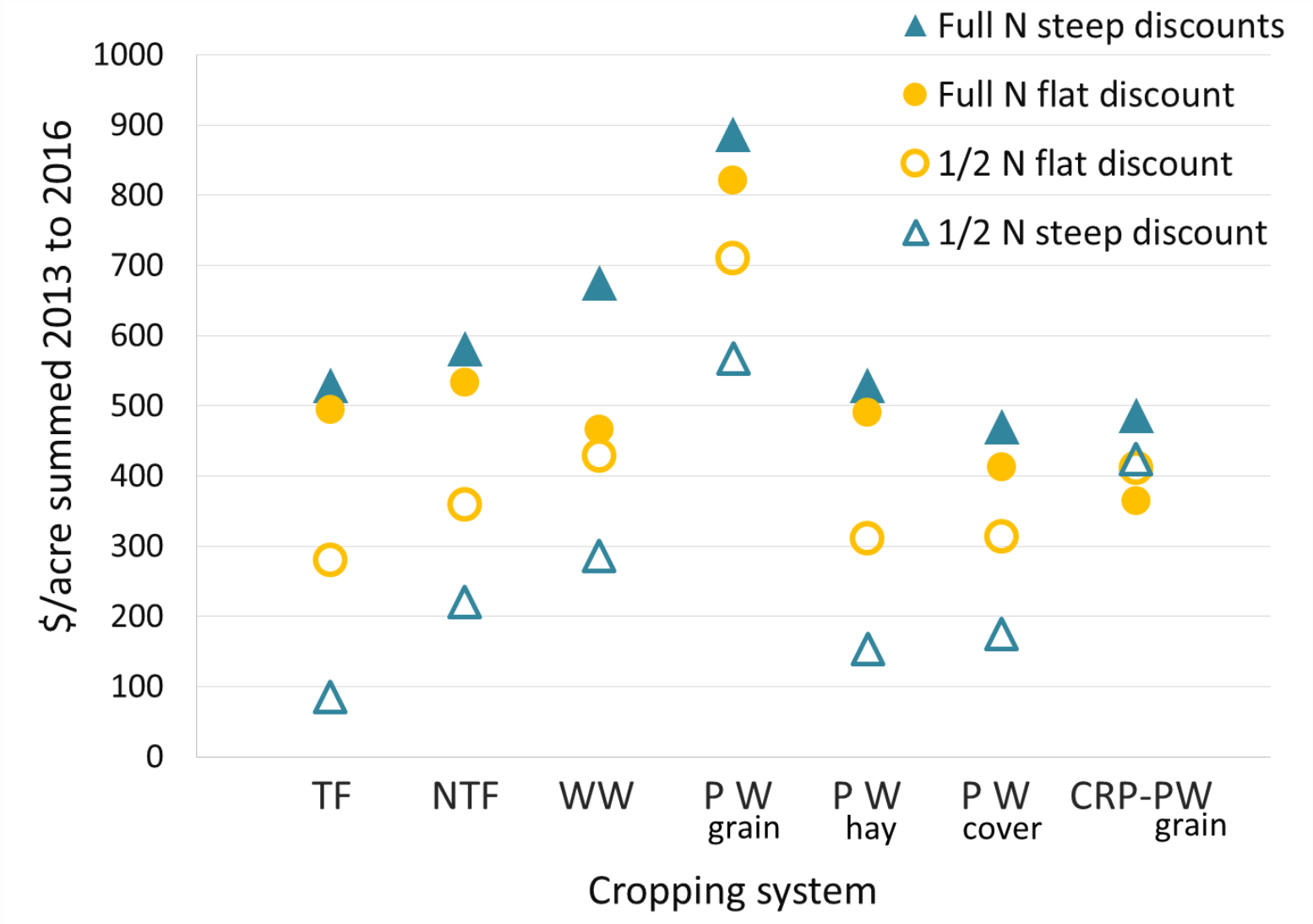
Total available N **(lb N/bu)** for maximum return: Winter wheat following fallow

Protein discount (¢/0.25%)	**$/ton urea**		
	$275	$460	$740
5	2.9	2.6	2.3
10	3.2	3.0	2.5

Based on $5/bu, 80 bu/ac, 2% O.M.

Best way to help producers maximize profit (and stay in business?) is to point out that N rates should be adjusted based on costs, prices, and discounts, and take time to show them the MSU calculator.

N more important for bottom line with steep protein discounts



Fertilizer Fact # 72

Pea grown for grain followed by wheat had most profit, regardless of discount or N rate.

Questions?

On to *Calculating N Fertilizer Rate*

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

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

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

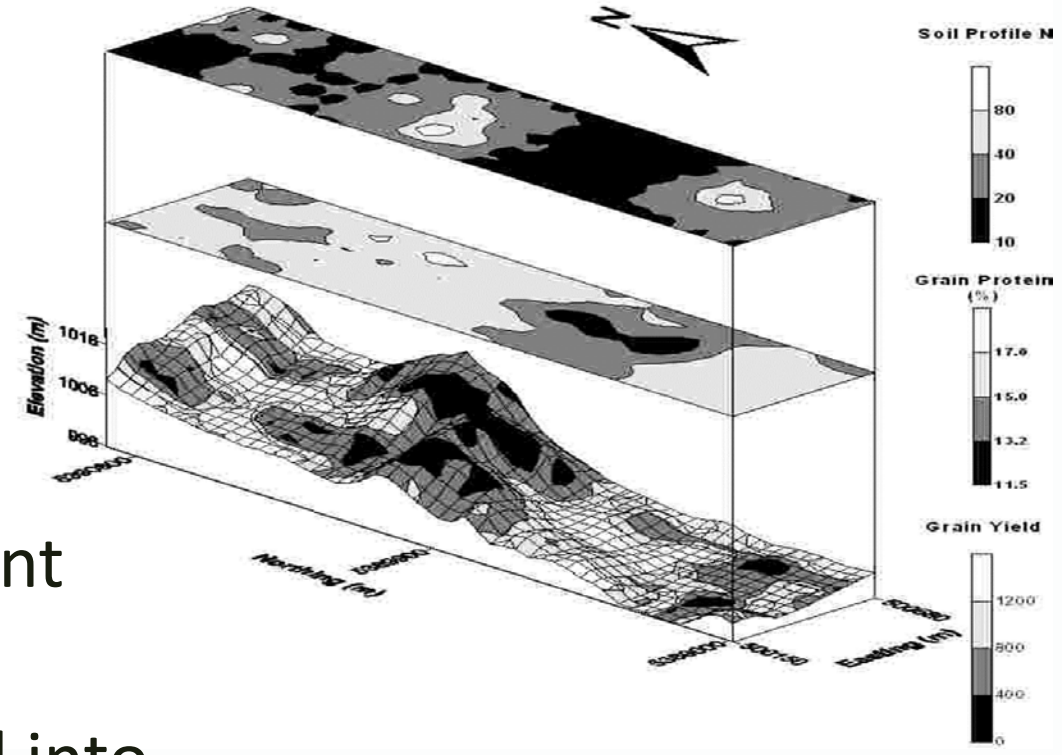
- After legume rotation:

  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

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

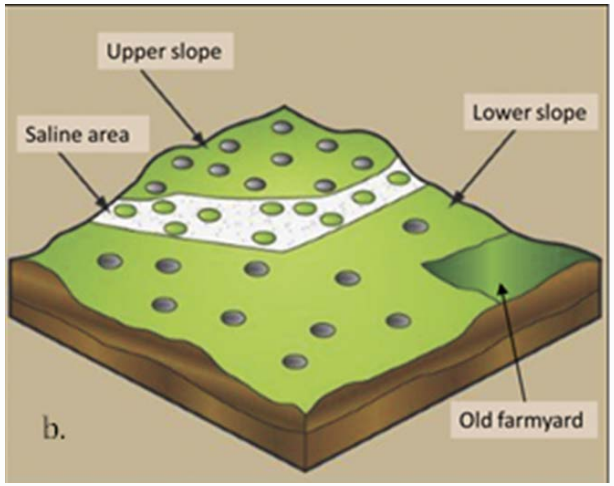


Image adapted from IPNI 2012

Evaluate past N management

- Yield was likely limited if:
  - Winter wheat protein < 12.5% (FF 34)
  - Spring wheat protein < 13.2% (FF 21)
- To increase wheat protein by 1 point, apply
  - ~0.75 lb N/bu before flower for dryland (not to exceed 30 lb N/ac)
  - ~ 0.5 lb N/bu at heading for irrigated

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

➢ Consider mapping protein during harvest if have protein monitor

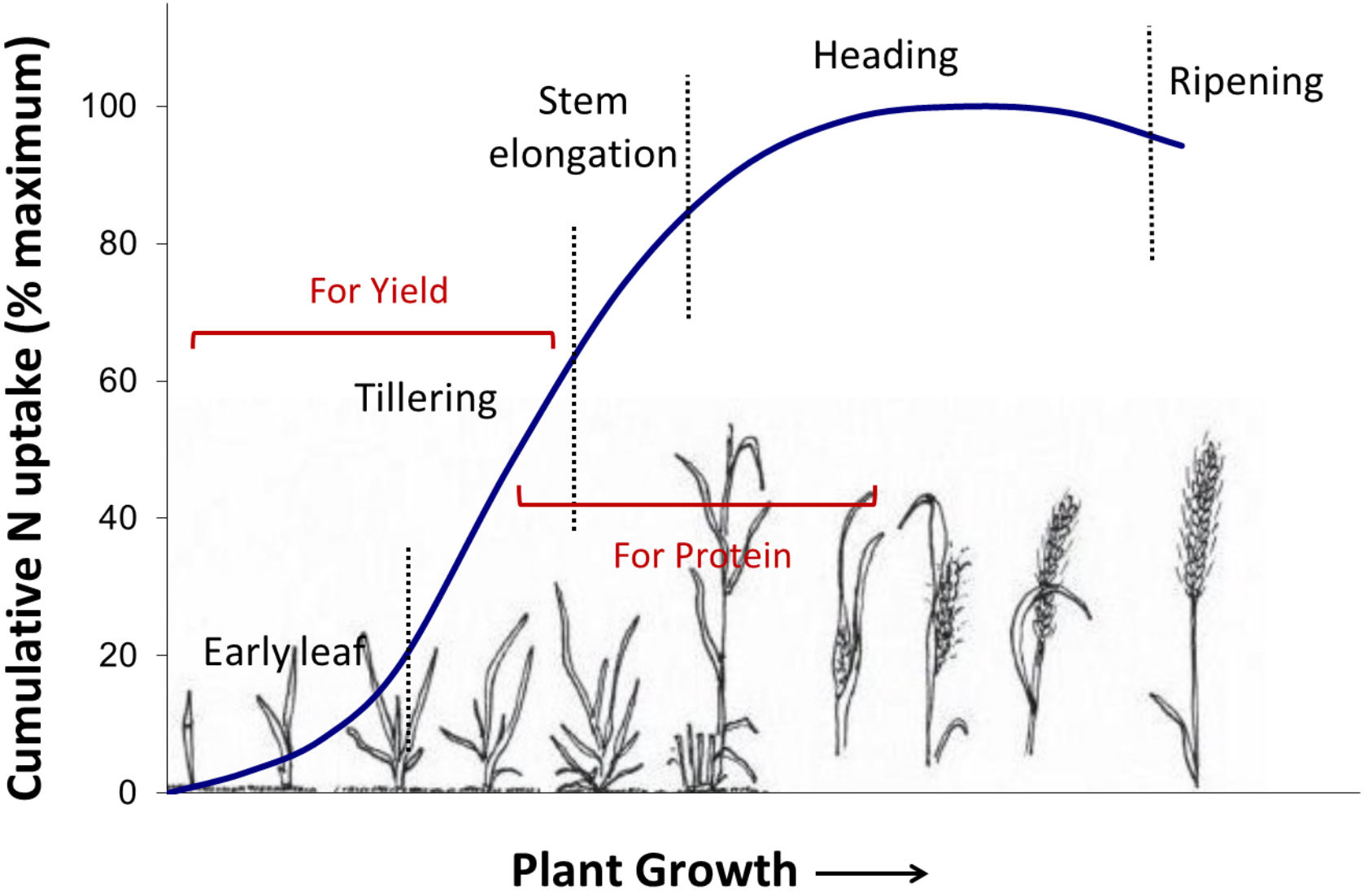
Questions?

On to *Timing*

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

N uptake by wheat for yield and protein



Use Nutrient Uptake figure to time top-dress

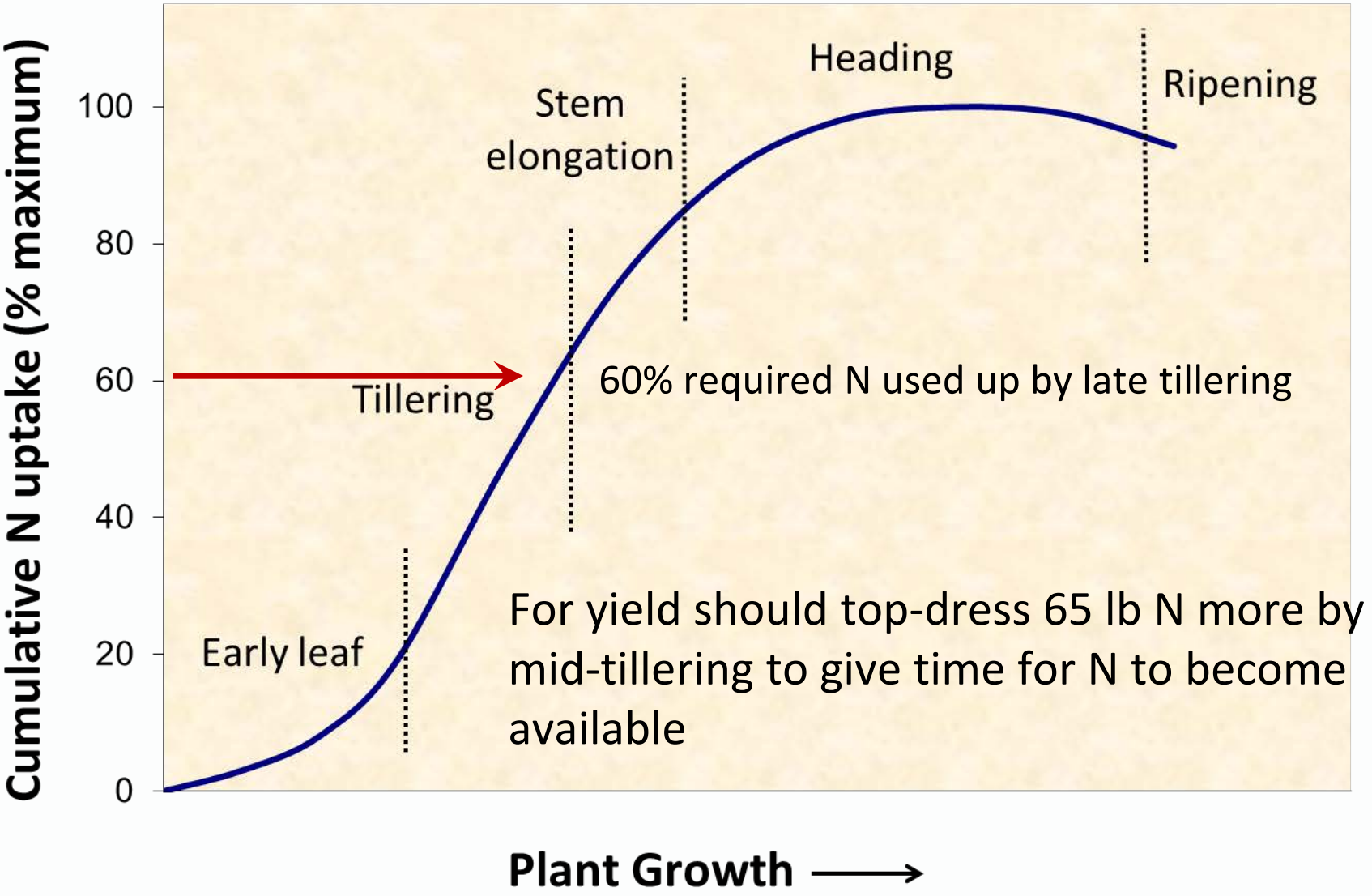
Example on per acre basis:

- 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

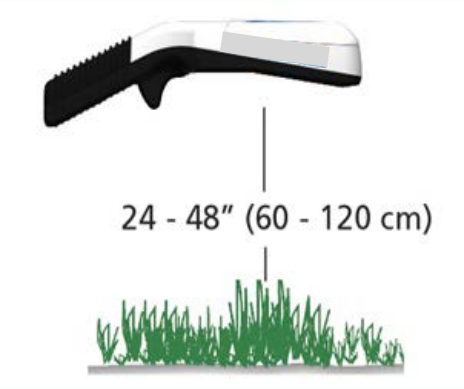
http://landresources.montana.edu/soilfertility/nutuptake.html

Top-dress amount and timing based on wheat growth stage

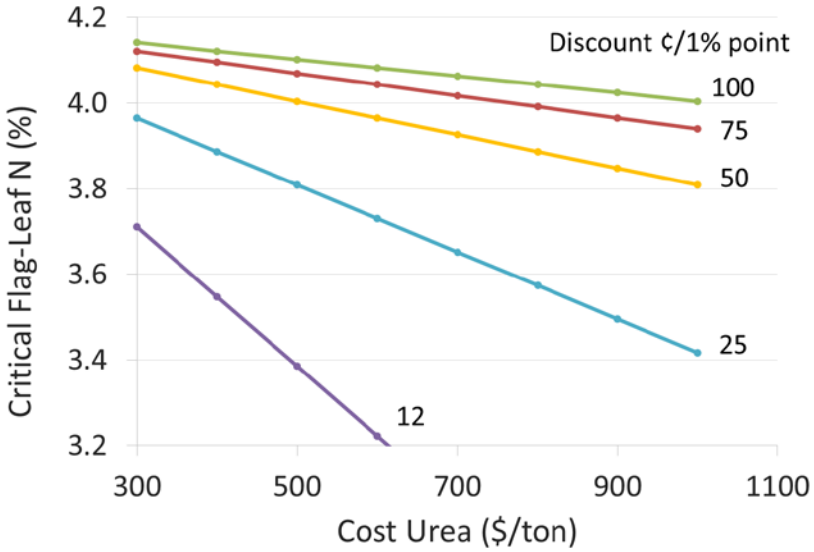


To apply late season or not?

- 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



- Flag leaf N concentration (sampled at heading)
  - Critical FLN = FLN below which should top-dress N to maximize profit (and above which should result in a loss).
  - Critical FLN =



Soil Scoop *N Mgt for Grain Protein*

4.2 – 13.3(N cost in $/lb N)/((protein discount per point)(expected yield))

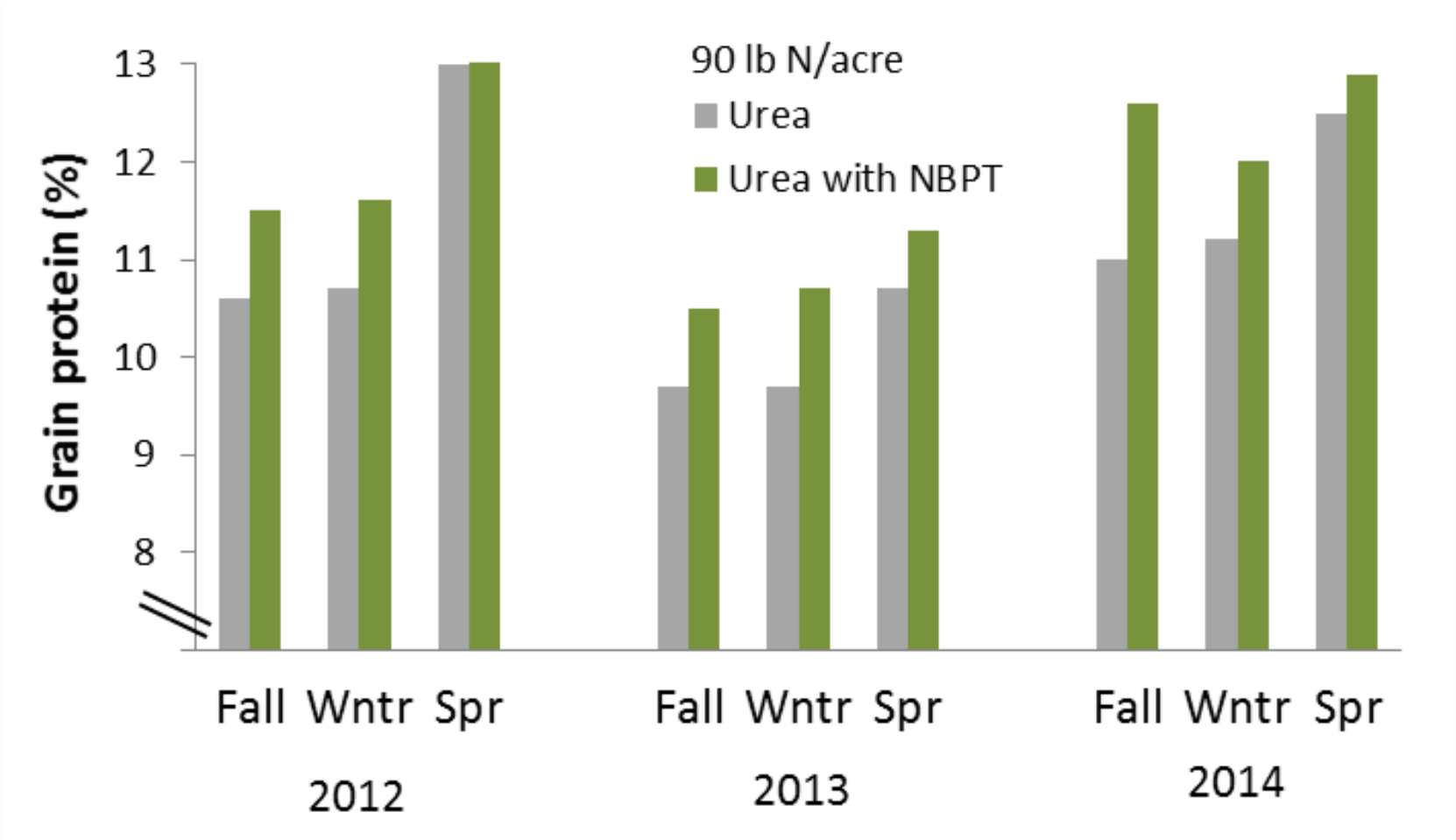
Questions?

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, N-Fixx, Arborite® AG)	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 winter wheat grain protein



Coffee Creek, MT
MSU Fertilizer
eFact 71

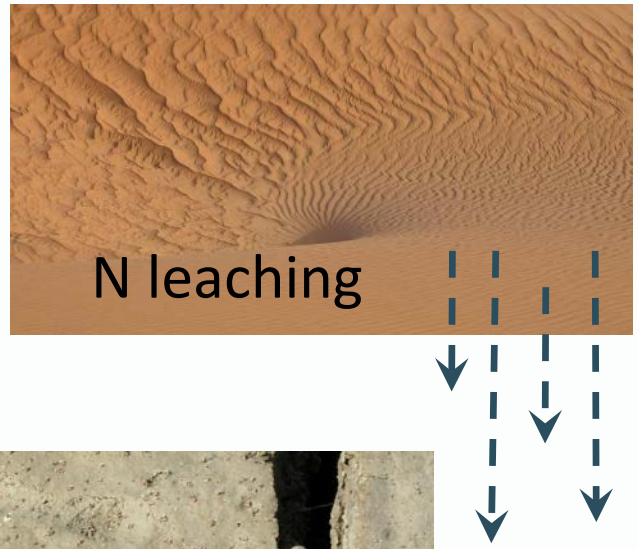
NBPT sig increased protein by 0.4 to 1.6 % points.
NBPT only increased yield in Fall 2012.
Spring application likely less expensive, equally effective alternative

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

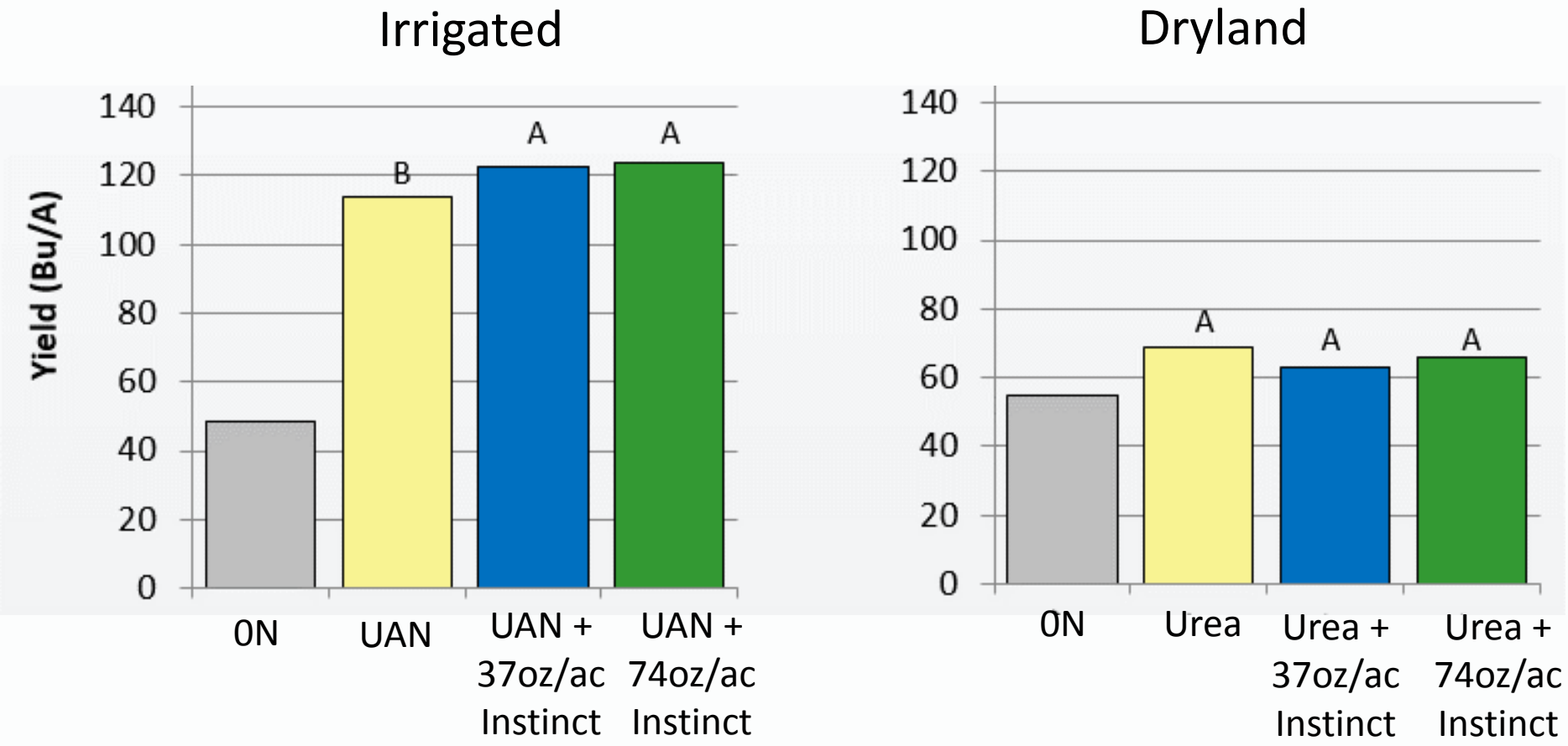
Nitrification inhibitors

- 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

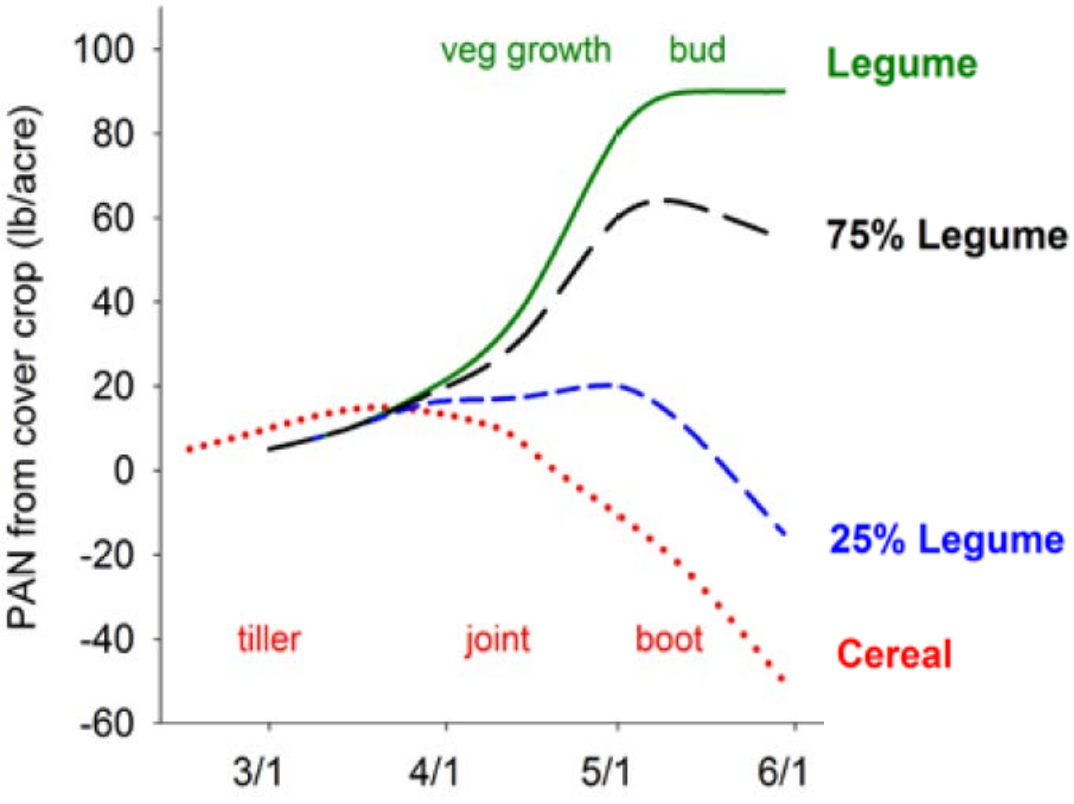
Instinct II® (nitrification inhibitor) increased winter wheat grain yield under irrigation (but not dryland)



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

Legume cover crops to supply N

- Terminate by first bloom



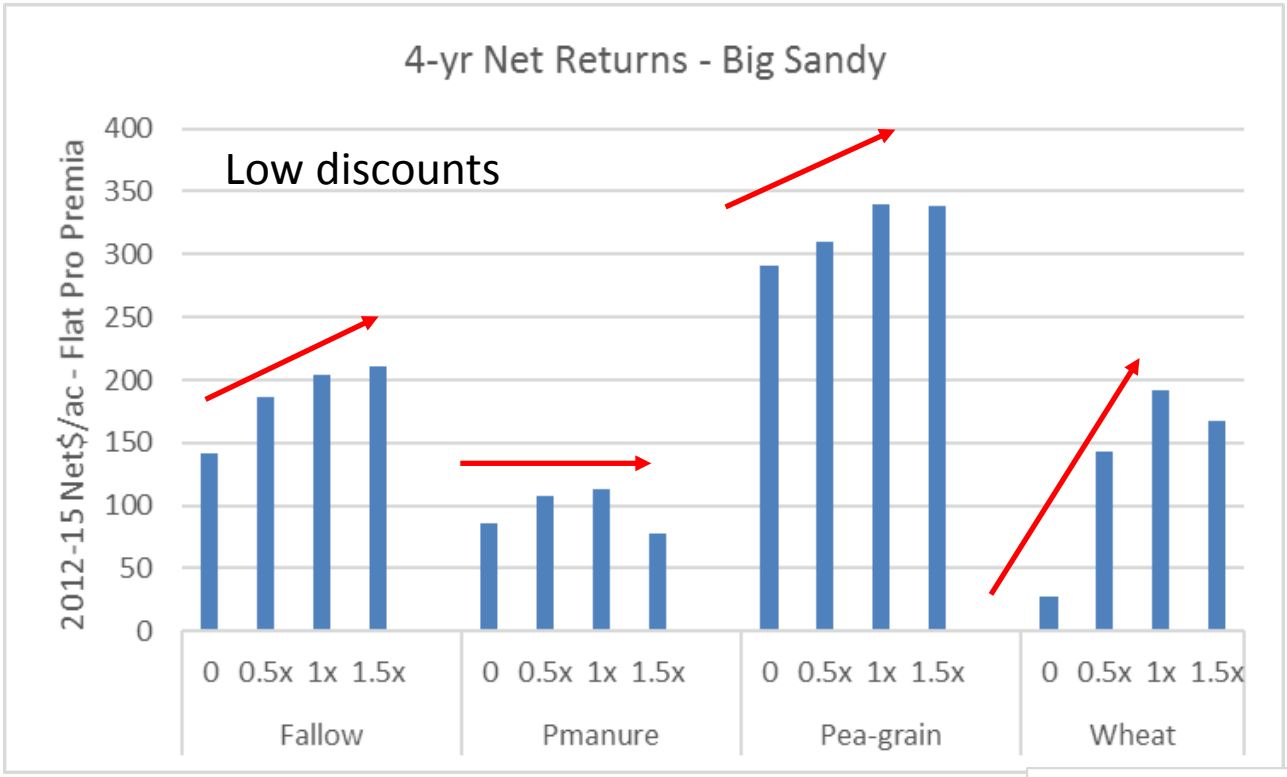
- Comprise 50% of ccrop to provide plant available N (PAN), especially if terminated late

Willamette Valley, Oregon
Sullivan and Andrews, 2012

MSU Cover Crop Studies

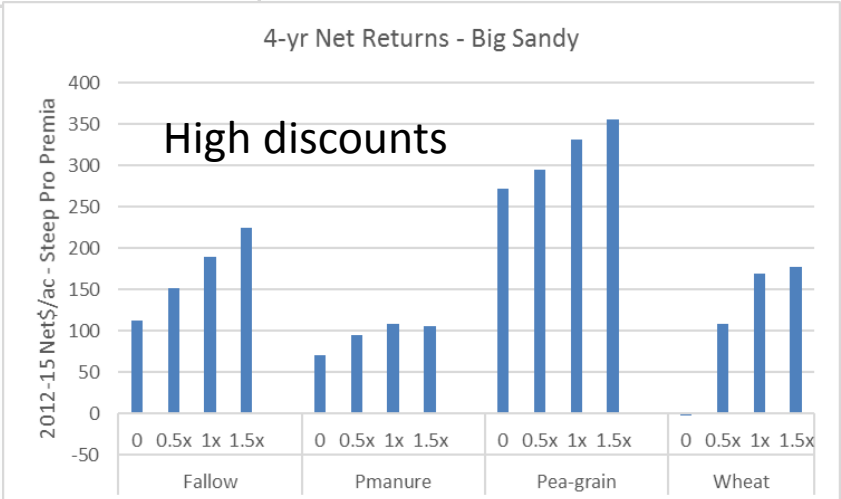
- Spring wheat grain yield was lower after CC than fallow in four of six field-scale studies, and protein results were mixed.
- High water use from late termination was likely cause of yield differences.
- Not a stellar outlook for cover crops in short term. What about long term?
- *Net return from pea cover crop - wheat similar to tilled fallow in 11th to 14th year of study near Bozeman* (MSU Ffacts # 72)

4-yr Net Returns – Big Sandy (sandy clay loam, 1.4% OM)

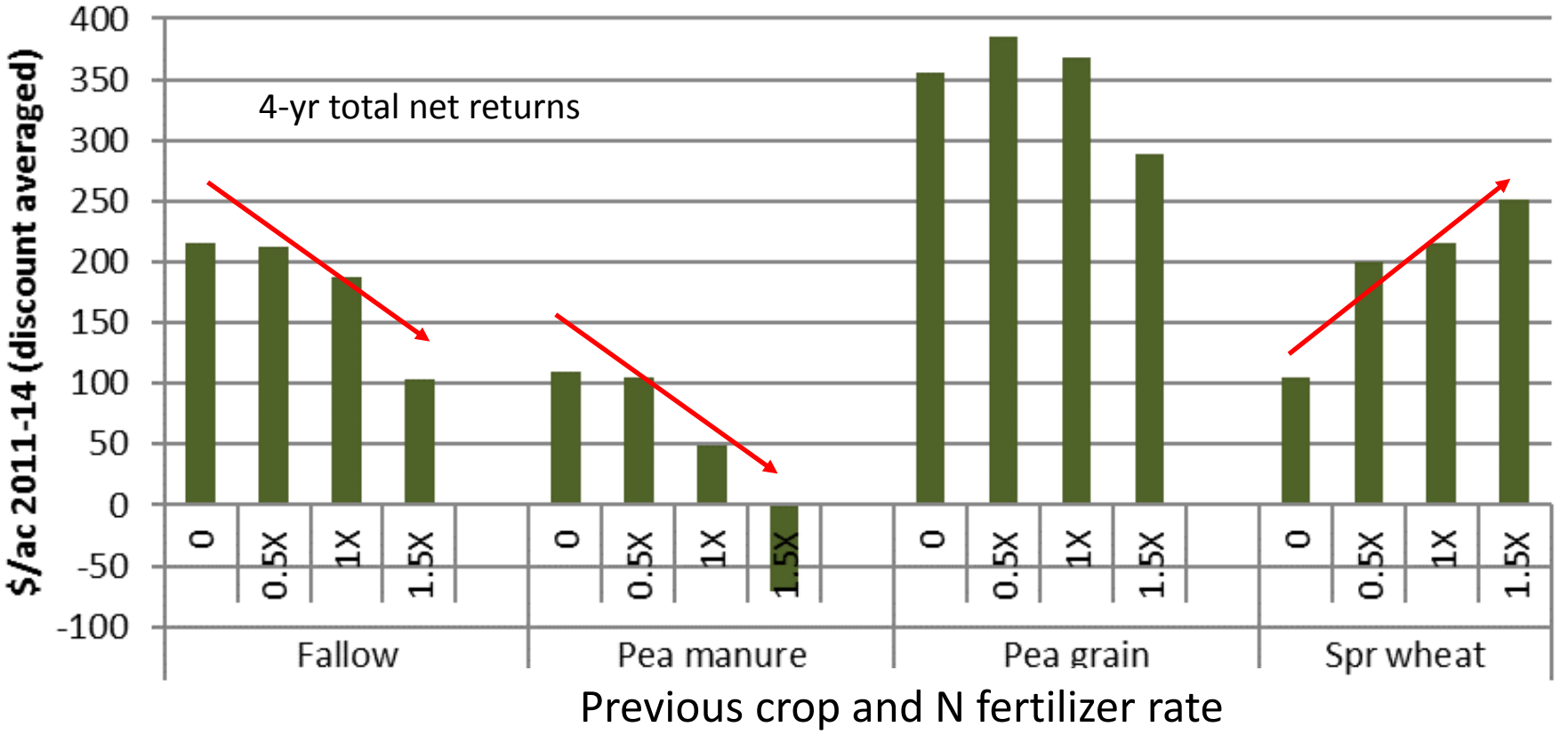


1x = 3 lb N/bu

Do results make sense?

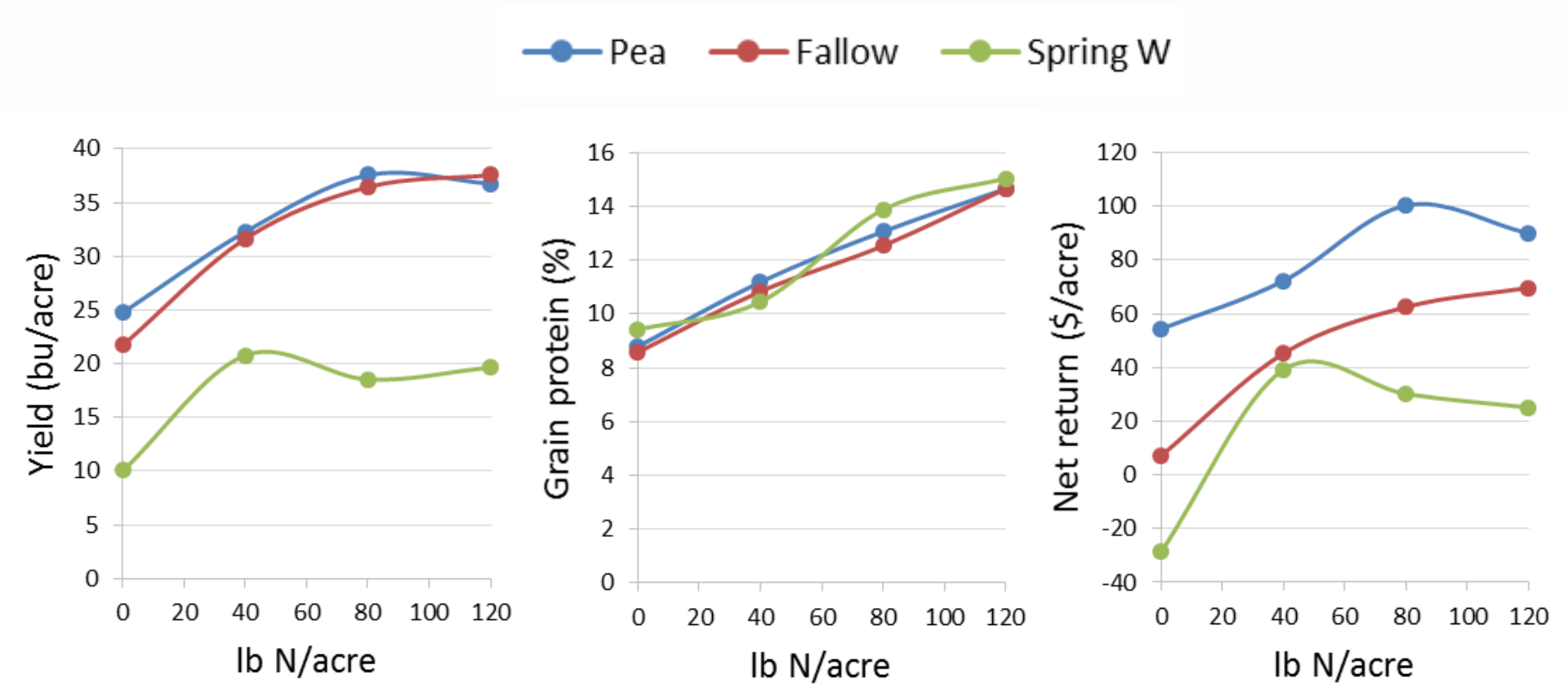


4-yr Net returns – Dutton (clay loam to clay, 2% OM)



Take home: Pea grown for grain – winter wheat yields highest profit in Triangle in both coarse and fine textured soils. Optimum N rate on WW appears highly dependent on previous crop, texture, and whether yield goal met (Big Sandy) or not met (Dutton).

Average winter wheat yield, protein, and annual net return after pea, fallow, and spring wheat (2005-2010)



Chen et al., 2012, Moccasin, MT, dryland, notill, shallow soil (18”)

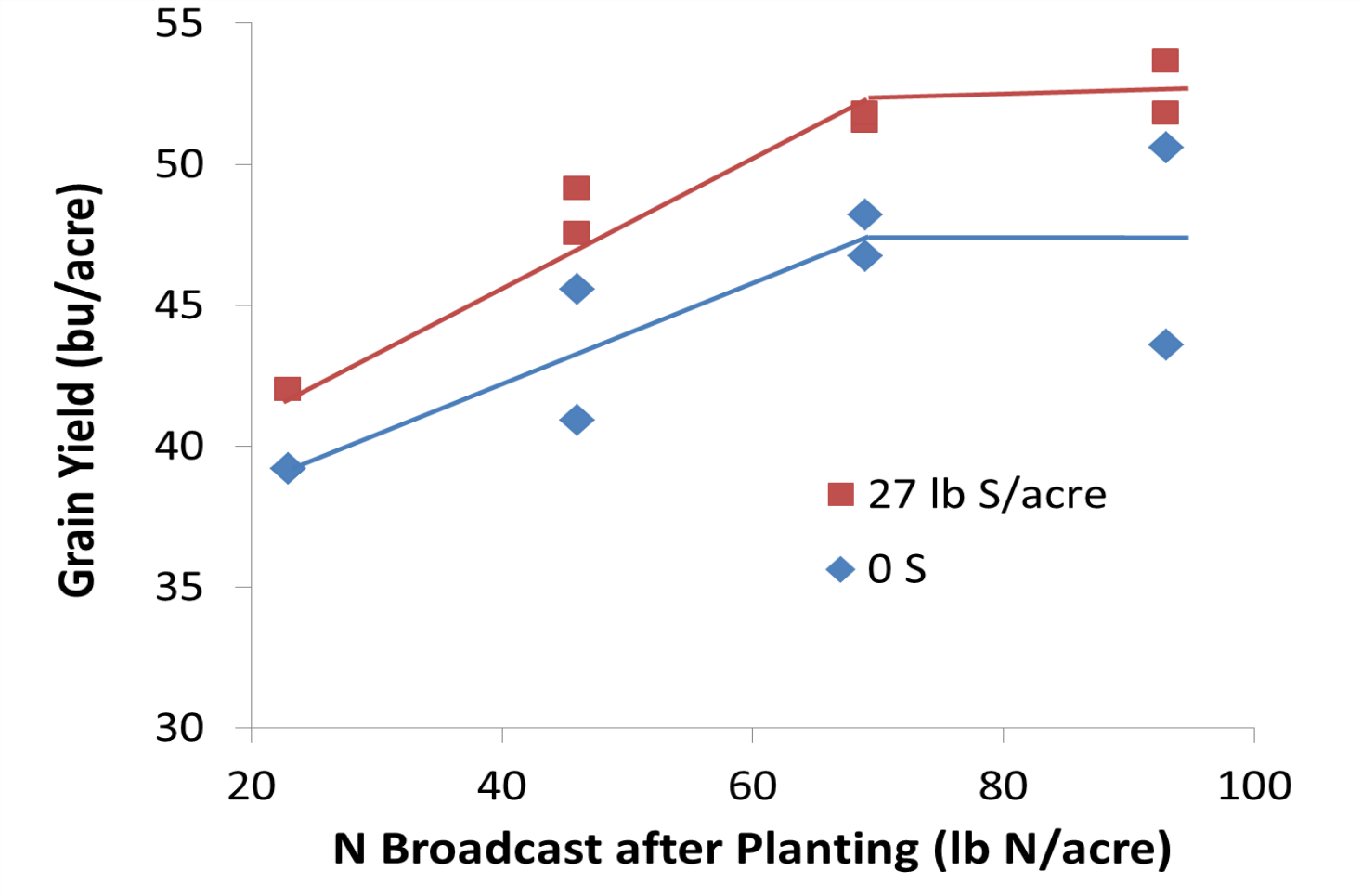
Placement – uniform application, where its needed

- Urea and ammonium based fertilizers – best subsurface placed
- Banding is more efficient use of N, use less N but different equipment and takes more time
- Safe rates for seed placed
  - On-line resources to calculate
  - 2-3 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

Questions?

On to *S, P, K, and micronutrients*

Sulfur increases N uptake and yield



Salvagiotti et al. 2009

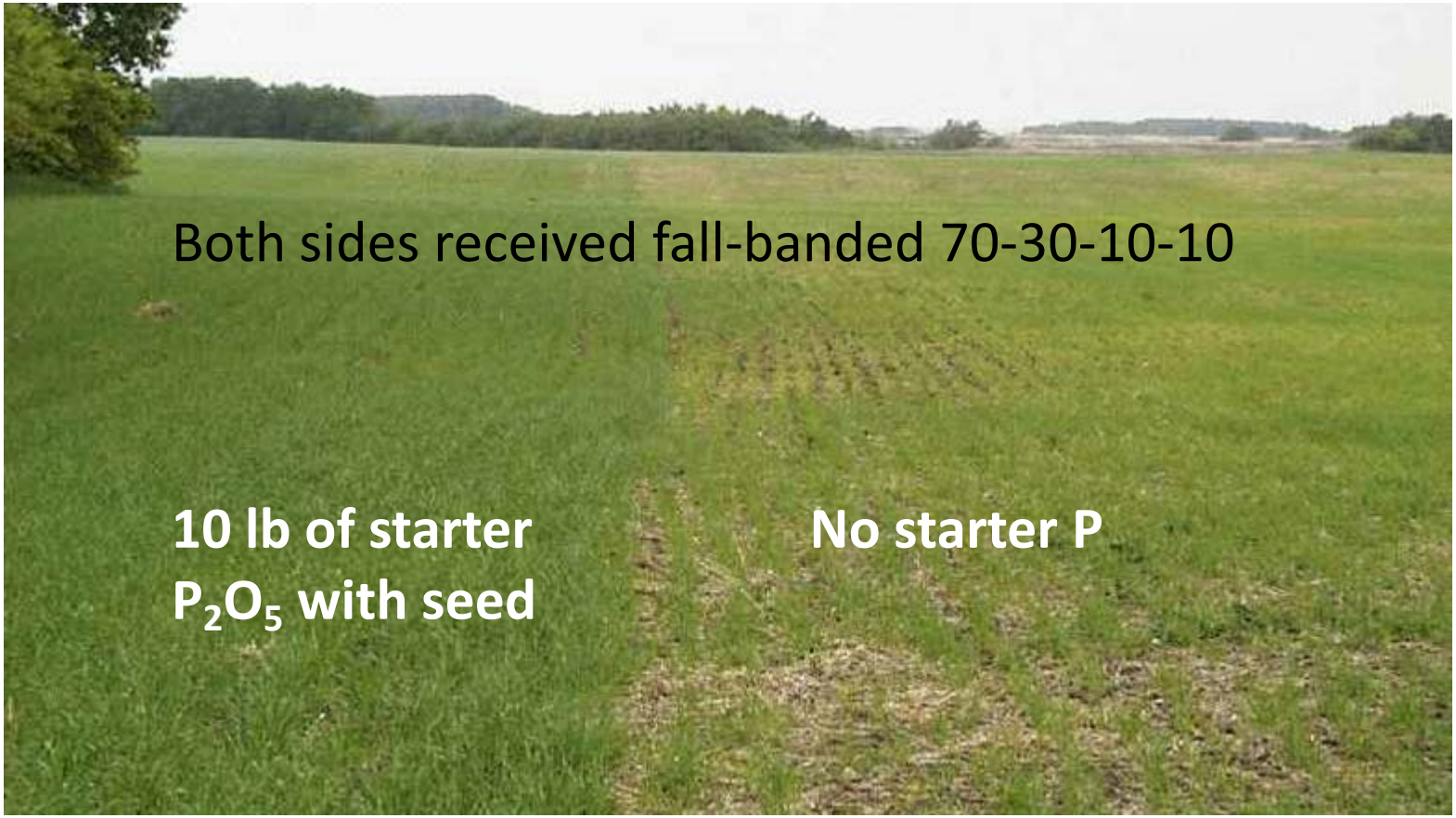
Insufficient S decreases utilization of N, limits yield and protein

S fertilization

- Use crop and field history (sandy, acidic, or low OM soils are more likely low in S), crop appearance, and soil and tissue sampling
- If the prior crop showed S deficiency, then 10-15 lb S/acre before or at seeding could be a wise investment (MSU Ffacts # 41)
- If uppermost leaves just before heading < 0.20 to 0.25% S, 3-5 lb S/acre ammonium thiosulfate or ammonium sulfate could salvage yield and protein
- Apply sulfate S sources in spring to avoid overwinter leaching loss
- Elemental S slow to supply plant available S. Apply in fall to become available before peak demand. Will supply crop for > 2 years

Impact of starter P in a cool spring on spring wheat emergence

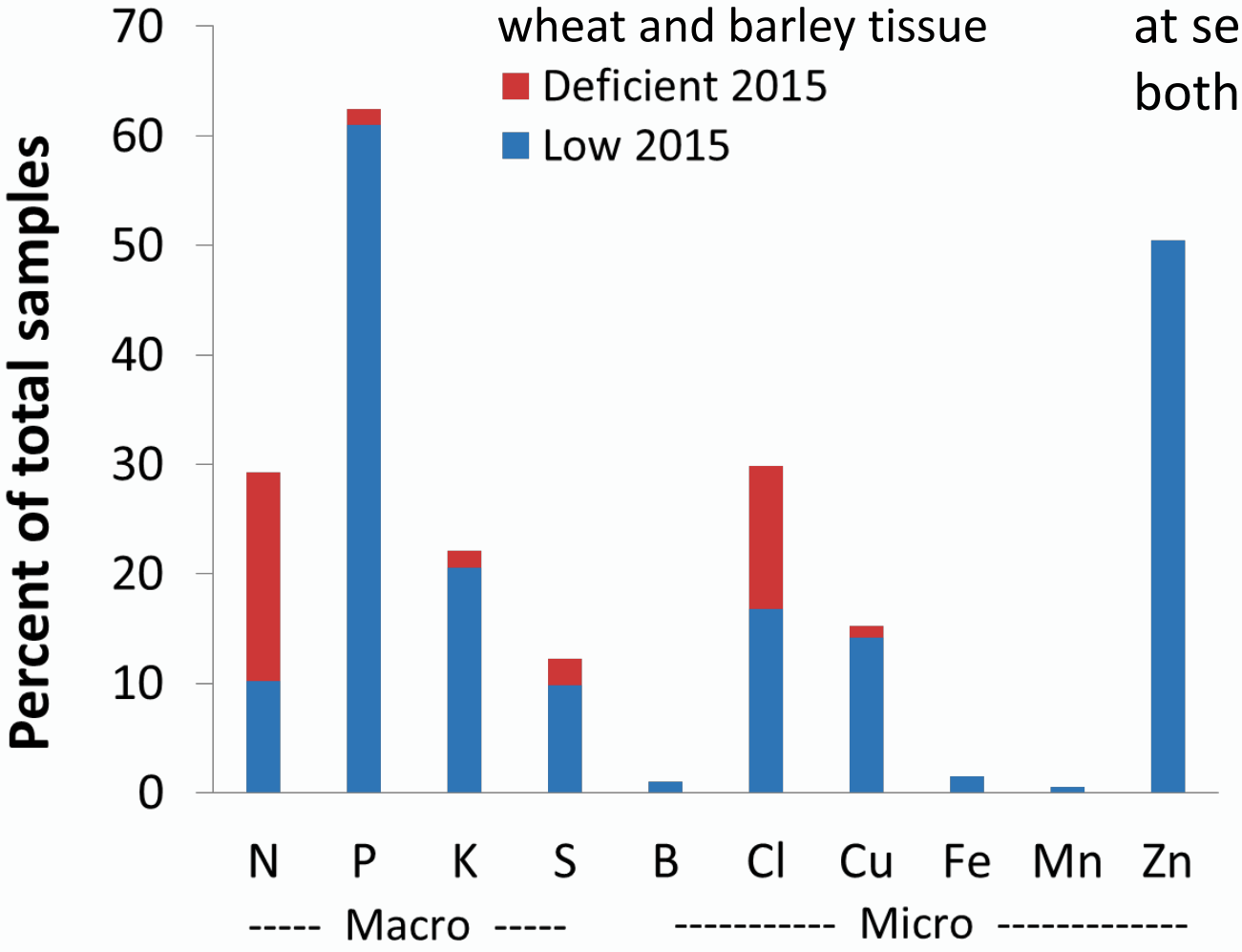
P is immobile and gets tied up in soil, consider “pop-up”



P Source options

- Generally no yield differences between sources
- Exception: Liquids can produce higher yields on highly calcareous soils (> 20% $CaCO_3$), but may not be economical
- Limited research on specialized P fertilizers for cereals in Montana and surrounding region
- Prior rotation of buckwheat, legumes or mustards can dissolve rock phosphate to benefit self, but no carryover to next rotation found (Rick et al., 2011)

Can K be ignored? Definitely not if supplying Cl.



20 lb KCl (0-0-60)/acre at seeding would supply both K and Cl

Data suggest of the micros, zinc should be given most attention

Agvise unpub. data, N=210 samples

Micronutrients

- A combination of deficiency symptoms, soil testing, and tissue testing may be best approach at identifying deficiencies. This is NOT an exact science.
- Micronutrient deficiencies are exception, not rule
- Cool wet conditions cause deficiency – likely disappear when weather warms
- Too much of some micros can hurt yield more than not enough
- The main challenge is even distribution of a very small quantity – consider foliar options

Relative response to micronutrients

	Response to micronutrient (Voss 1998)				
	Boron	Copper	Iron	Manganese	Zinc
Wheat	Low	High	Low	High	Low

Best test is field test strips and measured yield response

"Micronutrients should be used when there is an economic benefit to the farmer, ……" – R. Karamanos

Summary

- Use realistic yield goals and soil test N to calculate pre-plant N rate
- Adjust in-season for given year
- Select the source appropriate for conditions
- Use on-line tools for variety selection, optimal N rate, safe seed-placed rates
- Give peas a chance
- Build P & K in good times to rely on during lean times
- Watch for insufficient S, limiting N uptake

Resources - online

- Variety selection tool
  www.sarc.montana.edu/php/varieties/
- N rate calculation tool
  http://www.msuextension.org/econtools/nitrogen/index.html
- SARC Fertilizer Calculator
  http://www.sarc.montana.edu/php/soiltest/
- Safe Rate Seed Placed Calculator
  http://seed-damage-calculator.herokuapp.com/

Resources - publications

On soil fertility website under "*Extension Publications*"

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

- *Interpretation of Soil Test Reports for Agriculture* (MT200702AG)
- *Developing Fertilizer Recommendation for Agriculture* (MT200703AG)
- *Nutrient Uptake and Timing by Crops* (EB0191)
- *Practices to Increase Wheat Grain Protein* (EB0206)
- *Nutrient Management in No-Till* (EB0182)
- *Enhanced Efficiency Fertilizers* (EB0188)
- Soil Scoops - under "Soil Scoop"

QUESTIONS?

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

Photo by Andrew John