Fertilizer Management in a Down Market, Barley Focus

Tri-County Crop School, Three Forks, February 21, 2018

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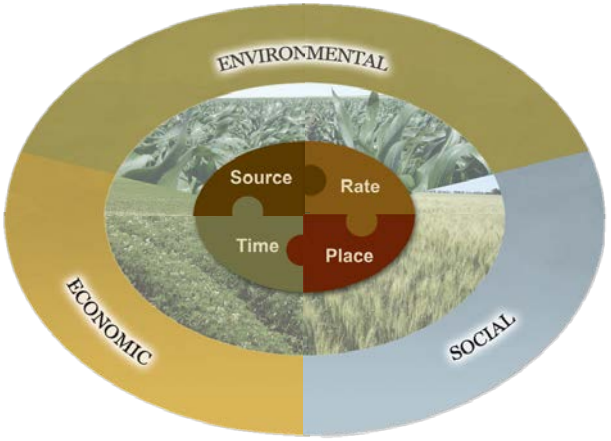
MONTANA STATE UNIVERSITY

MSU Soil Fertility Extension

Primary objective today: Assist you in maximizing profit from fertilizer management in era of low commodity prices

Specifically, I will discuss:

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



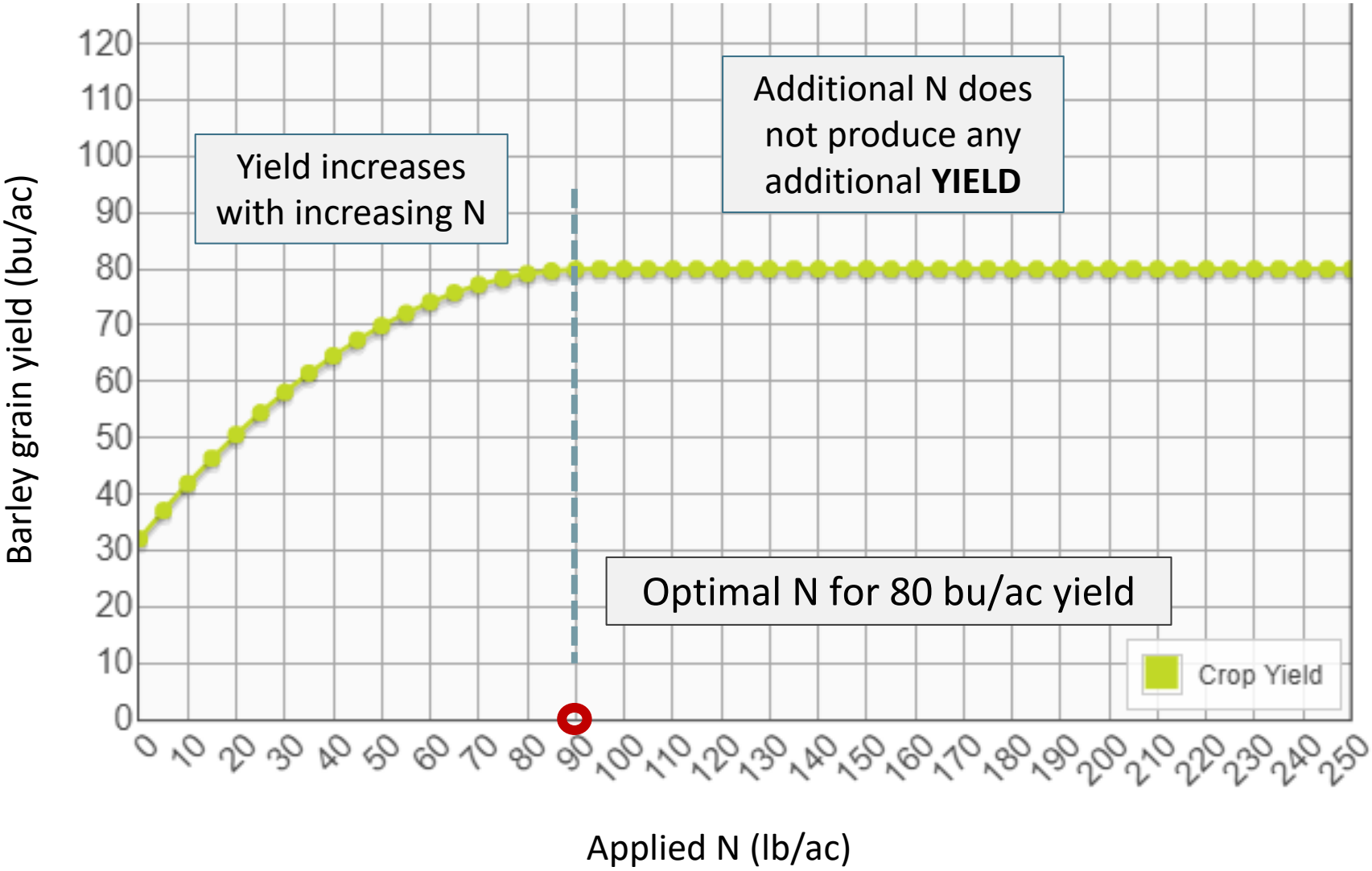
Driving forces behind fertilizer rates

- Soil nitrate-N: can vary greatly by year due to e.g. plant residue decomposition, leaching. Fertilization is influenced by yield goal, soil test ideally 2-3 ft. in the spring or late fall.
- P and K: are more stable in soil. Losses to erosion, and harvest and ‘fixation’, fertilization determined by 6” soil test level independent of yield goal.
- Soil S: can also vary greatly by year, but soil tests not best tool. Use field history, crop performance and tissue tests.
- Micronutrients: can vary seasonally and annually. Availability is influenced by organic matter and pH, which are relatively stable over time, and soil temperature and moisture, which vary greatly. Very little research.

N: Realistic yield goal for rate calculations

- Use variety selection tools (AMBA, MSU-SARC, MSU Dept Plant Sciences and Plant Pathology)
- Past yields indication of future performance
- Having ability for in-season N application allows conservative yield estimate for pre-plant rate

Law of diminishing returns



Soil N = 10 lb/acre, SOM = 2%

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

- Inputs
  - N fertilizer cost, malt/feed grain price, plump and protein cutoff
  - Yield goal
  - Residual soil N
  - SOM
  - These help calculate **TOTAL** available N for max net return

Calculators online for barley, SW, and WW after fallow

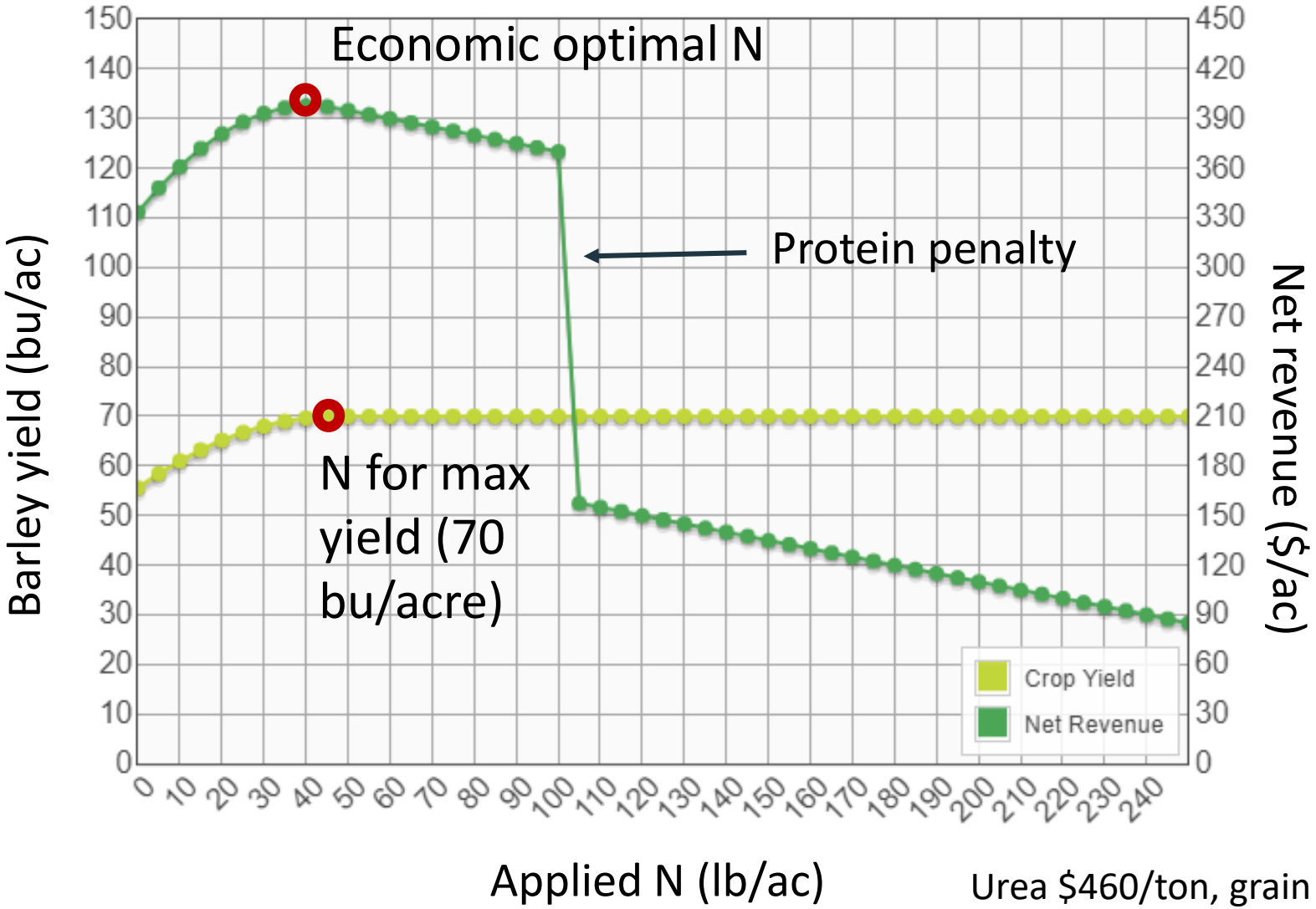
http://www.msuextension.org/econtools/nitrogen/index.html

N considerations unique to barley

- Malting barley 1.2 lb N/bu, feed barley 1.6 lb N/bu starting levels.
- Lower N for malting barley to decrease risk of low plump and high protein.
- Test spring soil N to avoid high protein.

Optimal N for 70 bu/ac barley

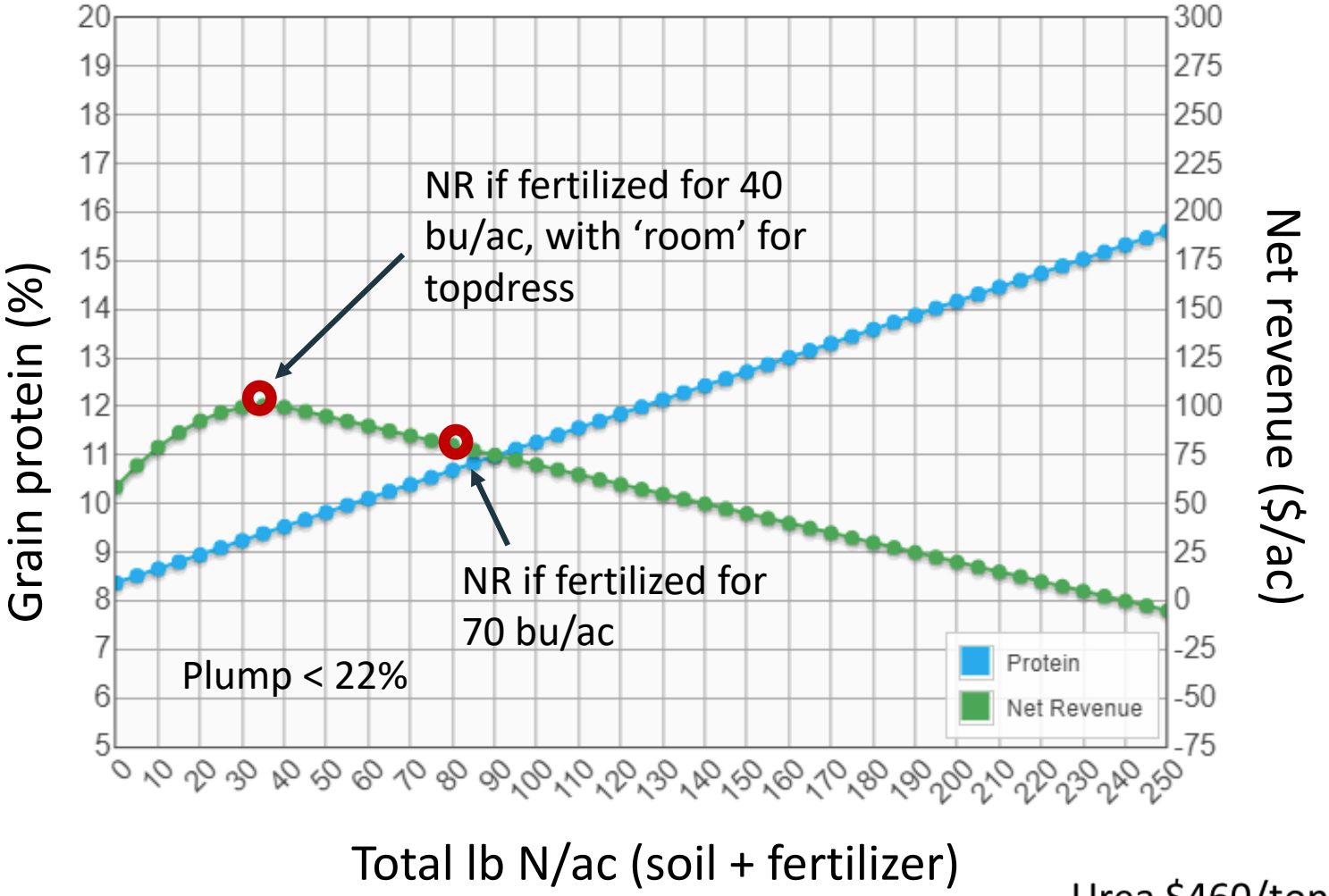
With 40 lb residual N, add 40 lb N/ac for optimal NR



Urea $460/ton, grain $6/bu

If fertilize for 70 bu/ac but get 40 bu/ac

Optimal total N for 40 bu/ac is 35 lb N/ac. Any additional N or soil residue N will not increase yield, which was water limited. Will produce feed grade barley.



Urea $460/ton, grain $6/bu

MSU N rate calculation tool takes into account fertilizer costs, grain prices, soil organic matter, residual soil N, and protein discounts/premiums (for wheat)

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

Total available N **(lb N/bu)** for maximum return: Malt barley following fallow

Barley ($/bu)	**$/ton urea**		
	$275	$460	$740
	Total lb N/bu		
4	1.16	1.08	1.00
6	1.16	1.08	1.08

Based on 60 bu/ac, 2% O.M.

Best way to maximize profit is to adjust rates based on costs, prices, and discounts, on the MSU calculator.

N rate adjustments

- Fall vs. spring soil test
- 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

Soil test: 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

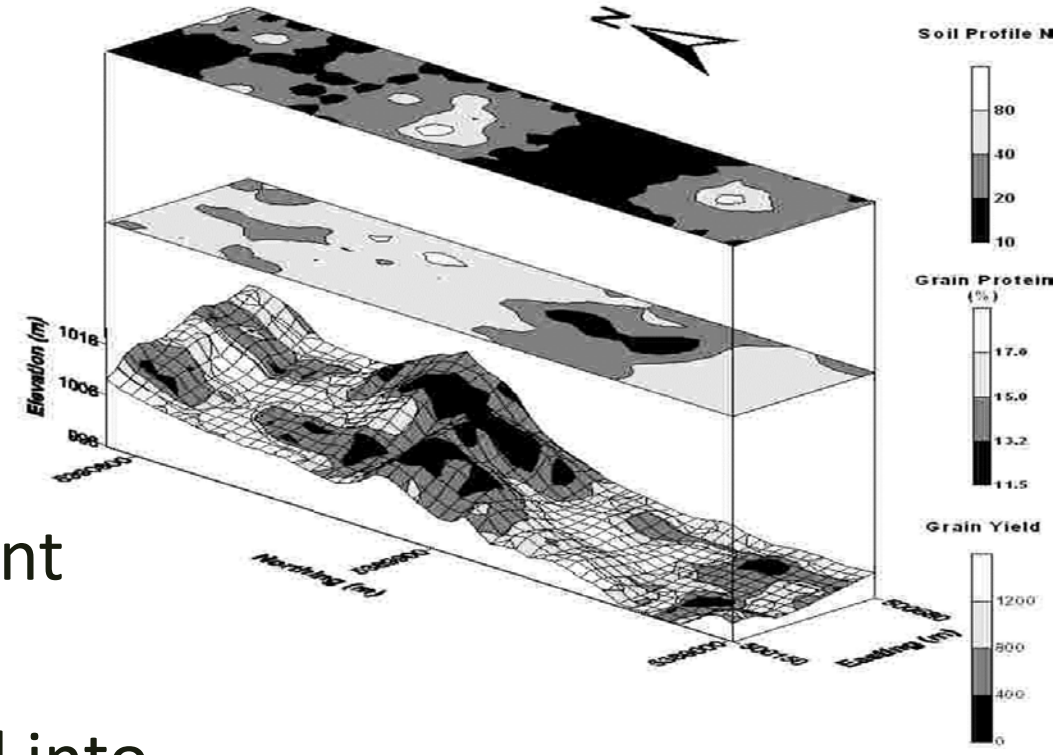
High N on shallow or coarse soil

Under fertilized

N leaching (or N_2 gas losses?)

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

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

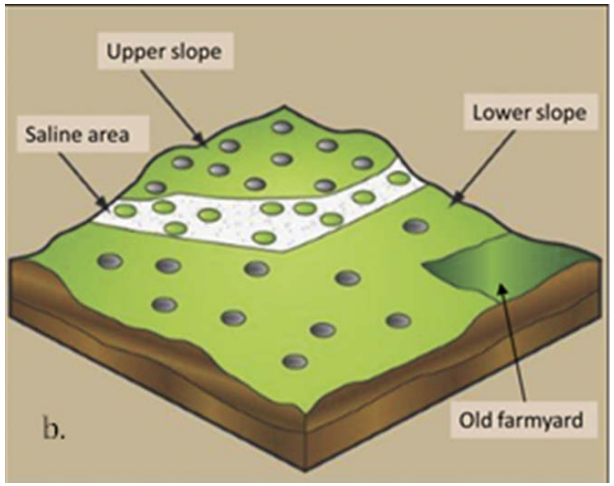
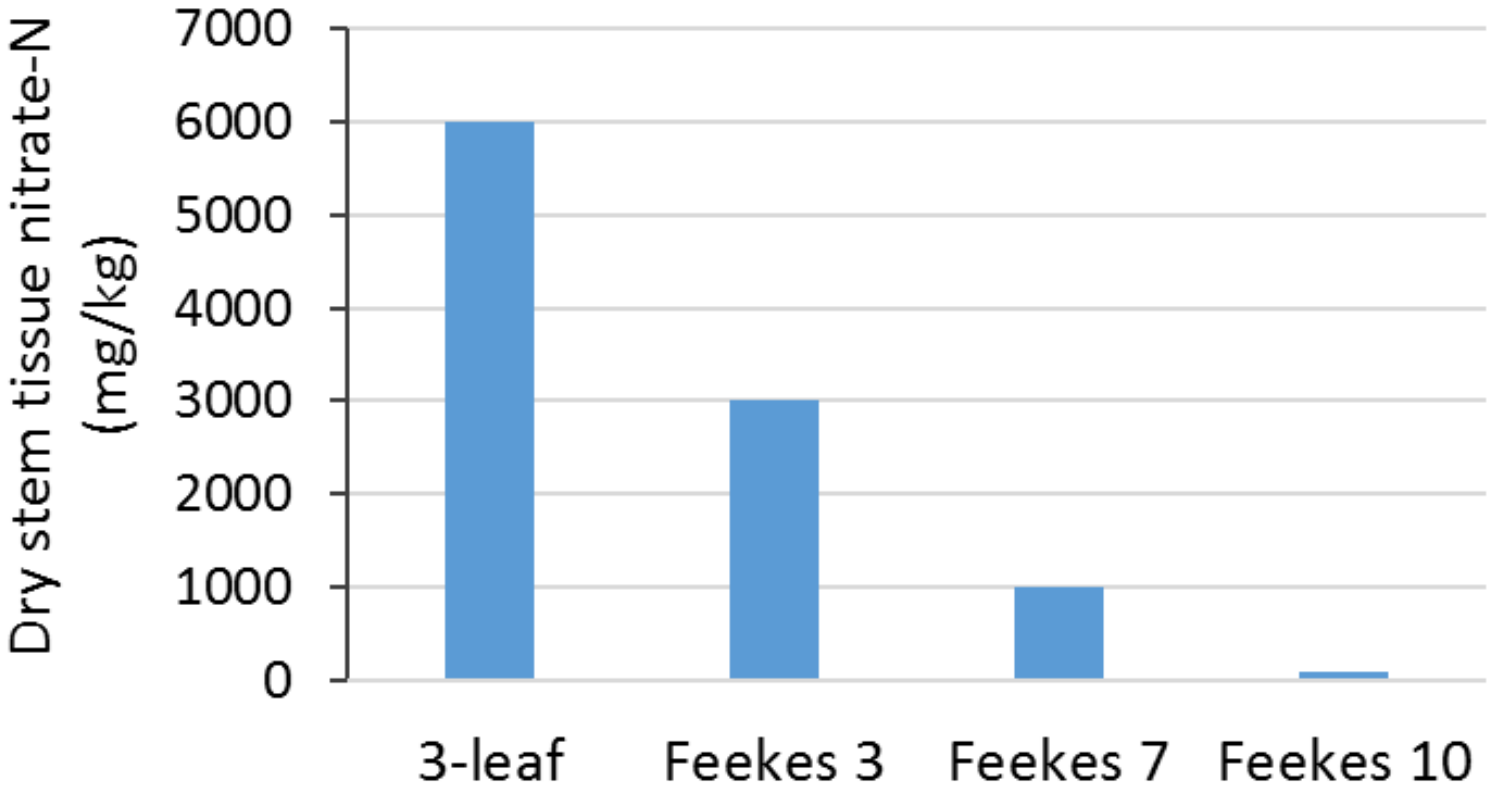


Image adapted from IPNI 2012

Critical barley stem tissue nitrate-N concentrations may help decide whether to topdress N



Feekes 3 = main shoot and 6 tillers, F7 = 2nd node visible, F10 = boot swelling

Stark and Brown, 1987, ID, irrigated, 3-leaf and Feekes 3

Thompson 2004, AZ, irrigated, Feekes 3, 7 and 10

Questions?

On to *Timing, Source, Placement*

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
- Legumes, the ultimate slow release, will be discussed under ‘rotations’

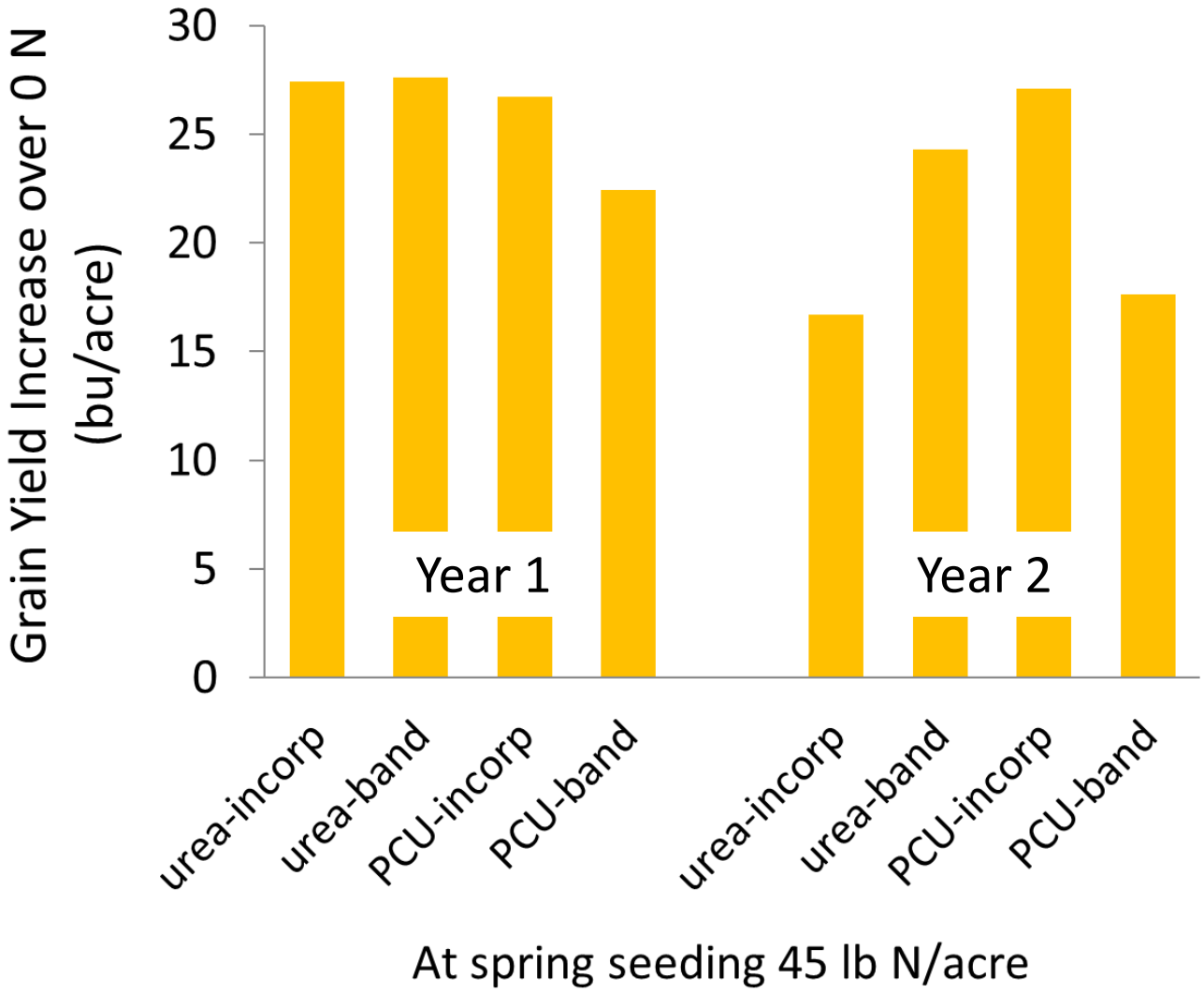
Different N sources have different volatilization and leaching loss potential

	***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?

Slow- and controlled-release for the northern Great Plains

- No consistent benefit shown
- Fall broadcast may increase yield over spring broadcast urea, especially in a wet year when urea may leach overwinter
- If fall application to reduce spring workload 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

Placement and N source on barley grain yield

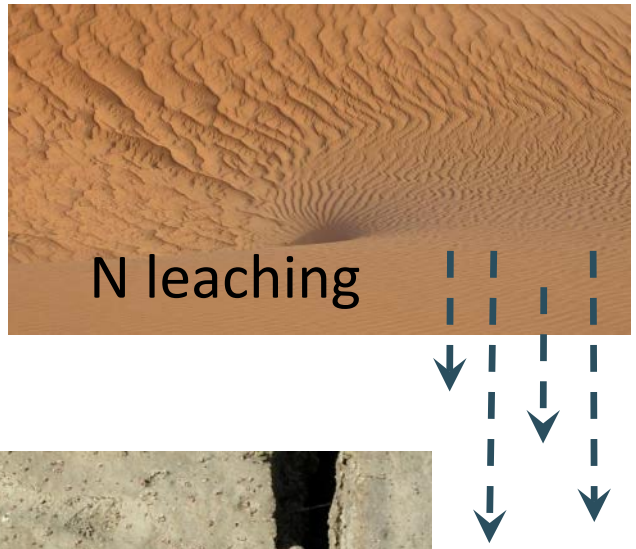


PCU = polymer coated urea

Edmonton, AB, Nyborg et al. 1999

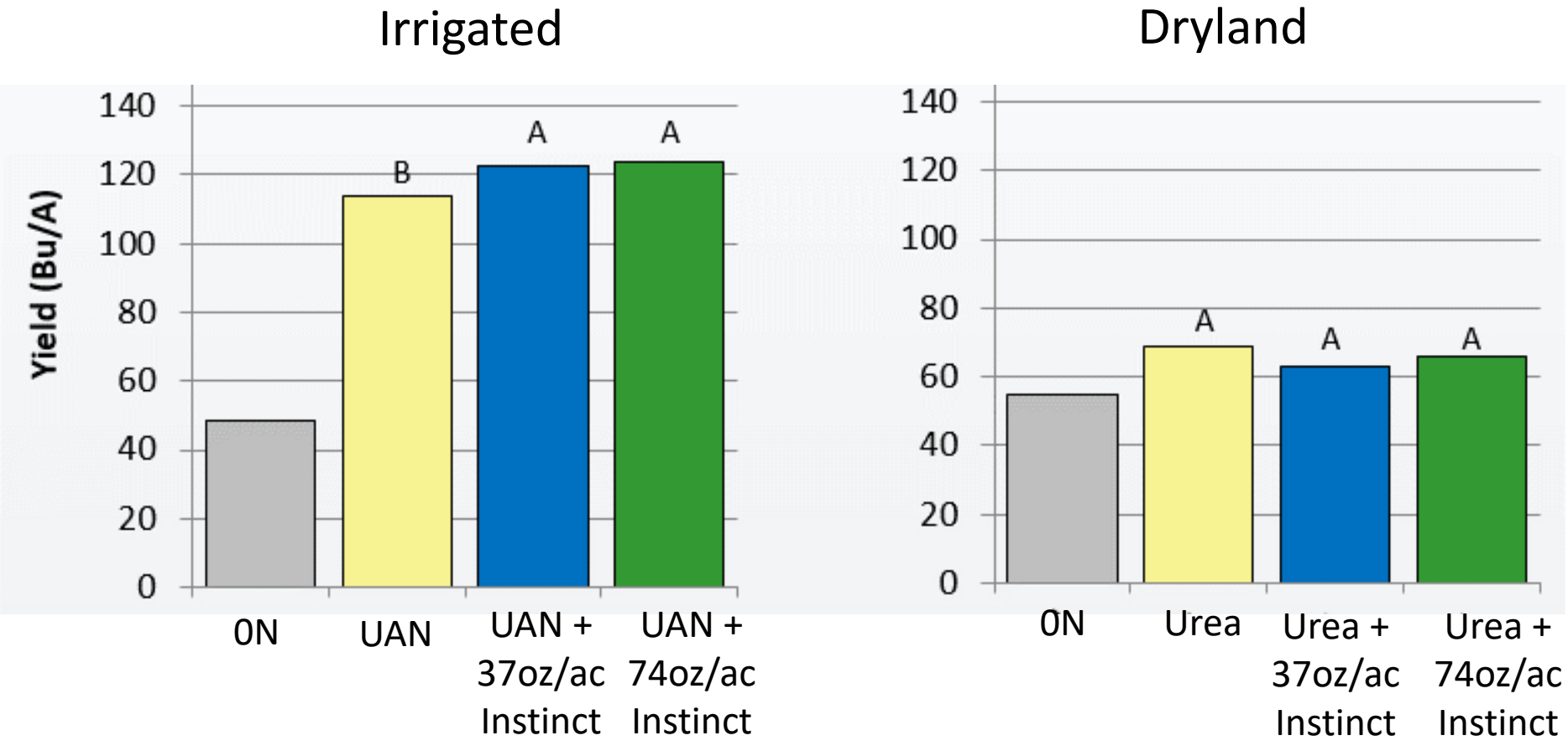
Nitrification inhibitors

- 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

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

Placement – uniform application, where its needed

- Urea and ammonium based fertilizers – best subsurface placed (due to volatilization)
- 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 *Rotations*

Crop rotations

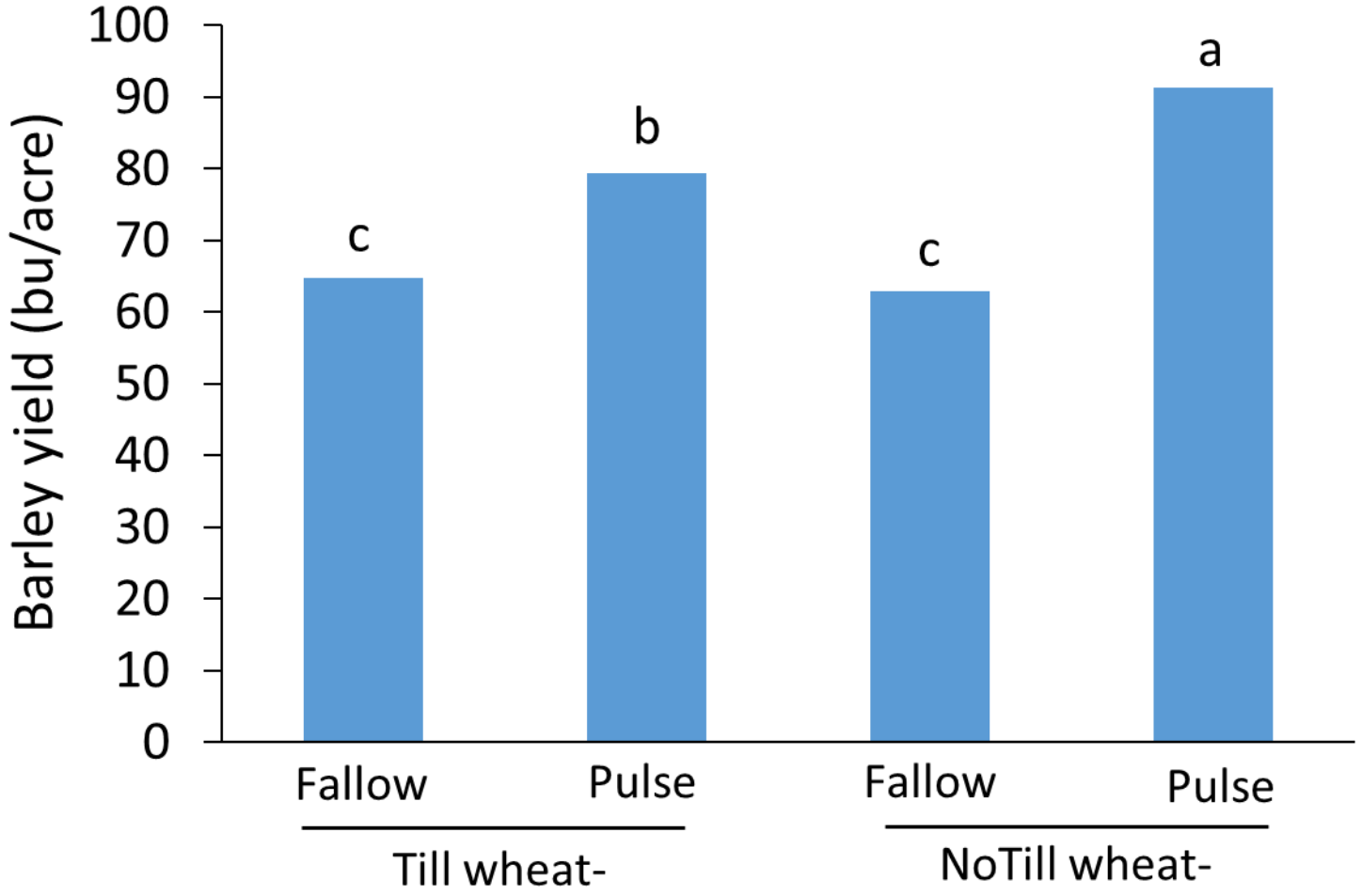
- Barley shows little yield response from previous crop. However there are other benefits:
  - Reduce pest levels of weeds, diseases and insects
  - Increase soil organic matter for increased water storage and nutrient supply
  - Increase economic and environmental resiliency

Residue	Relative Barley Yield
SW, Barley	1.00
Pea, Lentil	1.02
Canola	0.99
Sunflower, Safflower	0.95

Based on research at Mandan, ND, average over 4 rotations. Adapted from Tanaka et al., 2005 and 2007, by K. McVay

Crop rotation and tillage system effects

4 dryland crop cycles of wheat-fallow or wheat-pea grain, then all fallow before barley



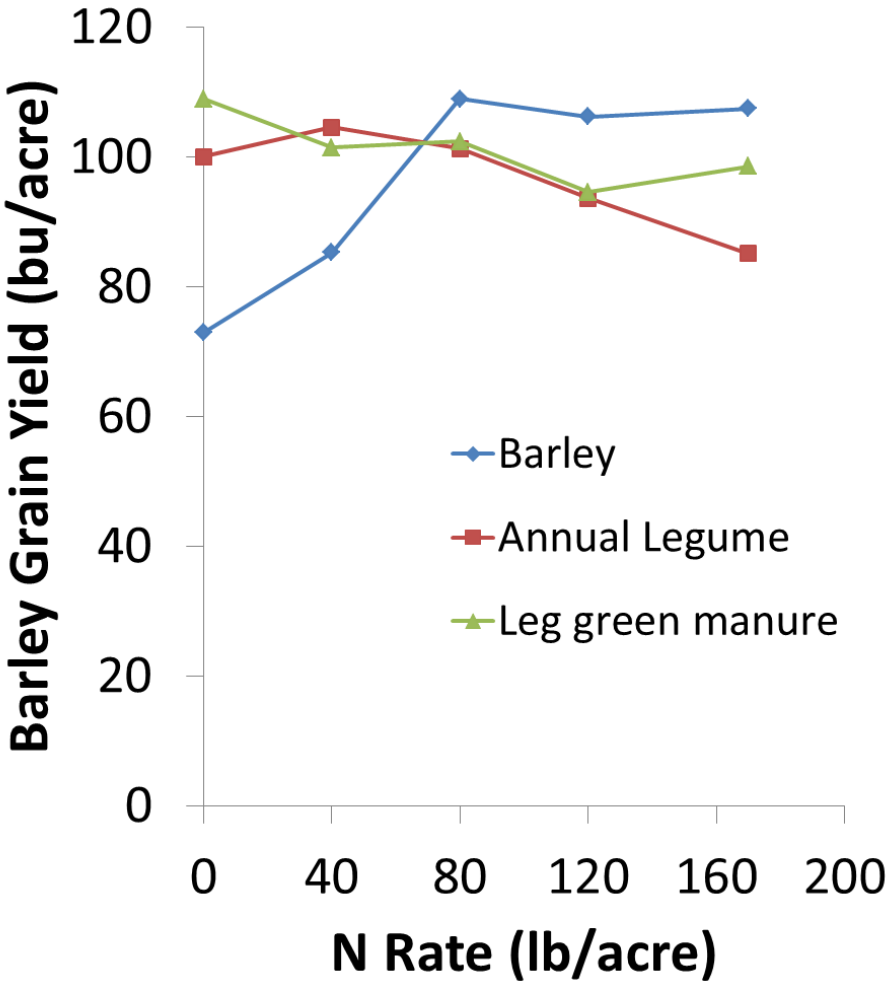
Perry Miller, Unpub data, Fife, MT

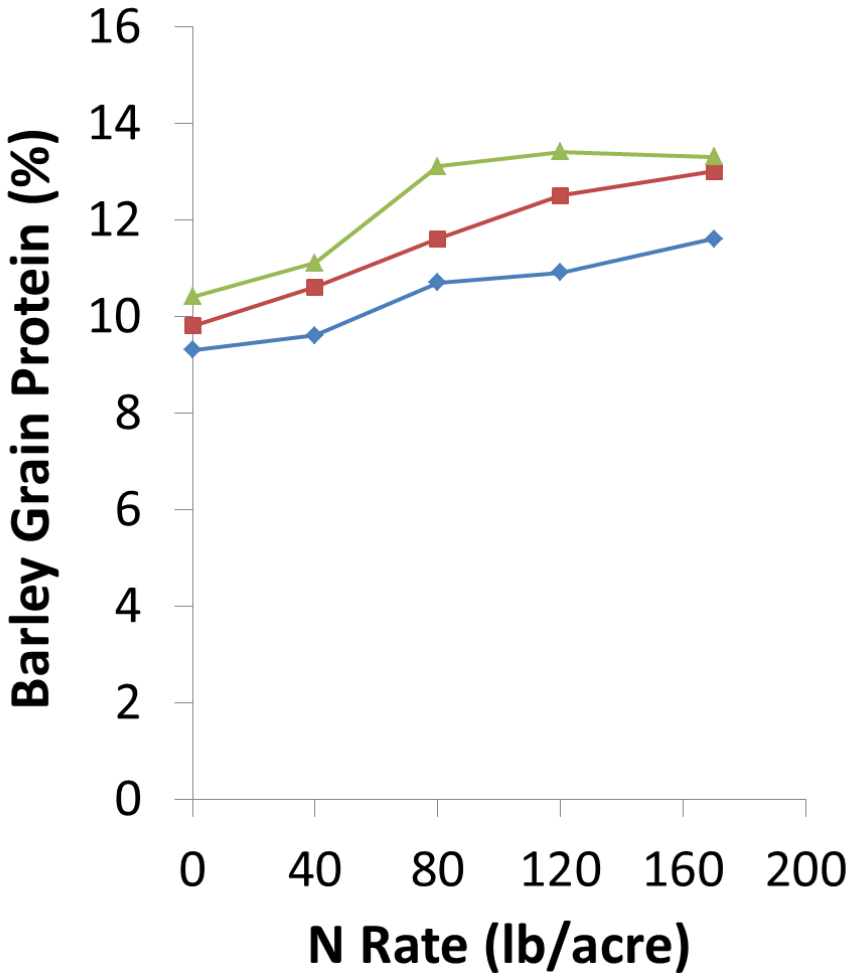
N from legumes

- Legume cover crops release more N more quickly than legume grain (pulse).
- Benefit to yield with less or no fertilizer N, compared to fallow, takes 3 to 4 cycles (several MSU studies with wheat; e.g., Miller et al., 2015).
- A pulse rotation can still increase barley yields planted three years after the pulse crop.
- Legume N credit is highly variable among species and agronomic conditions.

Legume crop	N Credit lb N/acre
Grain 1-2x	~10
Grain ≥ 3x	~20
Cover crop 1-2x	20-30
Cover crop ≥ 3x	30-50

Prior Crop Effect on Irrigated Barley Yield and Protein



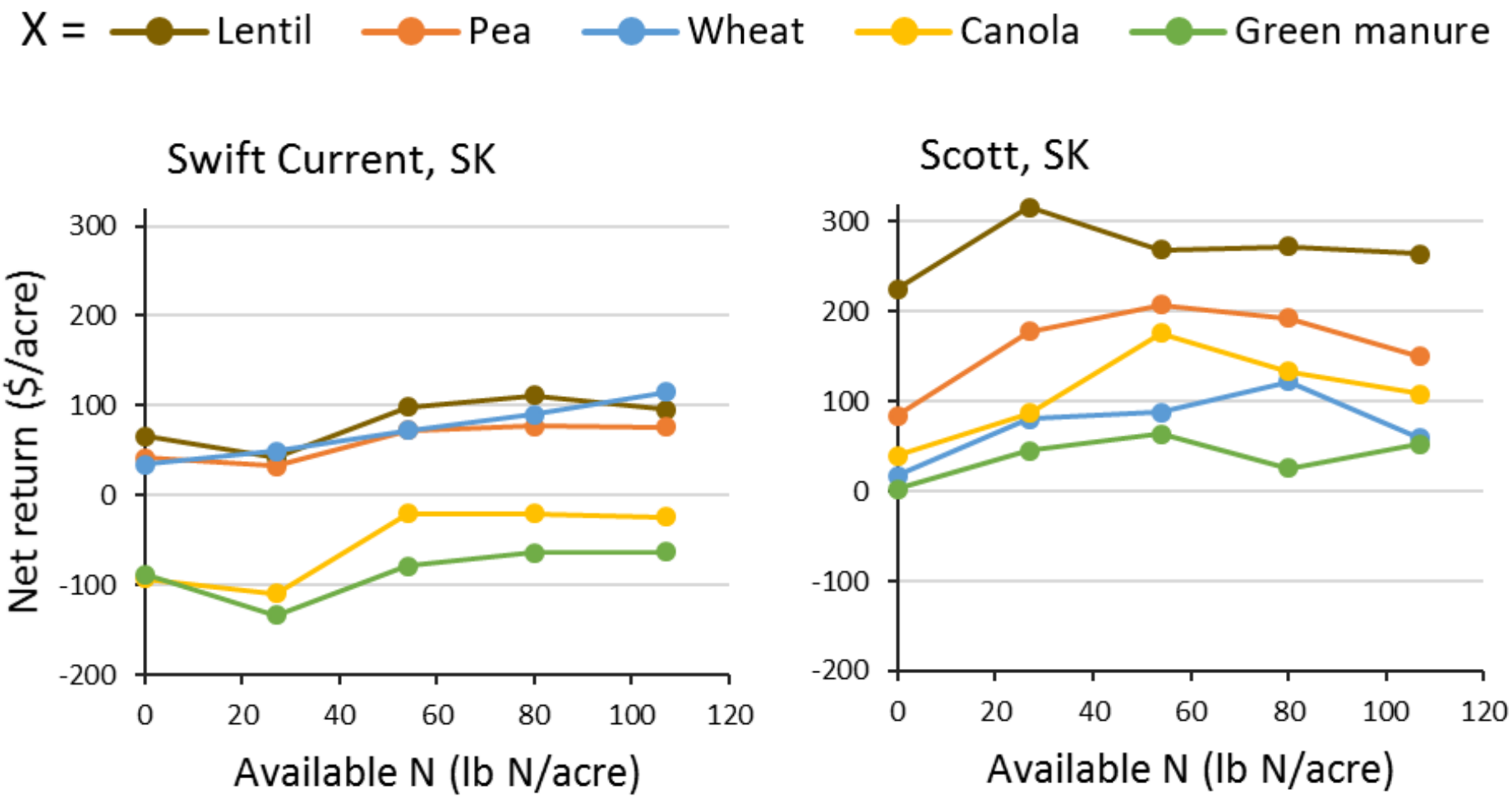


Huntley, MT, Welty et al. 1988, McGuire et al. 1989

Varieties for low protein

- Variety trials are regionally available
- MSU Post Farm in Gallatin Valley
  - irrigated: Champion, Haxby, Hockett, Metcalfe
  - dryland:MT090190, MT124112, MT124128
- Dillon irrigated: Champion, Haxby, Odyssey, Synergy
- Moccasin dryland: MT090190, MT124112, MT124128

3-year net return of x-canola-barley rotation



Khakbazan et al., 2014, SK, only 1 time 3-crop rotation

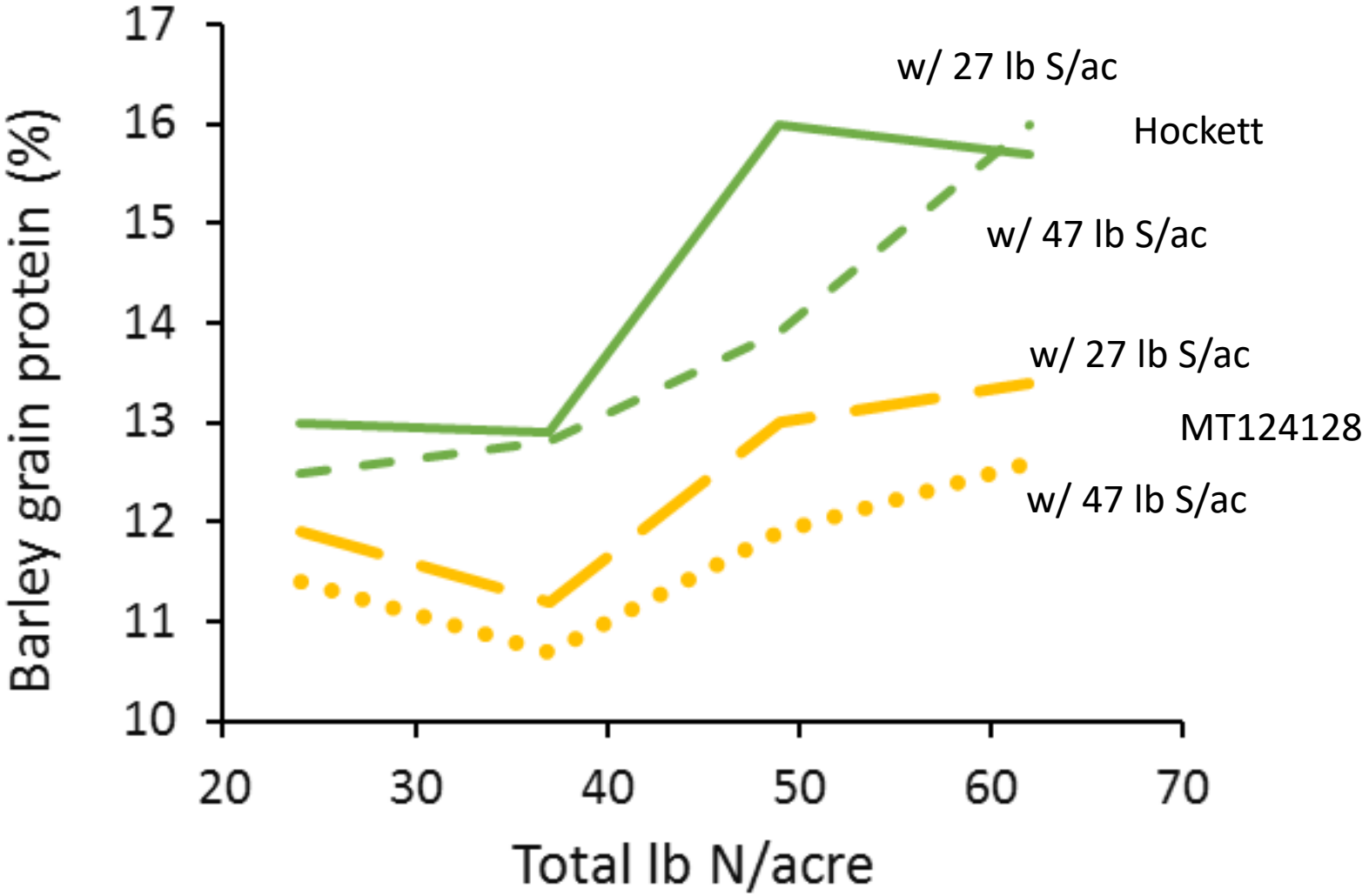
Questions?

On to S, P, K, and micronutrients

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)
- 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

With low soil S, balance S with N, select variety, for yield without high protein



Sherman et al., 2017, unpub data, dryland, Moccasin

P and K rates for feed/malt barley based on soil test levels to 6” depth

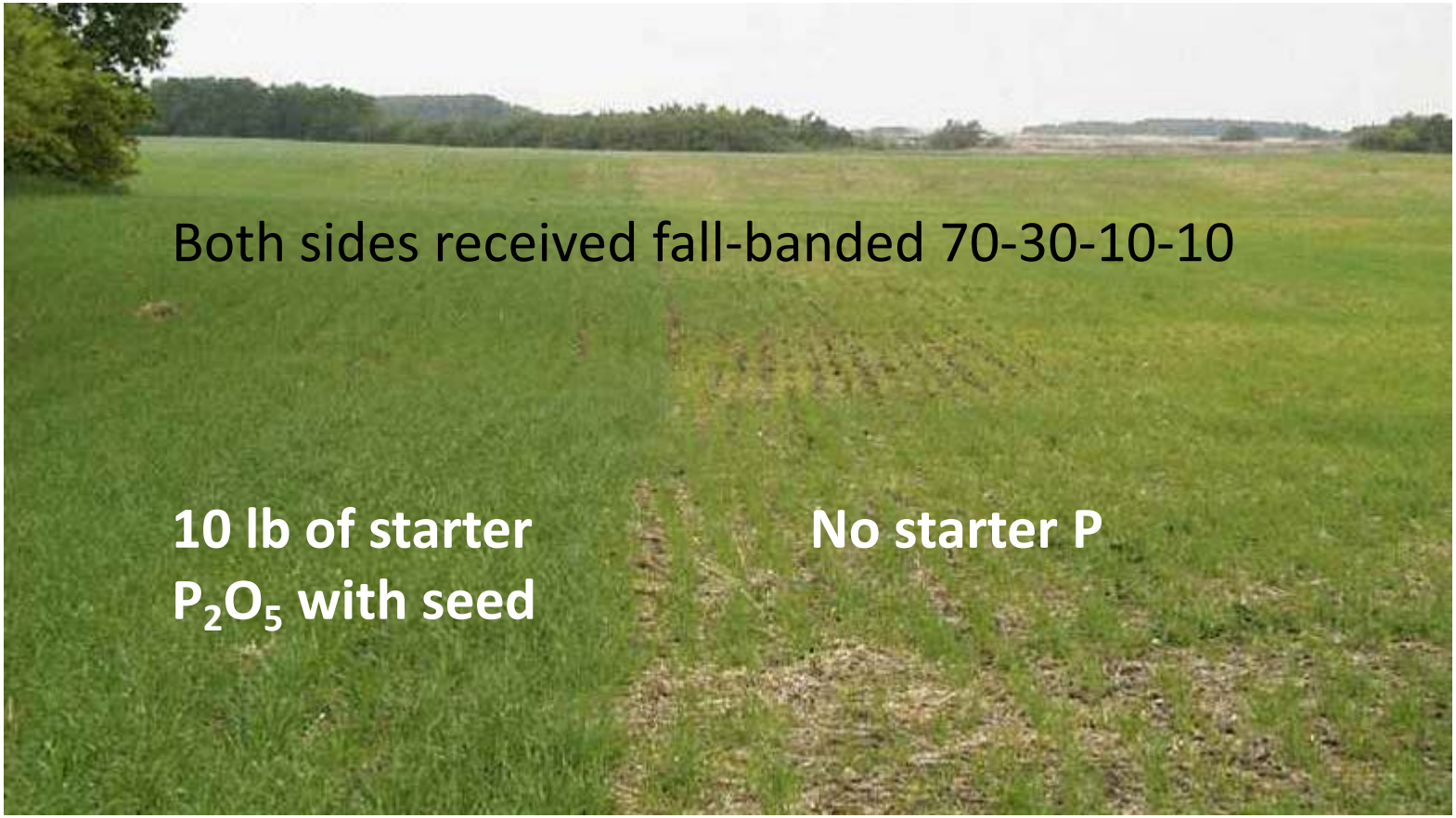
Olsen P soil test (ppm)	lb P_2O_5/acre
0	50
4	40
8	30
12	20
16	10
>16 use removal rates, 0.36 lb P_2O_5/bu grain and 4.1 lb P_2O_5/ton straw	

K soil test (ppm)	lb K_2O/acre	
	Feed	Malt
0	75	90
50	65	80
100	55	65
150	45	50
200	30	35
250	20	25
>250 use 0.25 lb K_2O/bu grain and 30 lb K_2O/ton straw		

Source: MT Fertilizer Guidelines EB0161

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

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

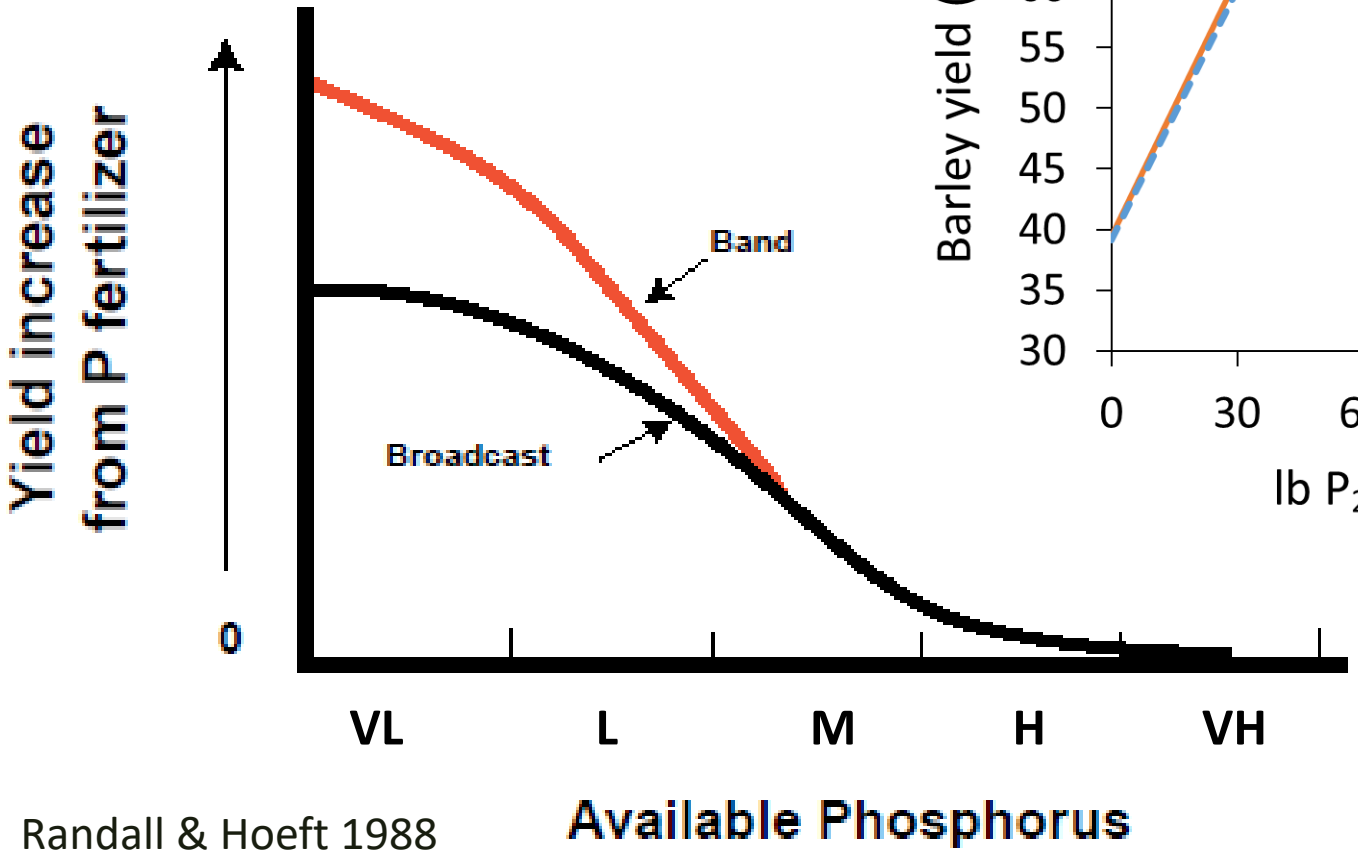


P band better than broadcast in:

Low soil P

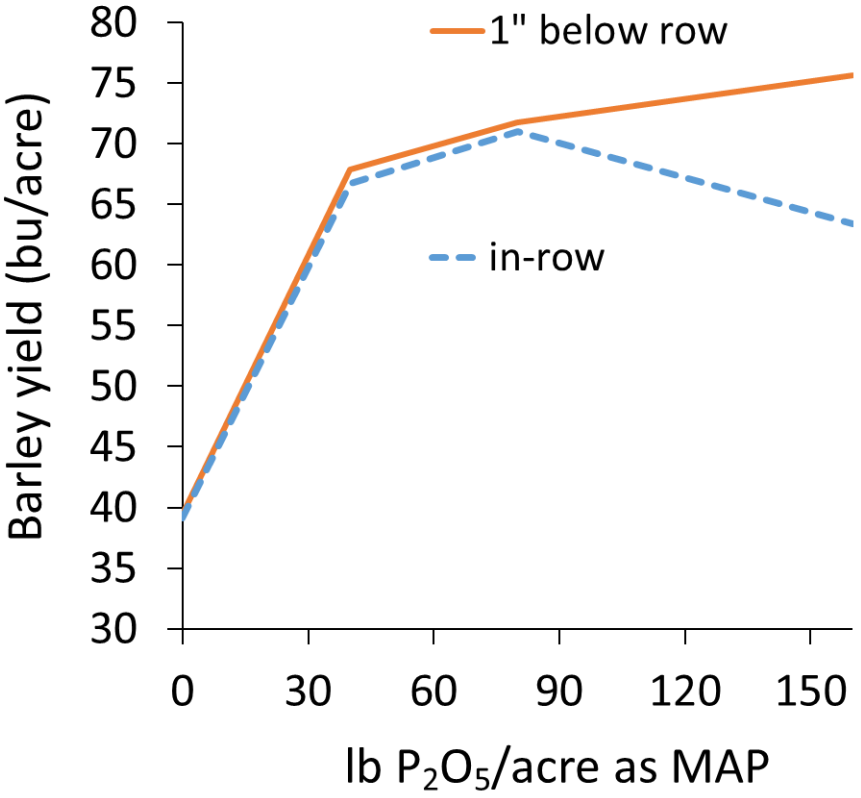
Dry soils

Reduced tillage



Randall & Hoeft 1988

Barley tolerant to high P rates in seed row

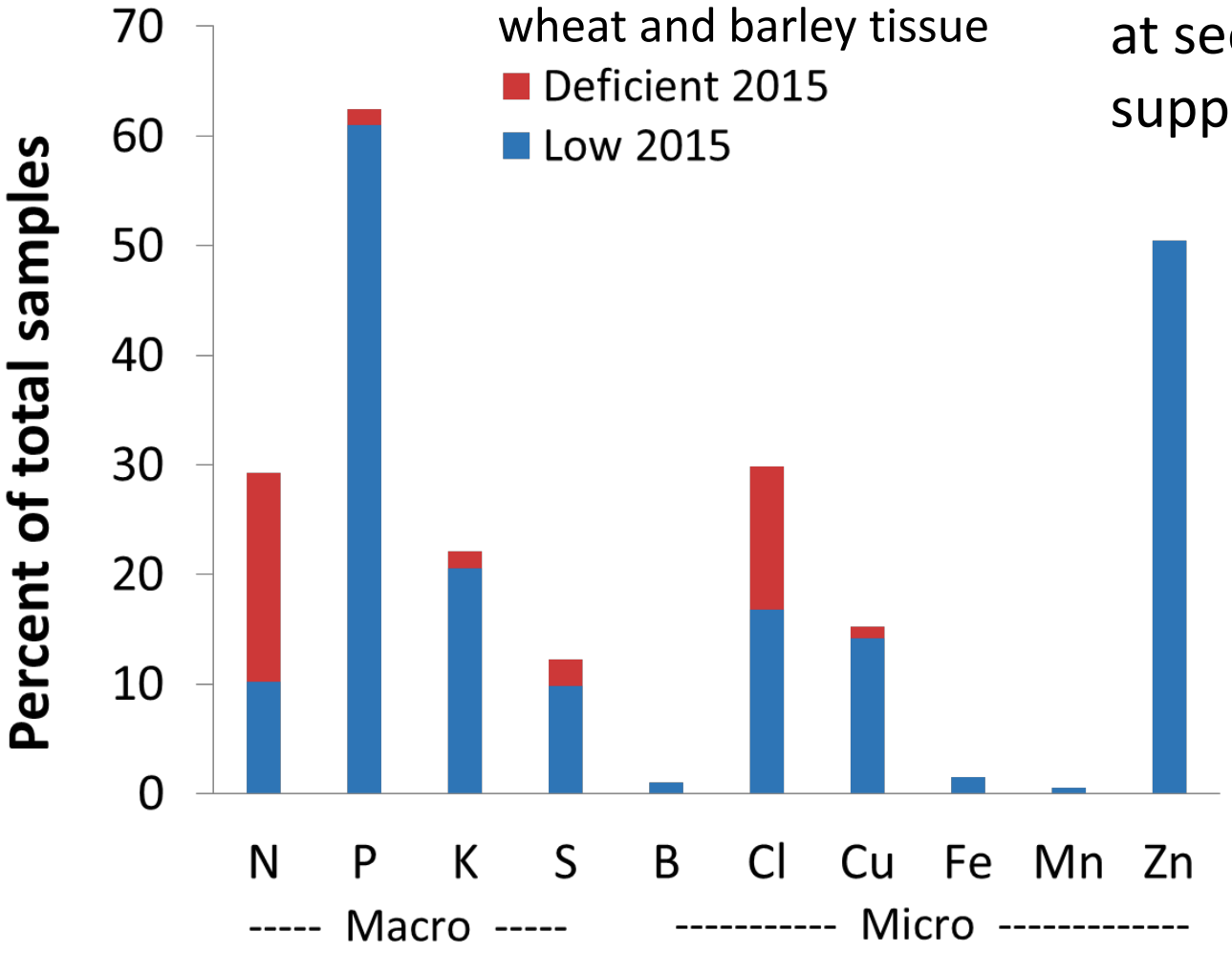


Nyborg & Hennig 1969, AB

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

Can 0-0-60 be ignored? Definitely not.



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

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

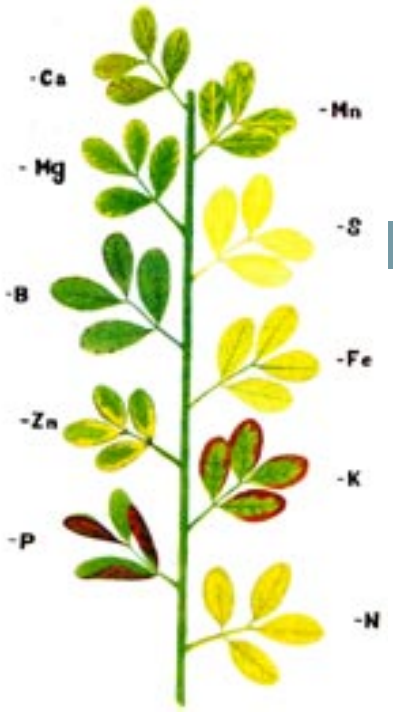
Agvise unpub. data, N=210 samples

Cl on small grains

- Cl is very mobile - may need more if leaching or yield potential is high. 20 lb KCl/acre annually should provide enough.
- Over 210 trials in KS, MN, MT, ND, SD, MB and SK have evaluated Cl-response in wheat and barley*
- Significant yield response in 48% of trials*
- Average response of 5 bu/acre*
- Especially consider KCl for barley varieties with low disease tolerance

*Source: Cindy Grant, Agriculture and Agri-Food Canada

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 the exception, not rule
- Cool wet conditions cause deficiency – will generally disappear when weather warms
- Too much micronutrient may hurt yield more than not enough

Micronutrients, cont.

- The main challenge is even distribution of a very small quantity – consider foliar options
- Read product label: look for ‘available’ micronutrients and watch for heavy metal contamination
- “Micronutrients should be used when there is an economic benefit to the farmer ….” – R. Karamanos, Ph.D. soil scientist
- *Most conclusive test is growth responses from field strip trials*

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
- Diversify and recrop, consider legumes
- 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 > research results > reports to MWBC > reports by year > spring barley variety performance
- 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/

- *MT Barley Production Guide* (EB0186)
- *Interpretation of Soil Test Reports for Agriculture* (MT200702AG)
- *Developing Fertilizer Recommendation for Agriculture* (MT200703AG)
- *Nutrient Uptake and Timing by Crops* (EB0191)
- *Nutrient Management in No-Till* (EB0182)
- *Enhanced Efficiency Fertilizers* (EB0188)
- Soil Scoops - under "Soil Scoop"

Under *"Presentations" Micronutrient Testing and Mgt in Barley, Corn, Pulses. Jan 2017*, and more

QUESTIONS?

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

Photo by Andrew John