FERTILIZATION OF FORAGES

Wheatland County
May 19, 2015

Clain Jones

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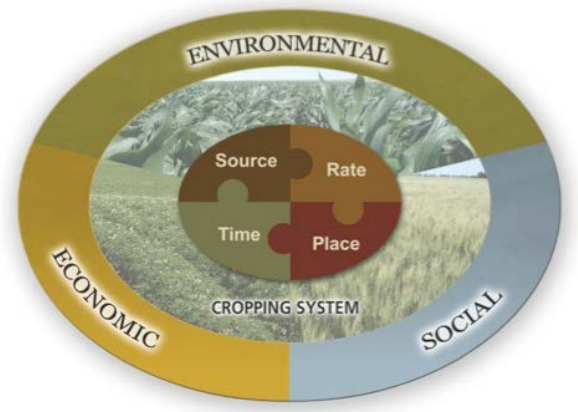
Some questions for you

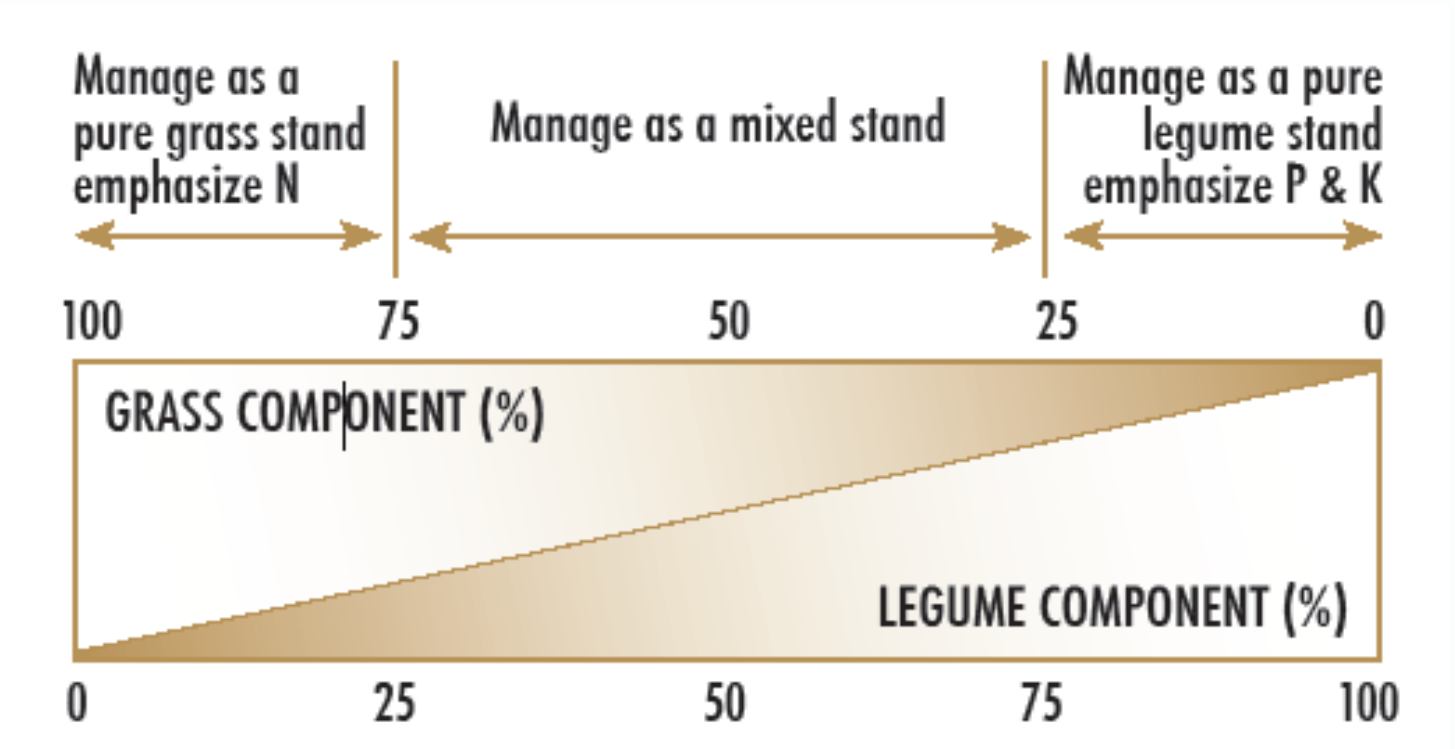
- Who raises grass hay?
- Who raises alfalfa hay?
- Who has pasture?
- Who grows annual forages (ex: Haybet barley, Willow Creek winter wheat)?
- Ok, now that we've all gotten the blood flowing….

Goals

- To review use of Fertilizer Guidelines to determine N, P and K rates on forages
- To present timing, source and placement considerations of N and P fertilization
- To illustrate yield and quality responses of hay to N fertilizer
- To provide an update on new fertilizer products that could benefit forage producers
- To provide economic considerations for fertilizing

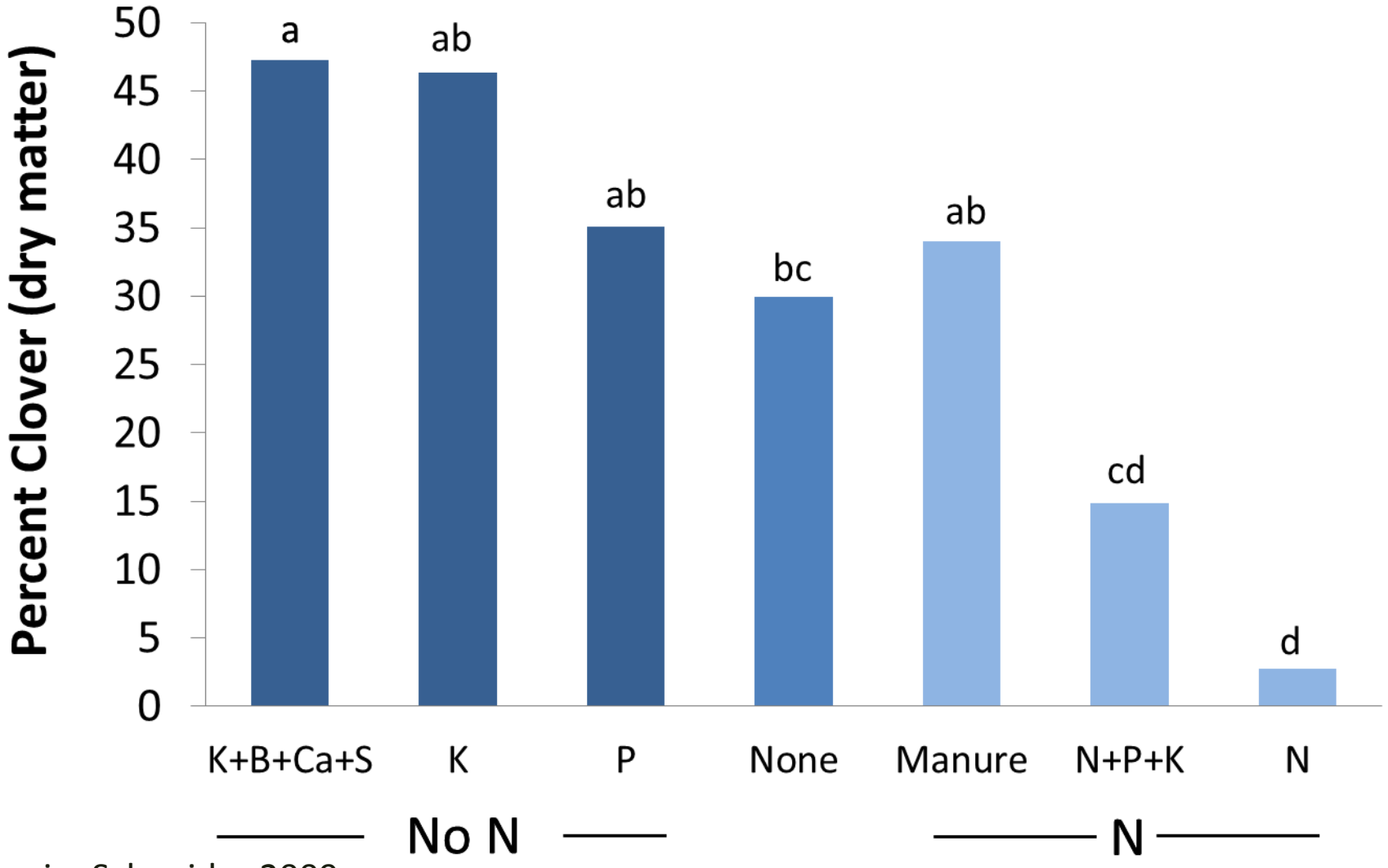


Focus of N or P and K depends on % legume in stand



- Yield increases and net returns greatest if < 36% alfalfa in stand and soil N < 5 lb N/acre (Malhi et al. 2004)

Fertilizing with nutrients other than N favors legumes over grass



Wisconsin, Schneider 2009

N rate depends on legume to grass ratio

N fertilizer guidelines for alfalfa and grass in MT
(Table 1 in EB0161)

Yield Potential (ton/acre)	Alfalfa/Grass				
	80/20	64/40	40/60	20/80	0/100
	Available N (lb/acre)				
1	5	10	15	20	25
2	10	20	30	40	50
3	15	30	45	60	75
4	20	40	60	80	100*
5	25	50	75	100*	125*
6	30	60	90	120*	150*

***Do not exceed 100 lb/ac in a single application on cool season grasses (Brummer et al. 2011).**
Need to divide by fraction of N in fertilizer to find total fertilizer need

Example soil test report

Nutrient In The Soil		Interpretation			
		VLow	Low	Med	High
Nitrate	0-6" 15 lb/ac 6-24" 24 lb/ac 24-42" 63 lb/ac 0-24" 39 lb/ac	********			
TOTAL N =	102#				
Phosphorus	Olsen 4 ppm	******			
Potassium	368 ppm	**********	**********	**********	**********
Chloride	0-24" 20 lb/ac	********			
Sulfur	0-6" 14 lb/ac 6-24" 36 lb/ac	**********	**********	**********	**********
Boron					
Zinc					
Iron					
Manganese					
Copper	0.5 ppm	**********	**********		
Magnesium					
Calcium					
Sodium					
Org.Matter	2.3 %	**********			
Carbonate(CCE)					
Sol. Salts	0-6" 0.36 mmho/cm 6-24" 0.35 mmho/cm	********	********		

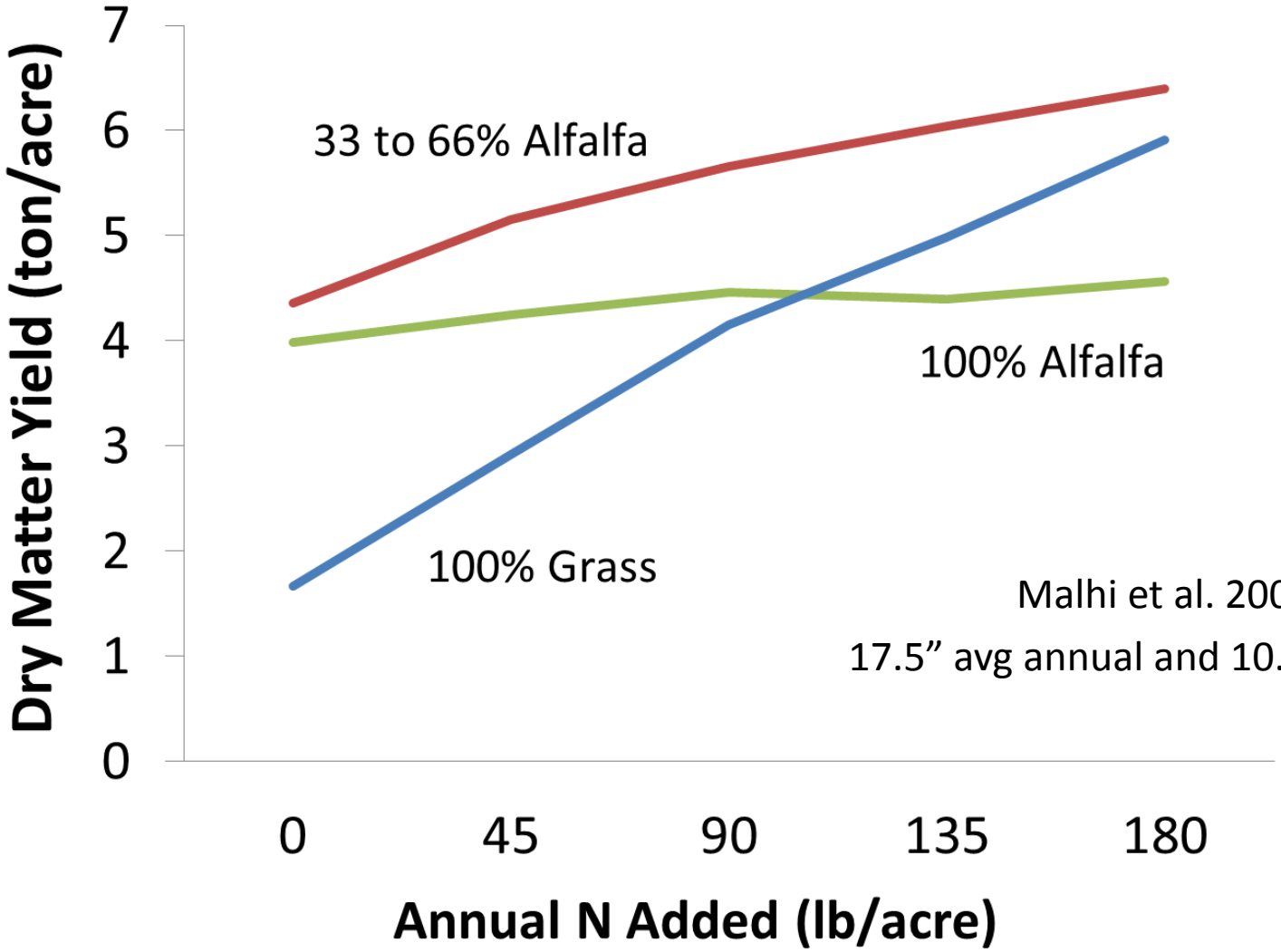
1st Crop Choice			2nd Crop Choice			3rd Crop Choice		
Wheat-High Pro.			Wheat-High Pro.			Barley-Malting		
YIELD GOAL			YIELD GOAL			YIELD GOAL		
50 Bu			60 Bu			70 BU		
SUGGESTED GUIDELINES			SUGGESTED GUIDELINES			SUGGESTED GUIDELINES		
Band			Band			Band		
LB/ACRE		APPLICATION	LB/ACRE		APPLICATION	LB/ACRE		APPLICATION
N	111	50	N	141	80	N	45	Customized
P_2O_5	36	Band *	P_2O_5	43	Band *	P_2O_5	35	Band *
K_2O	10	Band (Starter)*	K_2O	10	Band (Starter)*	K_2O	10	Band (Starter)*
Mg			Mg			Mg		
Lime			Lime			Lime		

To determine N rate you need:

1. Yield goal
2. Soil sample depth to convert ppm to lb N/acre (ppm x 2 x actual depth in inches / 6)

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.1 6-24" 8.4							

Adding N – having alfalfa in mix may be best source of N



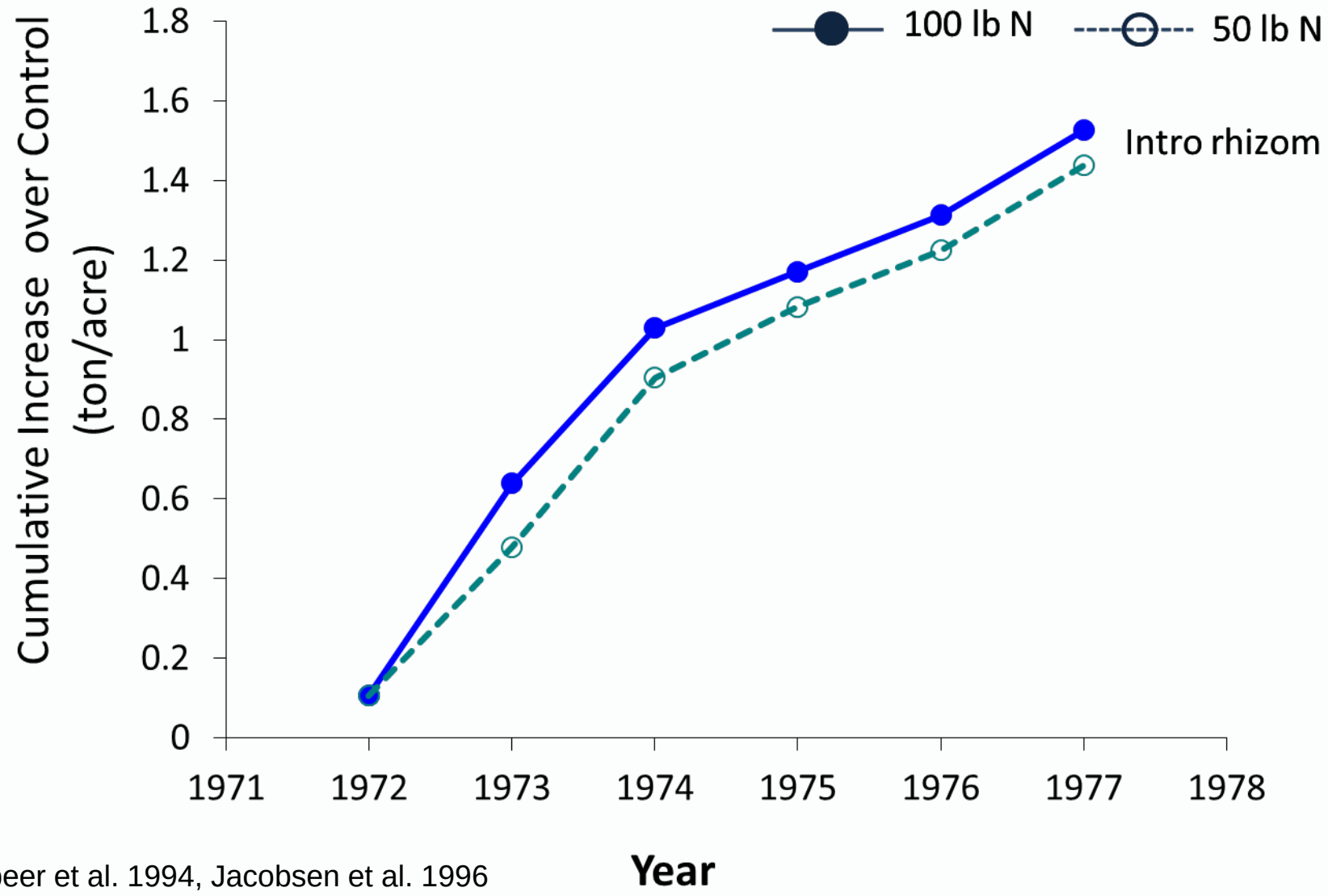
Malhi et al. 2002, Eckville, Alberta

17.5” avg annual and 10.5” May-Aug precip

Single N application to dryland grass pasture

- near Havre, MT (Lorbeer et al. 1994, Jacobsen et al. 1996)
- 0, 50 and 100 lb N/acre fall broadcast once
- harvested for 6 years
- dryland grasses
  - **Natv Bnch**: Basin wildrye, Beardless whtgrs, Green needlegrass, Slender whtgrass
  - **Natv Rhizom**: Thickspike whtgrass, Western whtgrass
  - **Intro Bnch**: Crested whtgrass, Russian wildrye, Tall whtgrass
  - **Intro Rhizom**: Pubescent whtgrass, Intermed whtgrass (2)

Cumulative increase in dryland grass production over the control over time after single N appl.



Lorbeer et al. 1994, Jacobsen et al. 1996
Havre, dryland grasses
single fall broadcast N lb/acre

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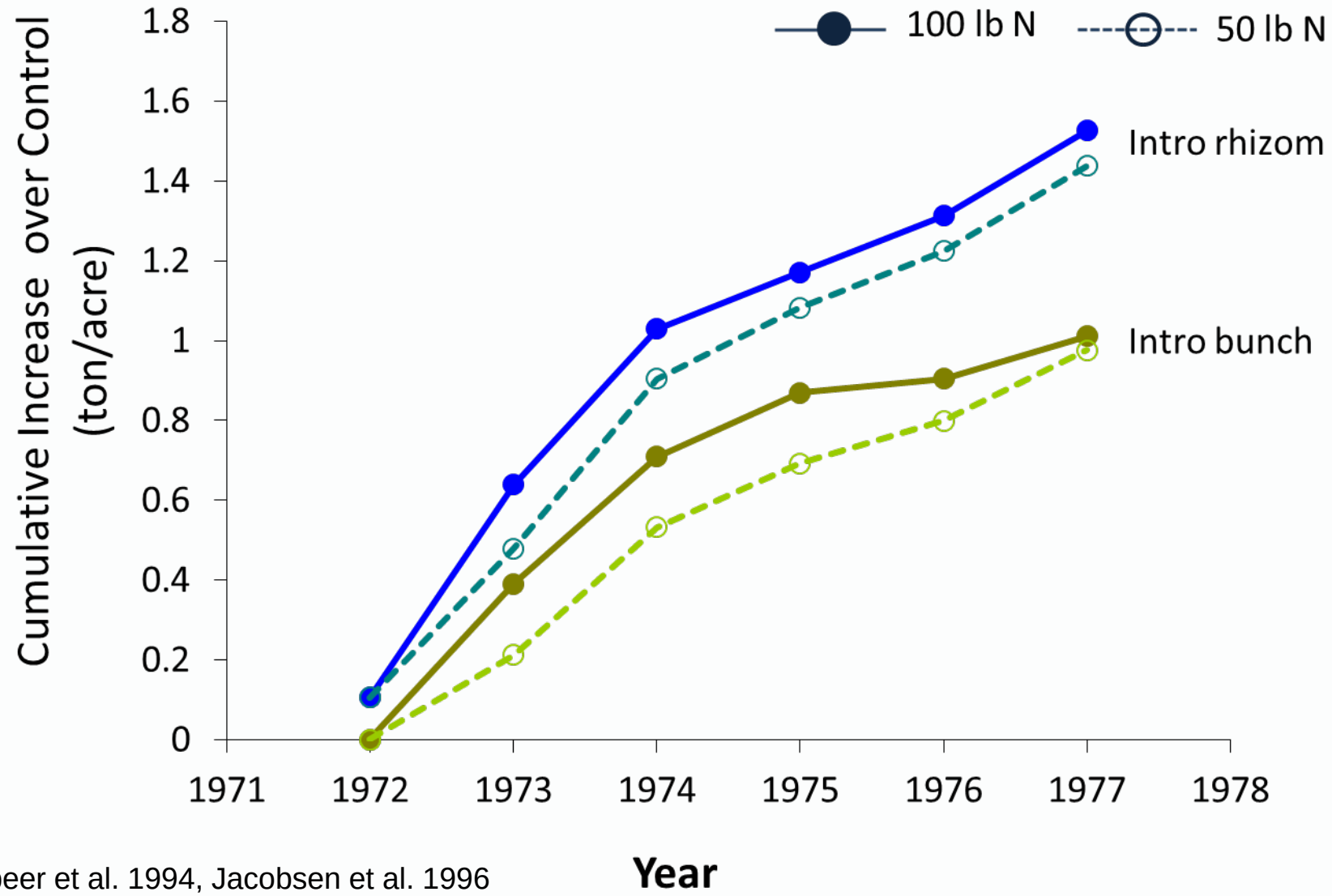

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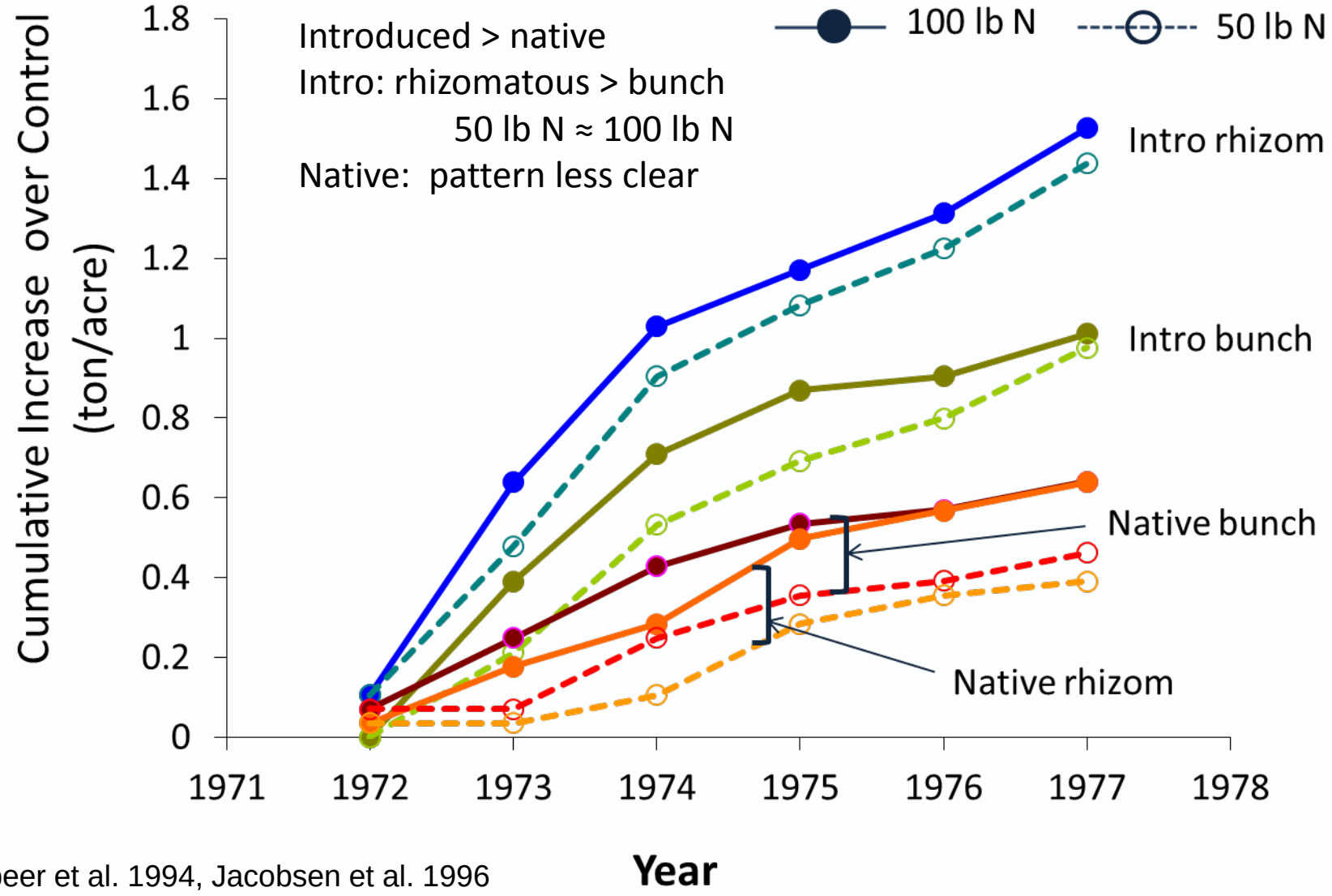
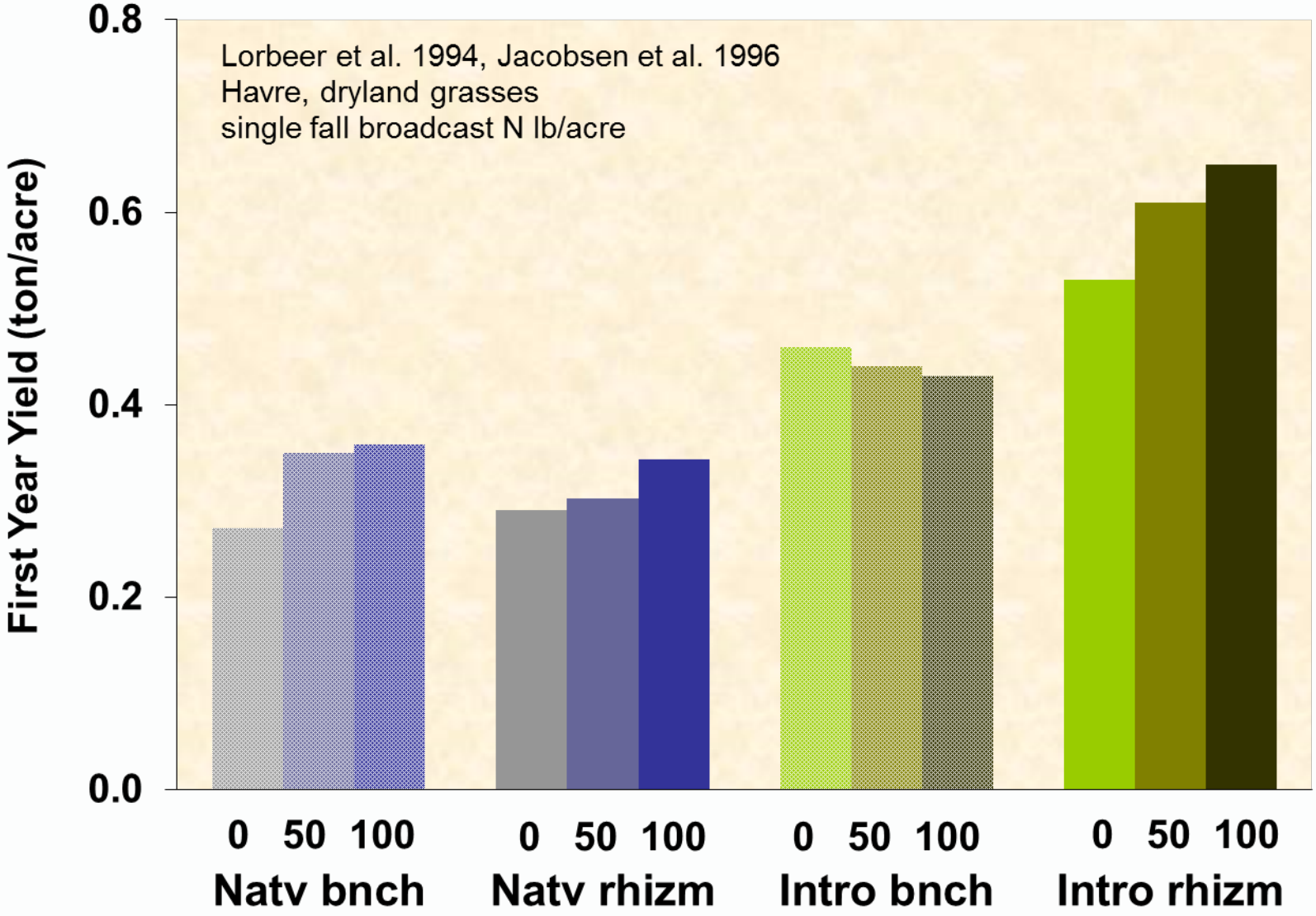
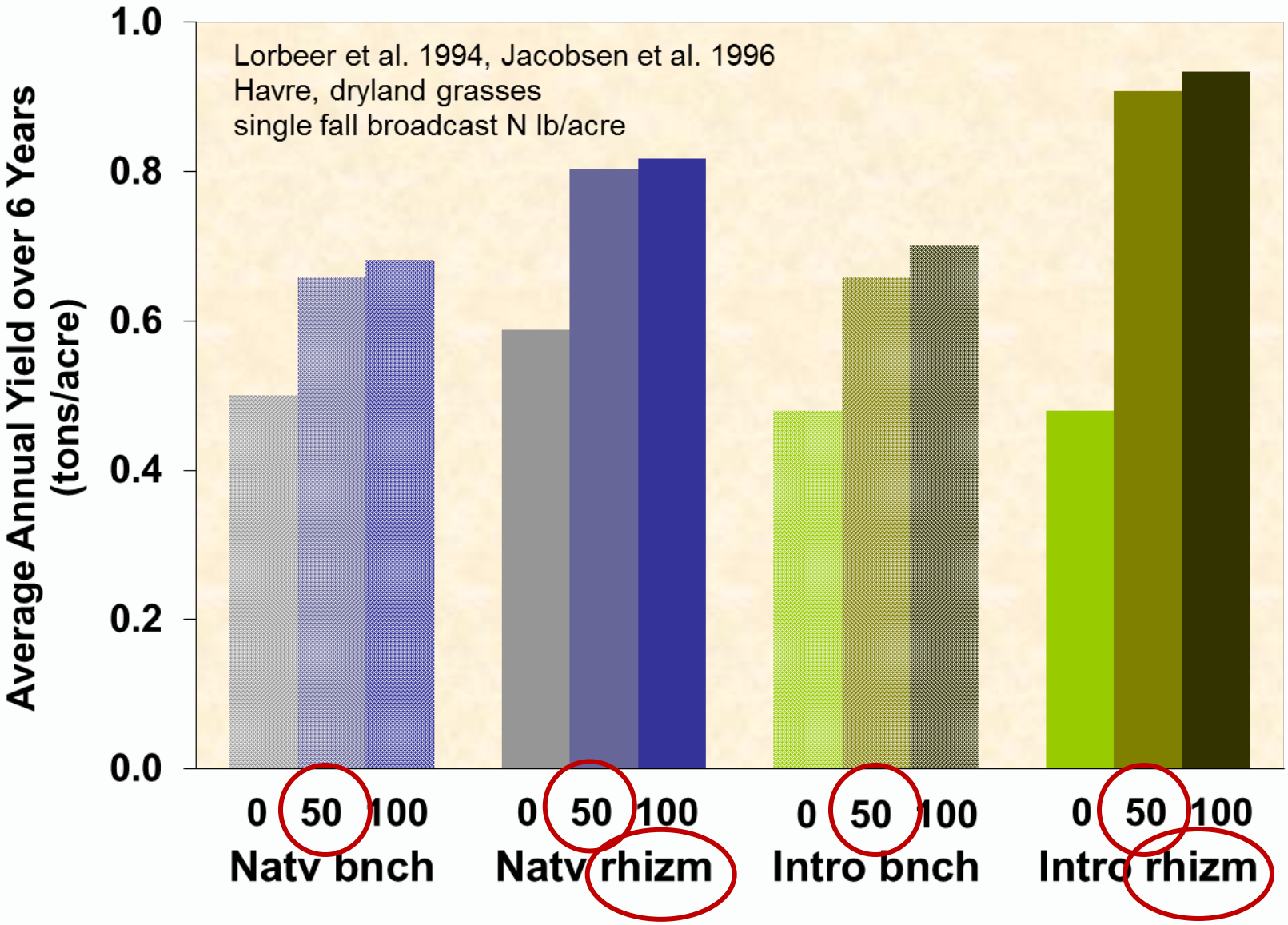


Lorbeer et al. 1994, Jacobsen et al. 1996
Havre, dryland grasses
single fall broadcast N lb/acre

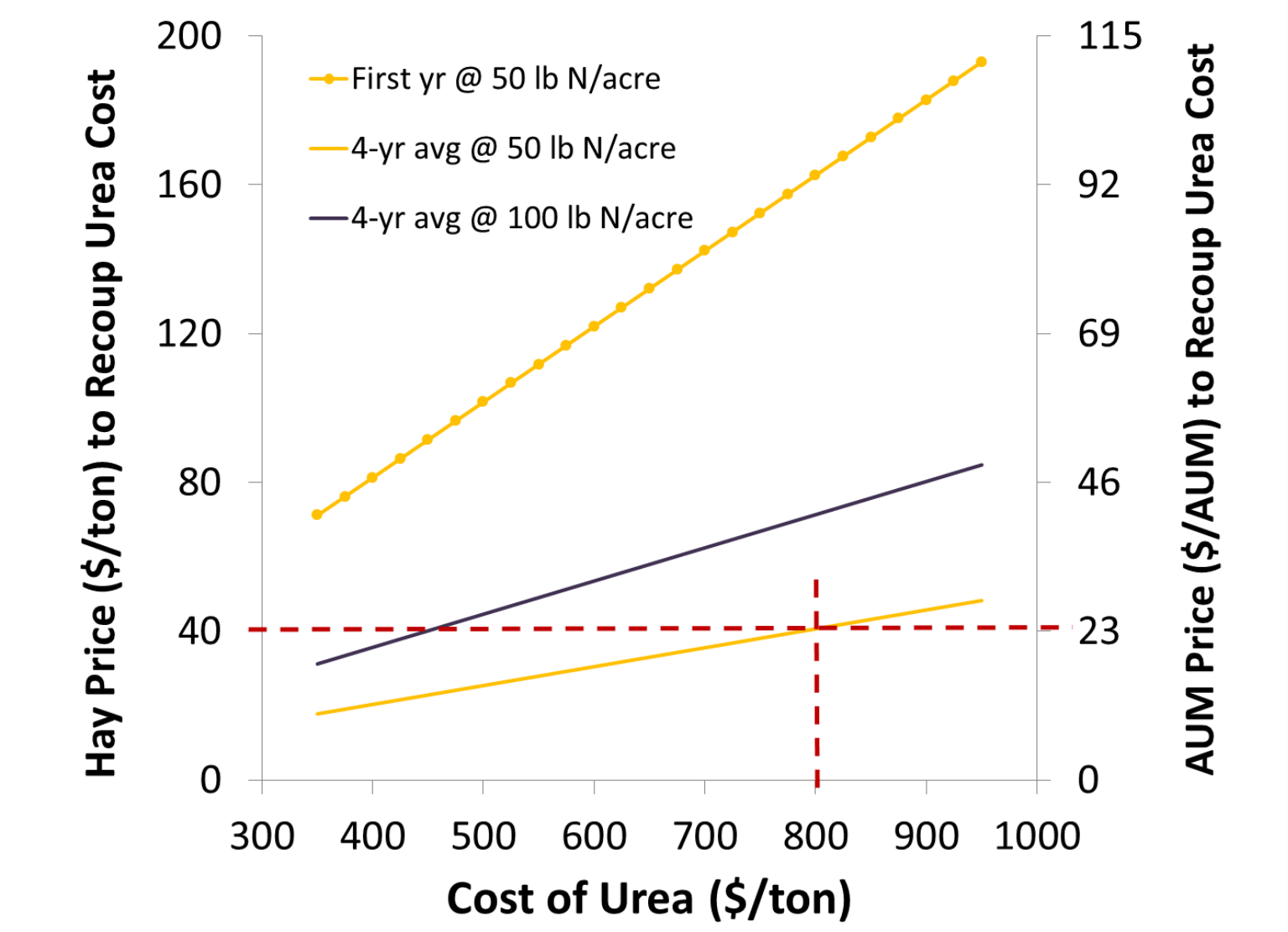
First year dryland grass yield after single N appl.



6 year average annual yield after a single N application



N Fertilization Economics: dryland introduced sod-forming grass

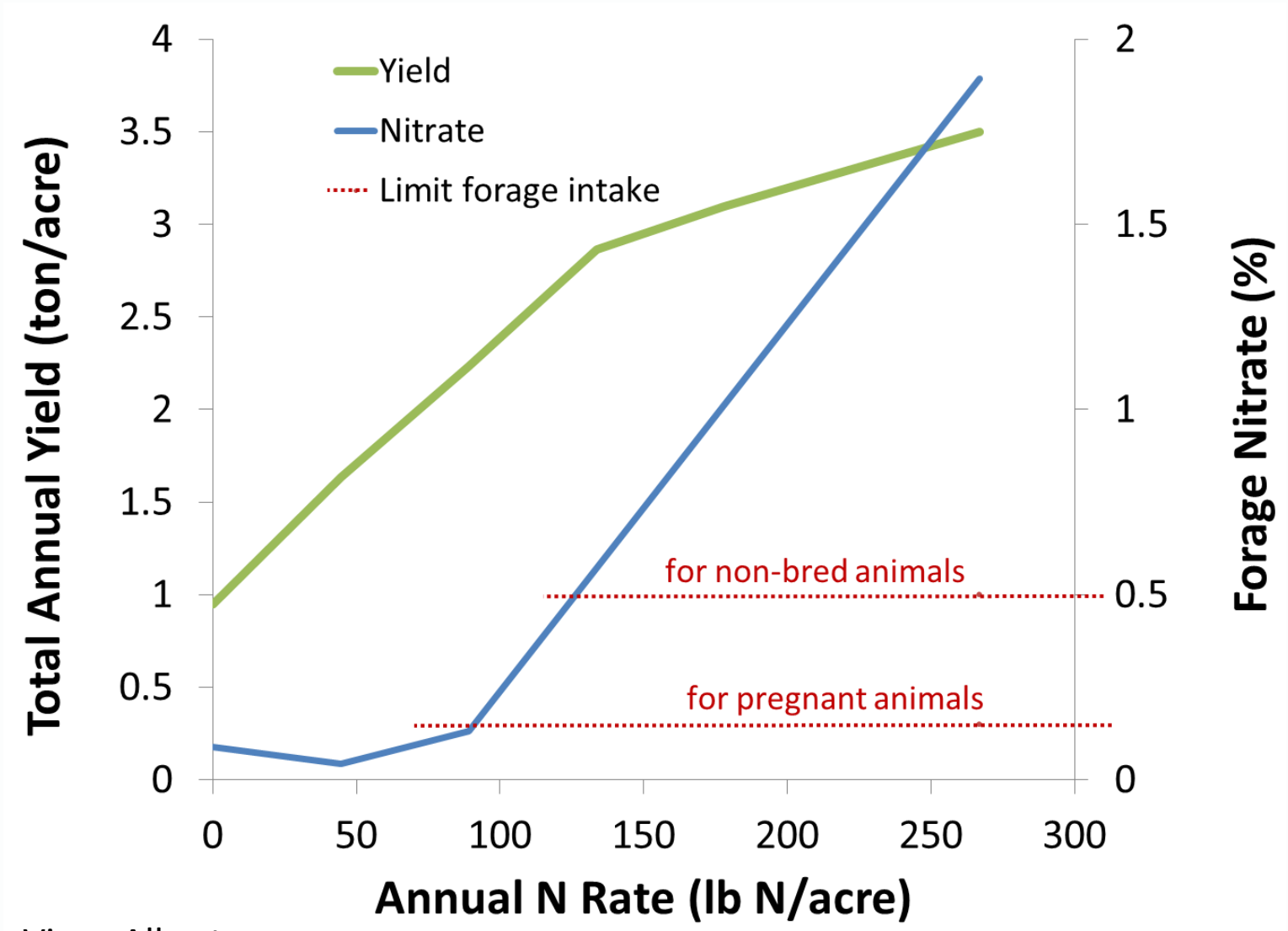


Havre, MT, Jacobsen et al. 1996

N for hay quality

- Higher yields may mean lower quality
- In dryland or mountain meadows 40-80 lb N/acre to increase yield and maintain quality (Brummer and Rill 1999, Brummer pers. comm.)
- Too much N may be lost to groundwater or cause nitrate toxicity in forage

Trade-off between yield and forage nitrate



Bromegrass, Vimy, Alberta
Penny et al. 1990 and MT200505AG

Placement

- Granular: On established forage, surface broadcast is essentially only option. Others?
- Liquid (UAN; 32-0-0 or 28-0-0): Surface broadcast including fertigation, surface band, or knifed.

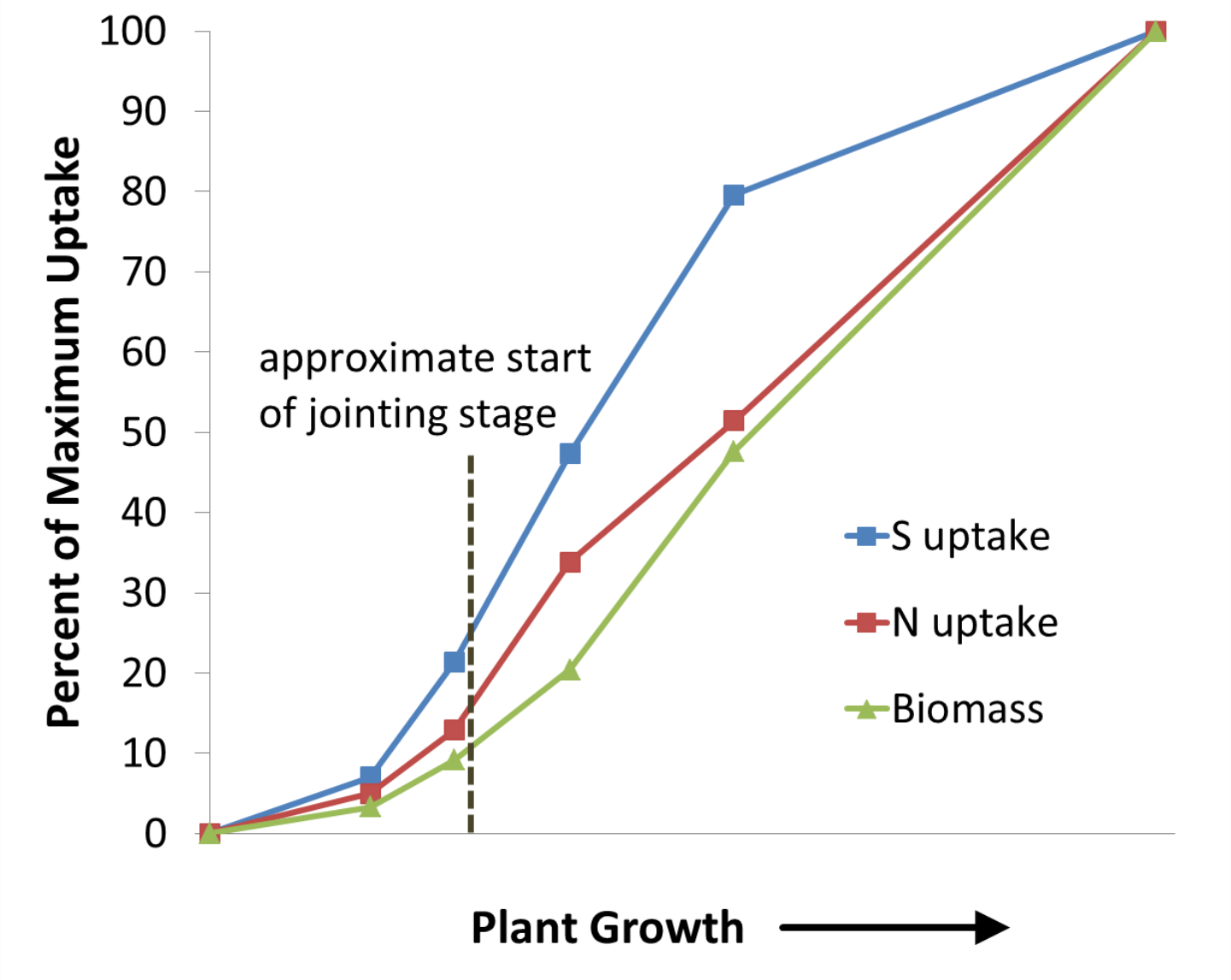
Method	Forage Yield
Broadcast	2.9 t/ac
Knife	2.8 t/ac
Surface Band	3.4 t/ac

N. Central Regional
Extension Pub #326, KSU

Timing

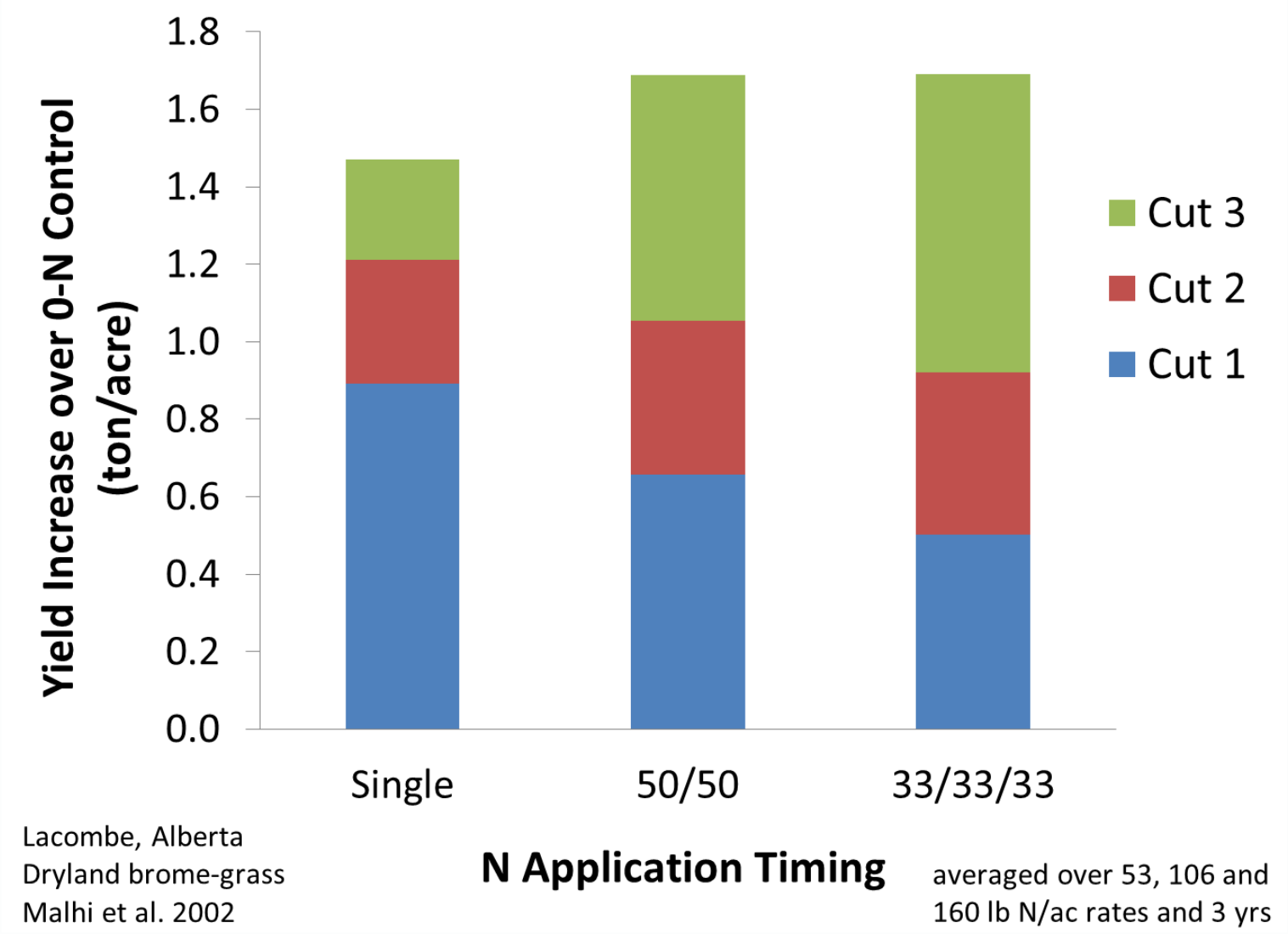
- Yield and quality are affected by timing
- Because urea may take days to weeks to become available, urea should be applied earlier than AN historically was for fast green-up.

Provide N shortly after green-up



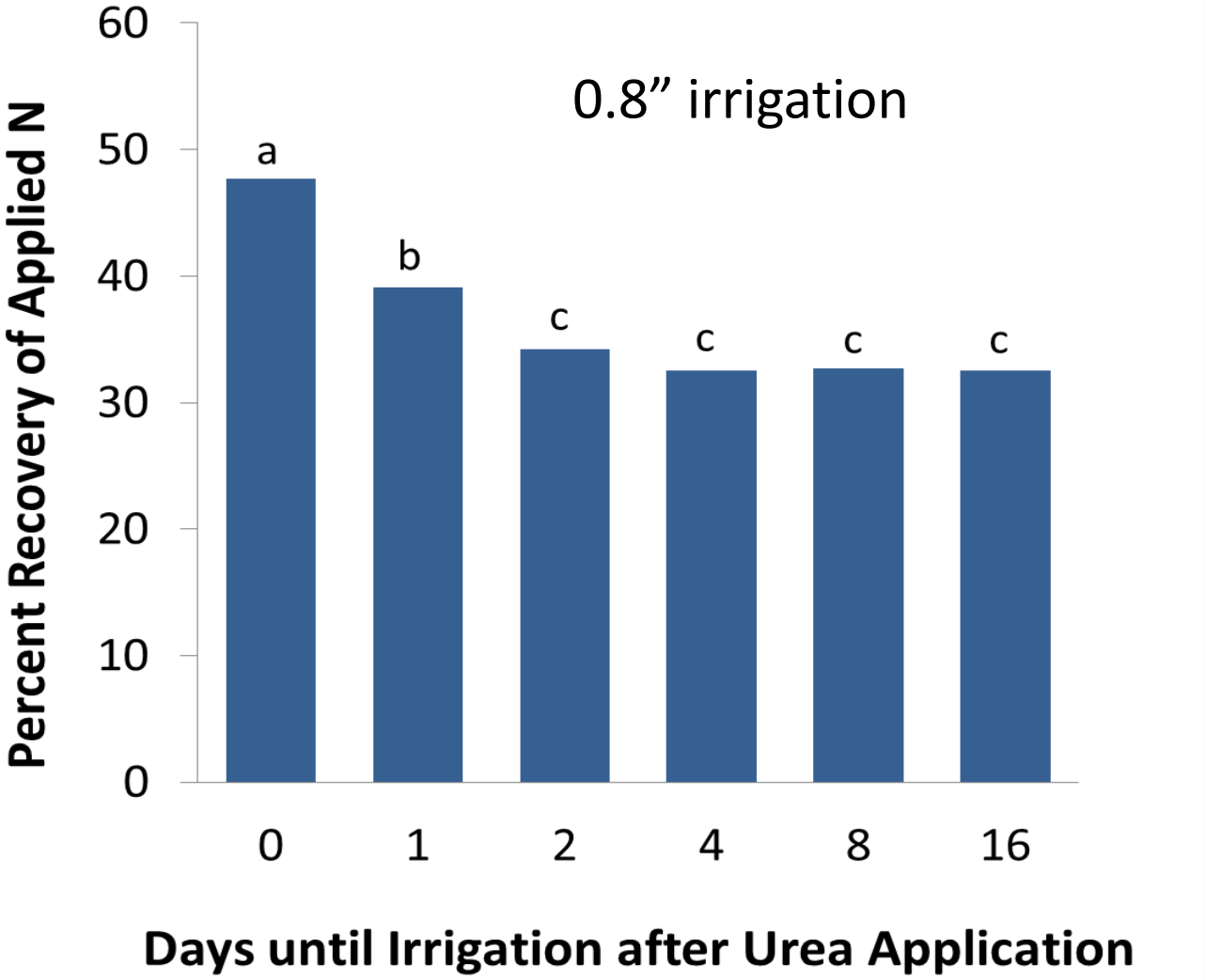
Willamette Valley, Oregon Hart et al. 1989

Split app may increase total yield, improves distribution over season



Early spring alone, or split between early spring and after the 1st, or 1st and 2nd cutting

Incorporate immediately with water to increase N recovery (likely a volatilization effect)



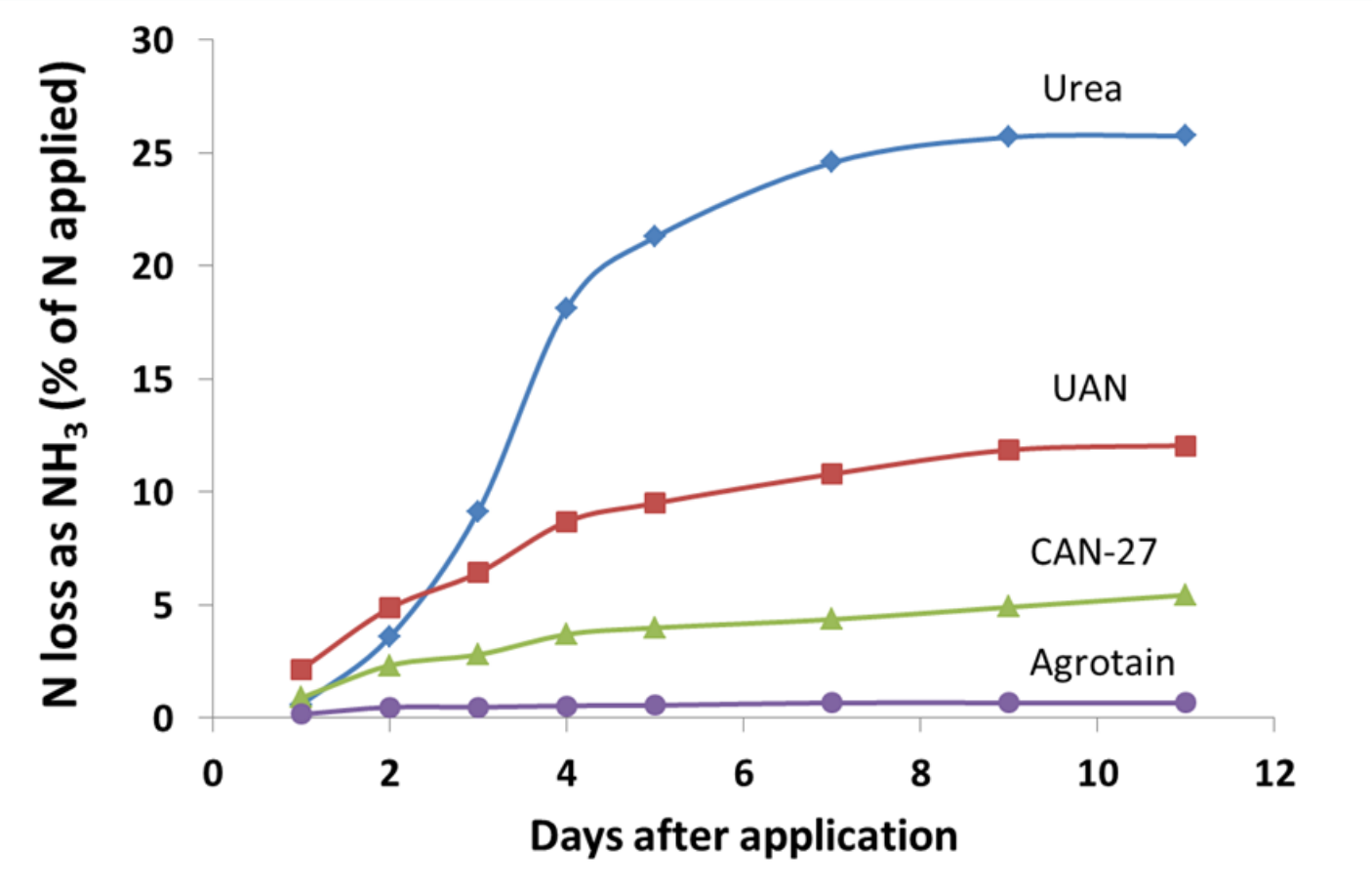
Eckville, Alberta

Bromegrass, Malhi et al. 1995

Enhanced Efficiency Fertilizers (EEFs) and forage production

- Difficult to incorporate N, and plant residue intercepts fertilizer, increases volatilization, and can tie up N
- EEFs retain N on site by reducing loss to volatilization, leaching and N-gas
  - Stabilize or inhibit soil processes to extend N availability (NSN®), reduce urea conversion to ammonia (NBPT) or ammonium to nitrate (DCD)
  - Slow release of urea through a coating (polymer coated – PCU such as ESN®, sulfur coated - SCU)
  - Calcium ammonium nitrate (CAN) isn't enhanced but is less explosive than ammonium nitrate

Effect of N source on volatilization losses



Applied to grass sod, avg. air temp 50 °F (Horneck and Holcomb)

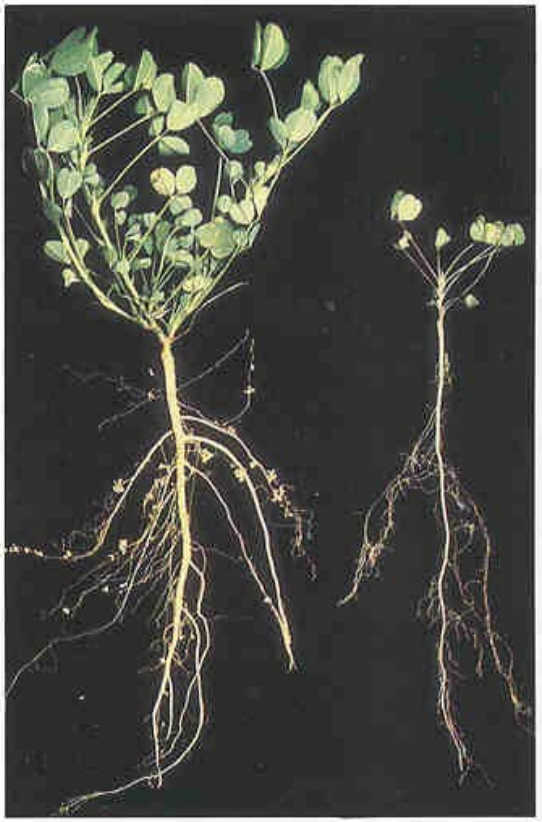
Nitrogen EEF and forage production

- Environmentally responsible but more $
- Conservation Stewardship Program incentive

Enhanced Efficiency Fertilizers (EB0188)
http://landresources.montana.edu/soilfertility

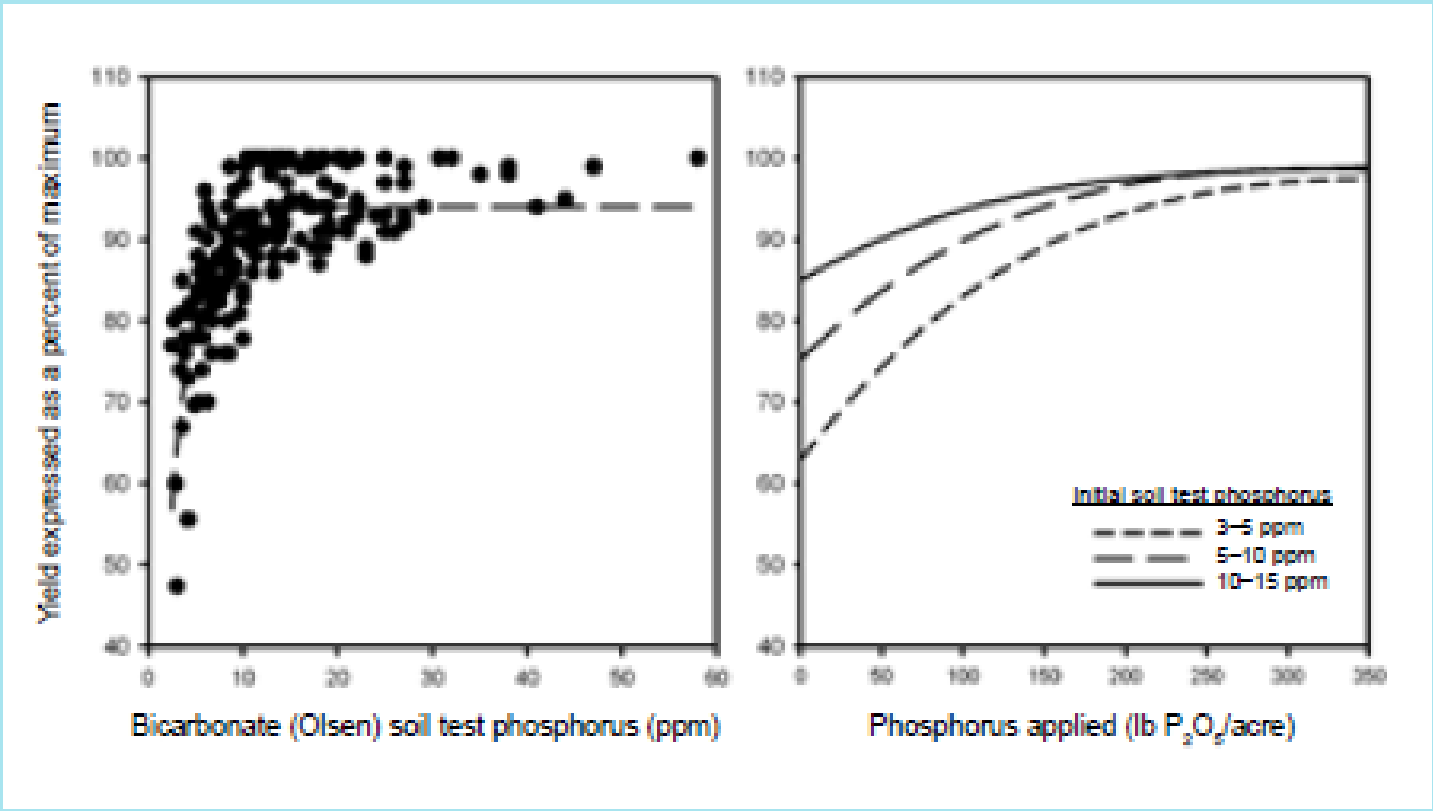
Phosphorus (P)

- Why important to grass/alfalfa stands?
  - Helps with N fixation in nodules
  - Favors alfalfa over grass
  - P improves alfalfa regrowth and recovery after cutting (IPNI)



Alfalfa response to P

- Alfalfa more likely to respond if soil levels low.



Data from Koenig et al. 1999

PNW bulletin 611

Example soil test report

Nutrient In The Soil		Interpretation			
		VLow	Low	Med	High
Nitrate	0-6" 15 lb/ac 6-24" 24 lb/ac 24-42" 63 lb/ac 0-24" 39 lb/ac	********			
Phosphorus	Olsen 4 ppm	******			
Potassium	[illegible]	[illegible]			
Chloride	0-24" 20 lb/ac	********			
Sulfur	0-6" 14 lb/ac 6-24" 36 lb/ac	**********			
Boron					
Zinc					
Iron					
Manganese					
Copper	0.5 ppm	**********			
Magnesium					
Calcium					
Sodium					
Org.Matter	2.3 %	**********			
Carbonate(CCE)					
Sol. Salts	0-6" 0.36 mmho/cm 6-24" 0.35 mmho/cm	********			

TOTAL N = 102#

1st Crop Choice			2nd Crop Choice			3rd Crop Choice		
Wheat-High Pro.			Wheat-High Pro.			Barley-Malting		
YIELD GOAL			YIELD GOAL			YIELD GOAL		
50 Bu			60 Bu			70 BU		
SUGGESTED GUIDELINES			SUGGESTED GUIDELINES			SUGGESTED GUIDELINES		
Band			Band			Band		
LB/ACRE		APPLICATION	LB/ACRE		APPLICATION	LB/ACRE		APPLICATION
N	141	30	N	141	80	N	45	Customized
P_2O_5	36	Band *	P_2O_5	43	Band *	P_2O_5	35	Band *
K_2O	10	Band (Starter)*	K_2O	10	Band (Starter)*	K_2O	10	Band (Starter)*
Cl	20	Broadcast	Cl	20	Broadcast	Cl	20	Broadcast
S	9	Band (1						d (Trial)
B								
Zn								
Fe			Fe			Fe		
Mn			Mn			Mn		
Cu	2	Band	Cu	2	Band	Cu	2	Band
Mg			Mg			Mg		
Lime			Lime			Lime		

MSU guidelines are based on Olsen P

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.1 6-24" 8.4							

P rates

P guidelines for alfalfa and grass in MT based on soil analysis (Table 18 in EB0161 w/ alfalfa/grass revised).

Crop	Olsen P Soil Test Level (ppm)				
	0	4	8	12	16
	P Fertilizer Rate (lb P_2O_5/acre)				
Alfalfa	140	110	75	40	20
Alfalfa/grass (50/50)	93	73	53	30	13
Grass	45	35	30	20	5

If soil test is above 16 ppm then use removal rate (10 to 11 lb P_2O_5/ton)

Potassium (K)

Benefits

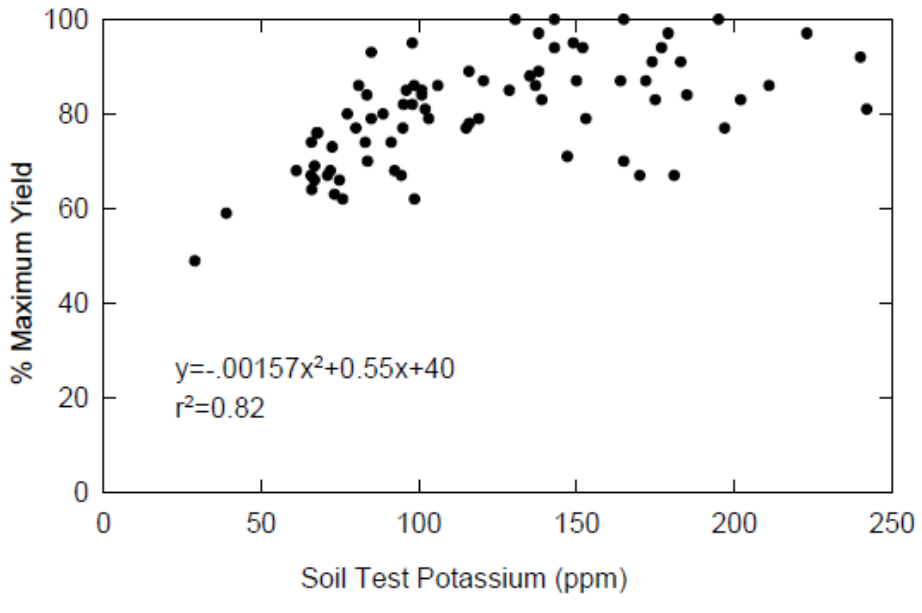
- Improved alfalfa stand persistence, shoots per plant and rhizobia activity
- Reduces leaf drop of alfalfa
- Improved resistance to plant diseases

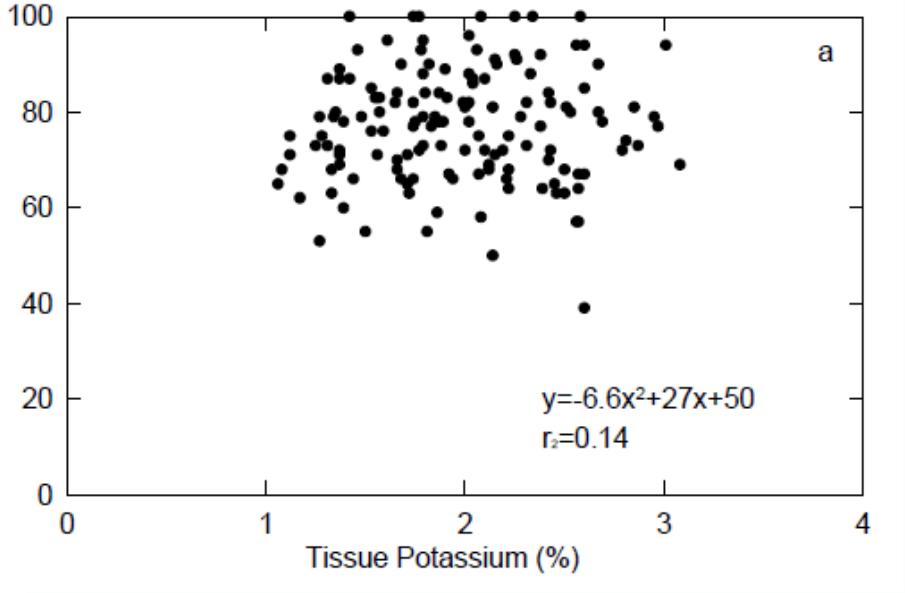
Needed in Montana?

Useful on many soils, even some having high K values (especially in cool spring soils)

How might lack of K affect an alfalfa-hay field?

Base alfalfa K need on soil test rather than tissue test





Koenig 2001 WNMC

- Too much K can lead to luxury consumption by first cutting and risk of milk fever.
- Apply ½ the rate after first cutting and rest after last cutting for following year

Example soil test report

Nutrient In The Soil		Interpretation			
		VLow	Low	Med	High
Nitrate	0-6" 15 lb/ac 6-24" 24 lb/ac 24-42" 63 lb/ac	********			
	0-24" 39 lb/ac				
TOTAL N = 102#					
Phosphorus	Olsen 4 ppm	******			
Potassium	368 ppm	**********	**********	**********	**********
Chloride	0-24" 20 lb/ac	********			
Sulfur	0-6" 14 lb/ac 6-24" 36 lb/ac	**********	**********	**********	**********
Boron					
Zinc					
Iron					
Manganese					
Copper	0.5 ppm	**********	**********		
Magnesium					
Calcium					
Sodium					
Org.Matter	2.3 %	**********			
Carbonate(CCE)					
Sol. Salts	0-6" 0.36 mmho/cm 6-24" 0.35 mmho/cm	********	********		

1st Crop Choice		
Wheat-High Pro.		
YIELD GOAL		
50 Bu		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	111	50
P_2O_5	36	Band *
K_2O	10	Band (Starter)*
Cl	20	Broadcast
S	9	Band (Trial)
B		
Zn		
Fe		
Mn		
Cu	2	Band
Mg		
Lime		

2nd Crop Choice		
Wheat-High Pro.		
YIELD GOAL		
60 Bu		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	141	80
P_2O_5	43	Band *
K_2O	10	Band (Starter)*
Cl	20	Broadcast
S	9	Band (Trial)
B		
Zn		
Fe		
Mn		
Cu	2	Band
Mg		
Lime		

3rd Crop Choice		
Barley-Malting		
YIELD GOAL		
70 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	45	Customized
P_2O_5	35	Band *
K_2O	10	Band (Starter)*
Cl	20	Broadcast
S	9	Band (Trial)
B		
Zn		
Fe		
Mn		
Cu	2	Band
Mg		
Lime		

Compare to MSU guidelines

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.1 6-24" 8.4							

K rates

K guidelines for alfalfa and grass in MT based on soil analysis (Table 19 in EB0161, alfalfa/grass rates revised).

Crop	K Soil Test Level (ppm)					
	0	50	100	150	200	250
	K Fertilizer Rate (lb K_2O/acre)					
Alfalfa	240	205	170	140	95	30
Alfalfa/grass (50/50)	192	165	137	112	76	26
Grass	80	70	60	45	30	15

If soil test is above 250 ppm then use removal rate

38 lb K_2O/ton grass, 53 lb/ton alfalfa

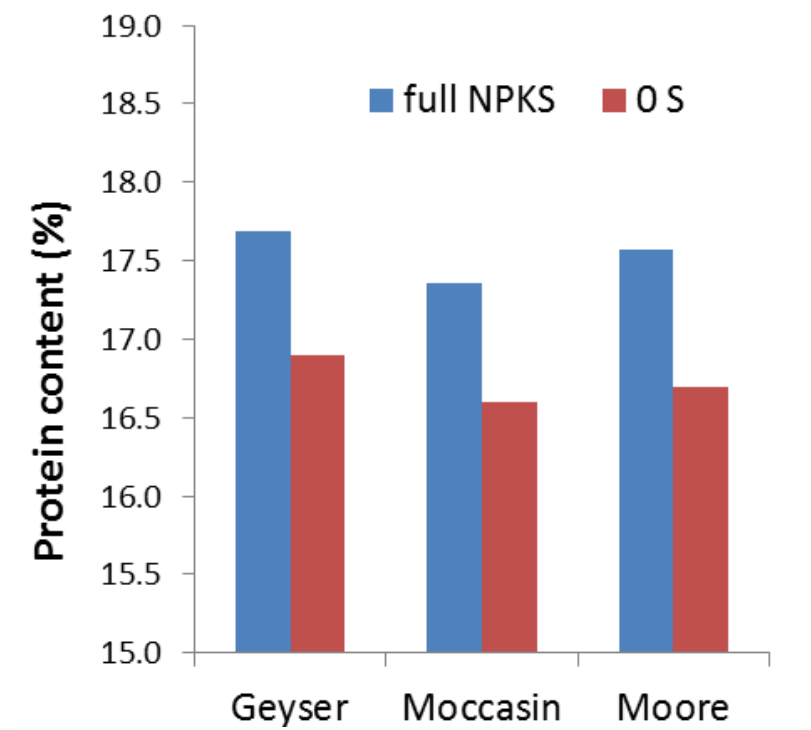
Sulfur (S)

- Useful on sandy, acidic or low organic matter soils, especially after high rainfall (sulfate leaches) or in spring with cool soils
- Soil tests are not reliable
- Use visual symptoms and field history or tissue sampling. If < 0.22% S in top 6 inches of alfalfa (early bud stage) then should get a yield increase S.

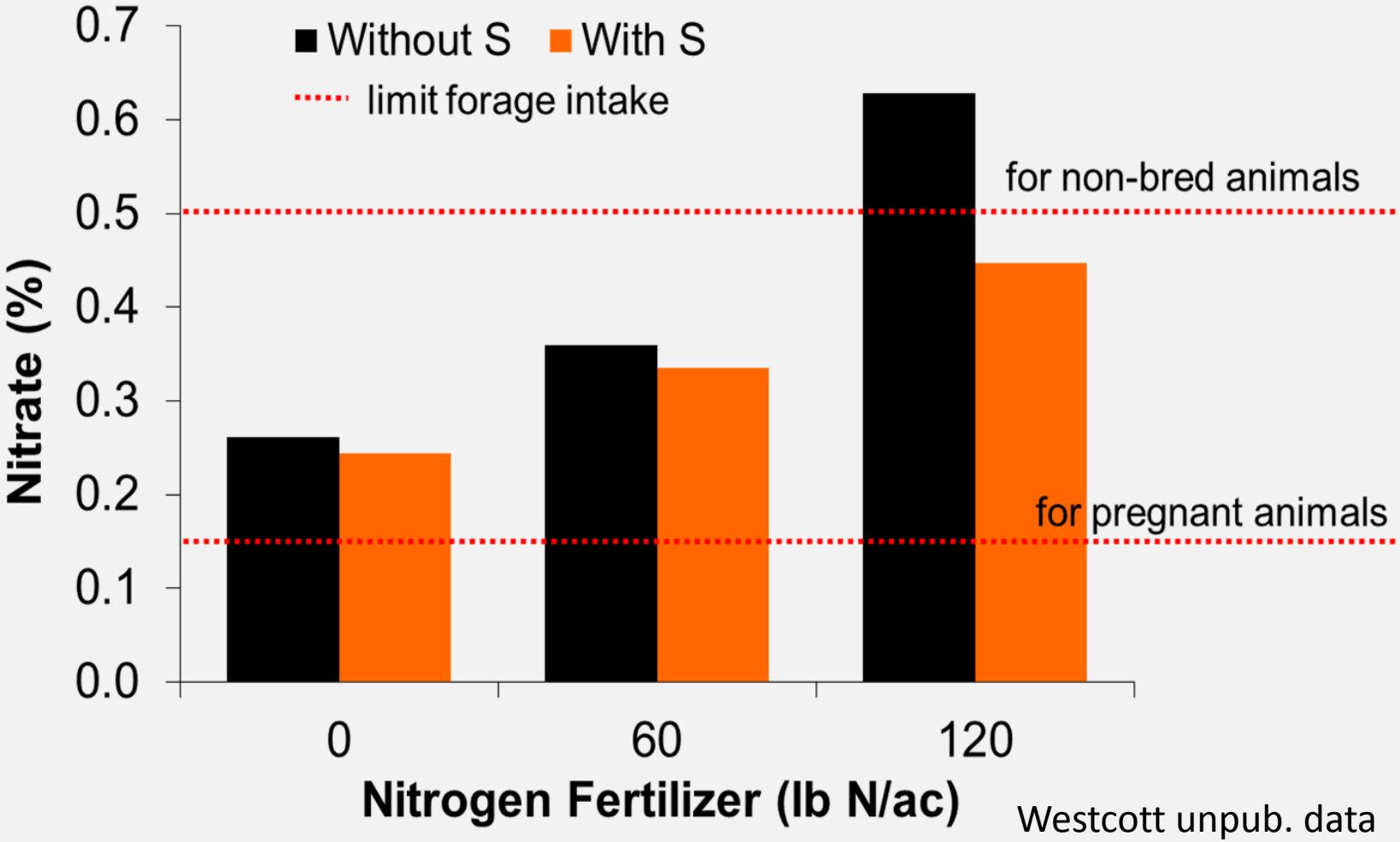
- S > 0.30% can cause livestock health problem

S influence on forage quality

- N conversion to protein requires S
- Increased S can lead to increased protein, digestibility and reduced nitrate concentration
- 25 lb S/ac on dryland alfalfa and alfalfa/grass mix increased forage protein 0.8 points (Fertilizer Fact 27)

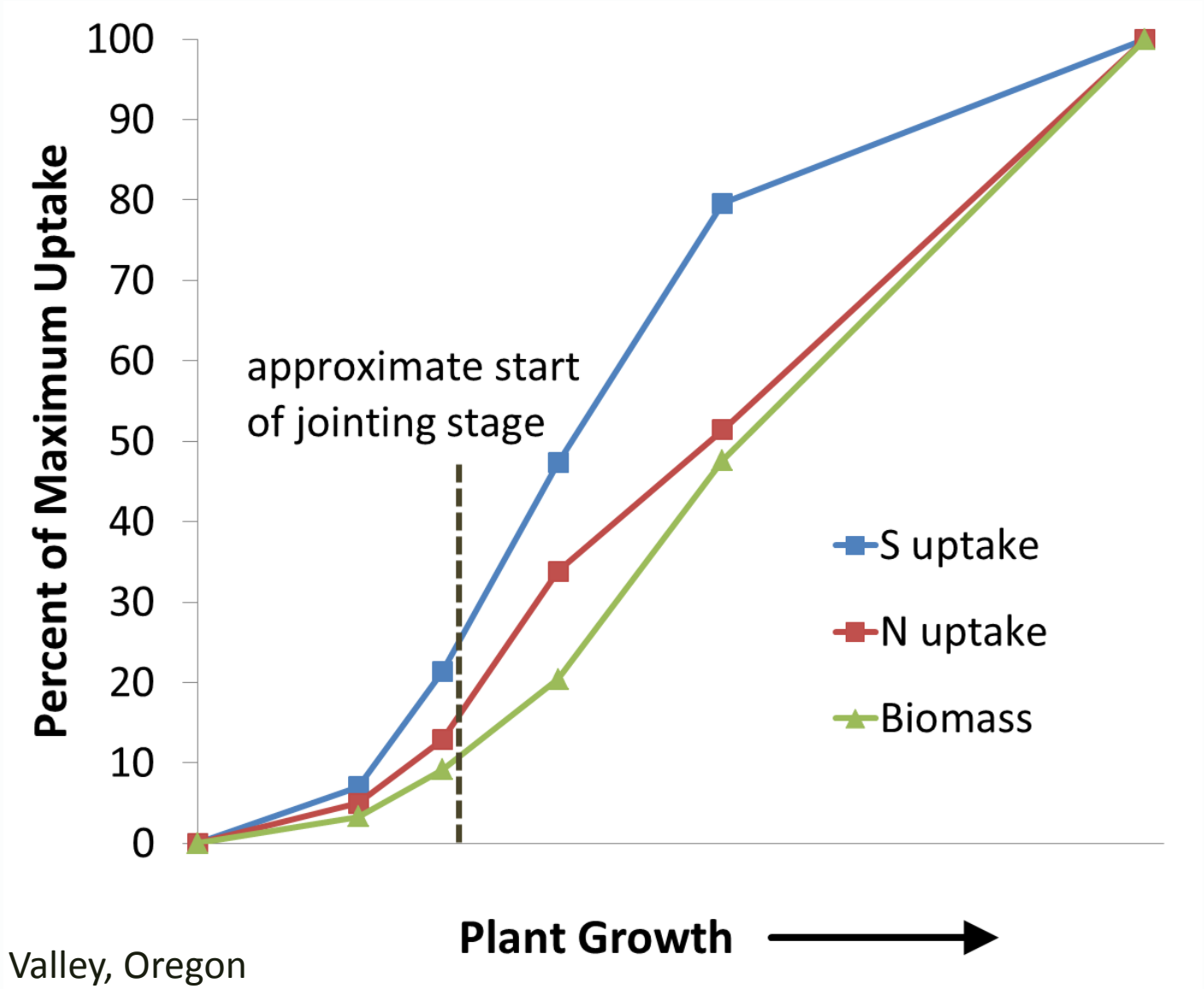


S influence on annual forage quality
(western Montana)



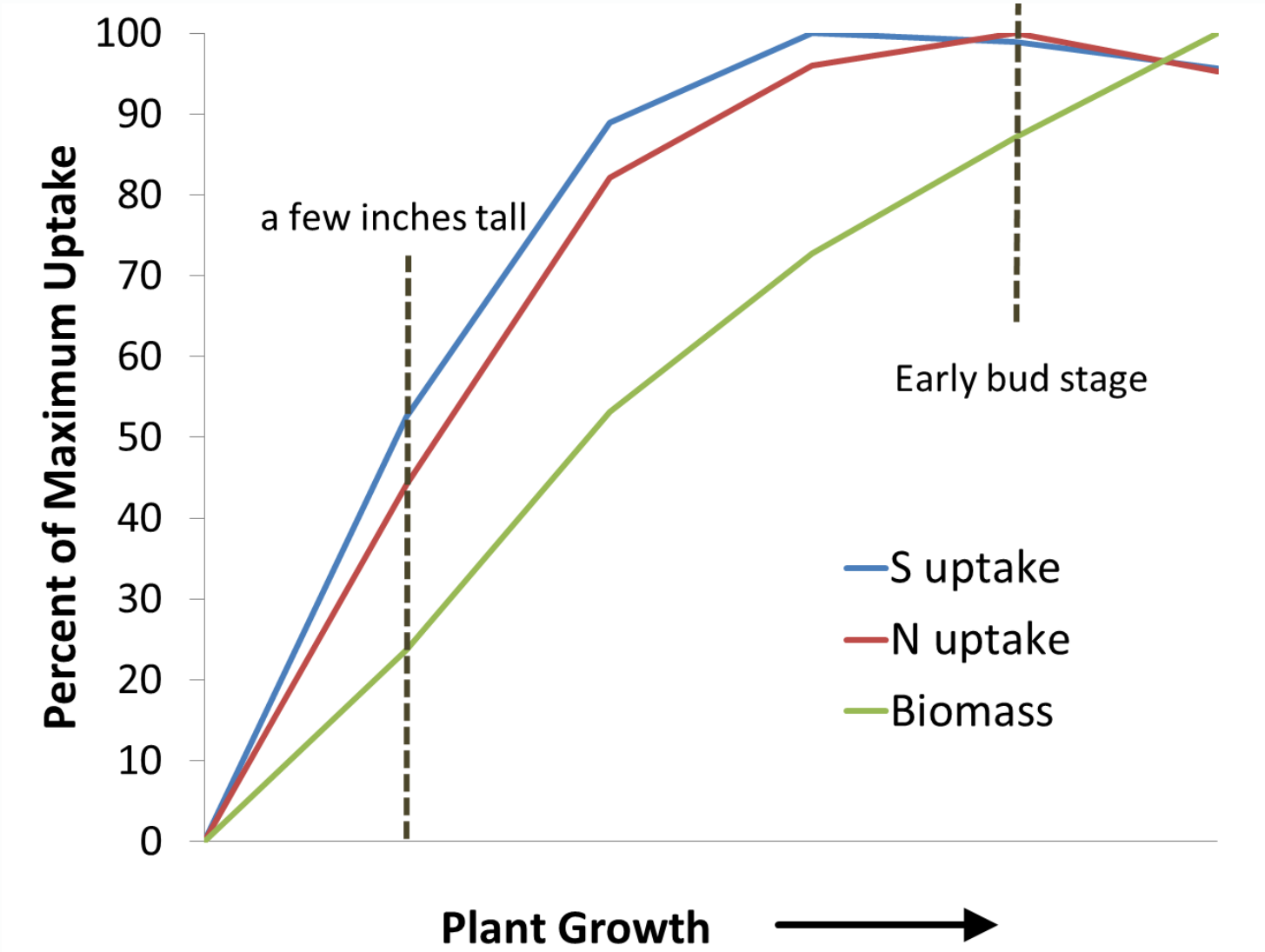
Westcott unpub. data

Provide S before start of jointing stage in grass



Willamette Valley, Oregon
Hart et al., 1989

Provide S early for alfalfa



Union, Oregon
Pumphrey and Moore 1965

General timing considerations for forage fertilization

- If sub-irrigated, fertilize for high yield potential but apply P in fall
- Irrigated/wet meadows apply nutrients in spring
- Late fall/early spring timing for cool season mix (except on sandy soil),mid-May for warm season mix

Fertilization strategy

- If a field containing < 75% legumes will be rotated into a different crop soon, consider N for immediate gain
- If goal is low input, long-term sustainable production rather than prime quality hay, adequate P and K are key and cheaper than re- or interseeding
- If you need to buy hay or rent pasture, you should consider fertilizing

P and K fertilization strategy

- Immobile nutrients can be banked – know soil test levels and if low, build up P and K when prices low
  - A single 100-400 lb P_2O_5/ac on dryland alfalfa produced similar yield, protein and profit as same amount divided over 5 annual applications (central Alberta, Malhi et al. 2001).

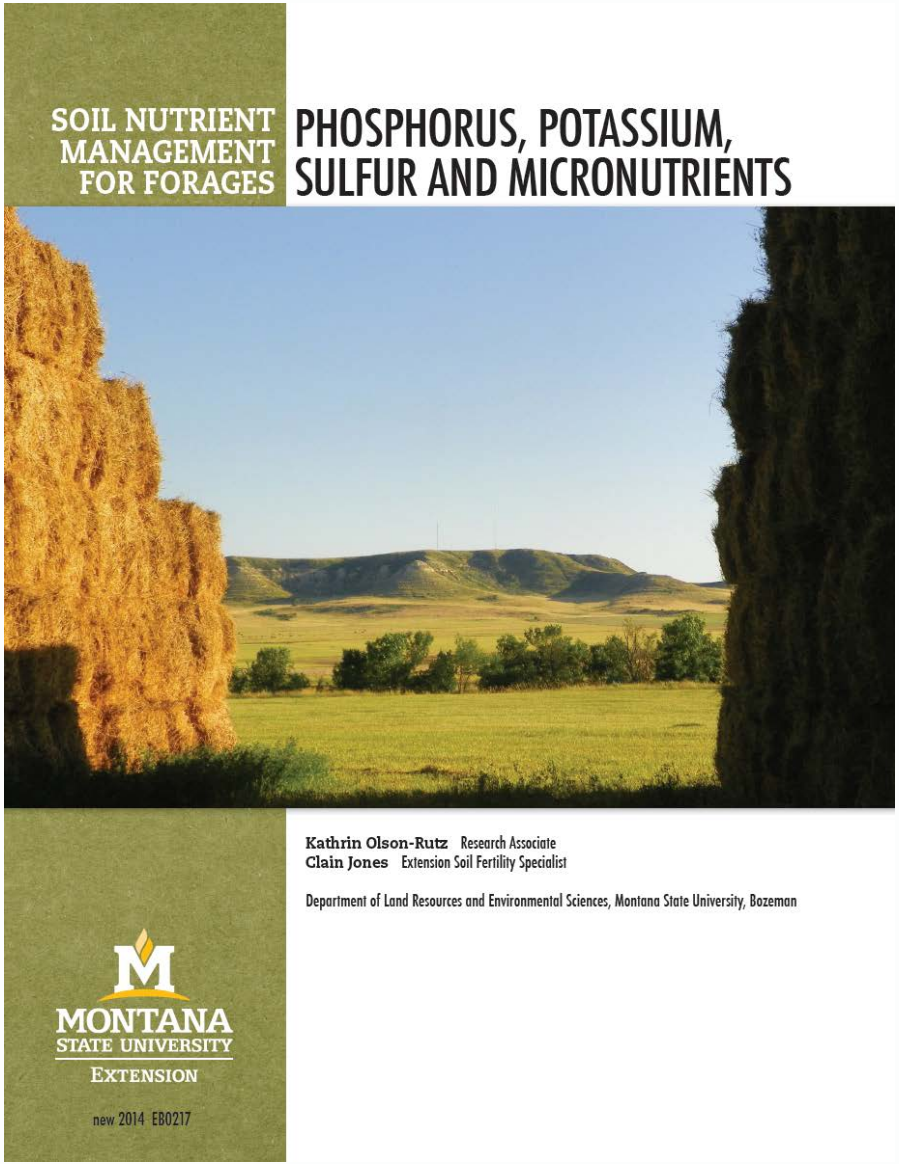
N, P, K for new seedings

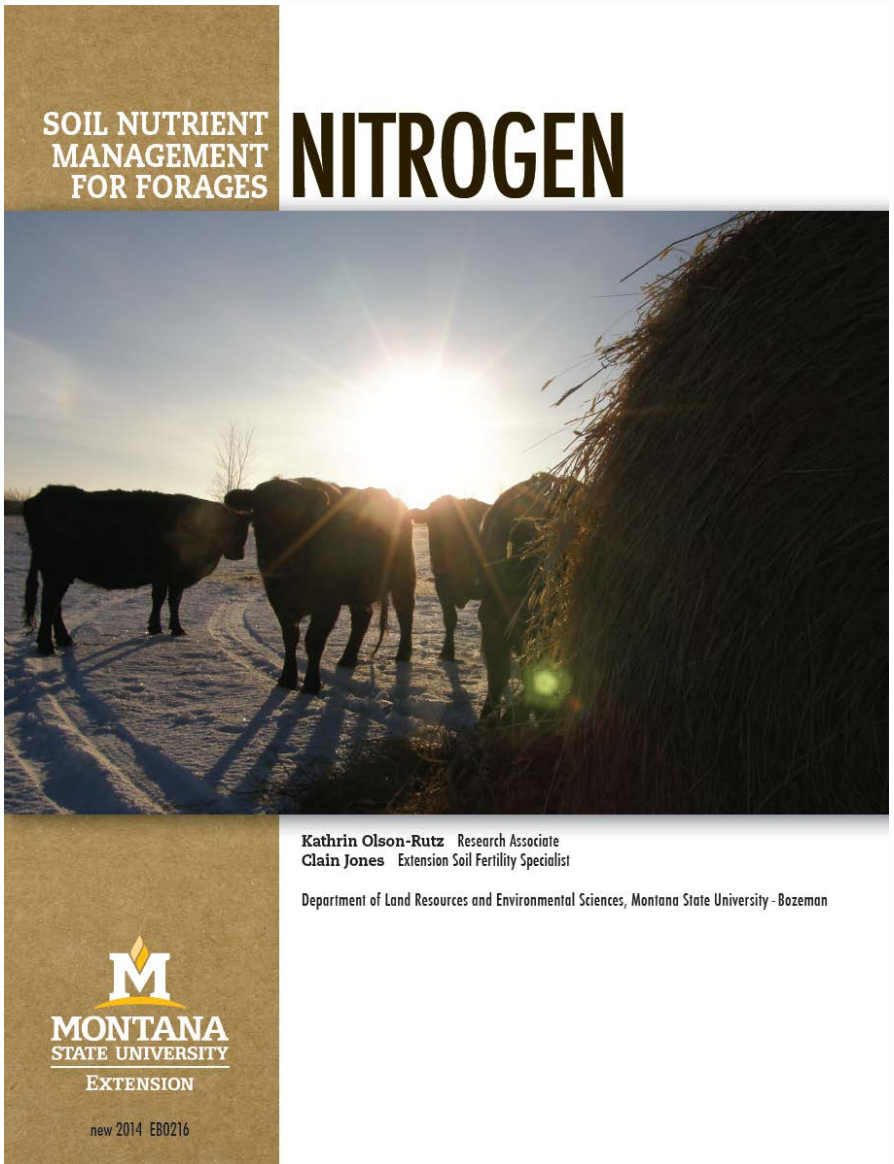
- Base N, P, K rates on soil tests
- If seeding on fallow, OM >3% provides adequate N for 2-3 years
- Do not exceed 60 lb N/acre in the first year
- If N is banded or seed placed do not exceed 10-15 lb N, P as 11-52-0, or (N + K_2O)/acre to reduce risk to seedlings
- Build up soil P and K levels prior to seeding
- Safe rates of additional P and K seed placed can increase seedling establishment, MAP is safer than DAP

Summary

- Nitrogen, phosphorus, potassium, and sulfur can all increase forage yields
- Economic benefits often aren't realized in the first year (so don't base advice on 1 yr studies!)
- Soil testing is essential for determining fertilizer needs
- Select the right rate, source, timing and placement

Pick up a copy or download these 2 Extension Bulletins






Questions?
Photo by Ann Ronning
Additional info at:
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