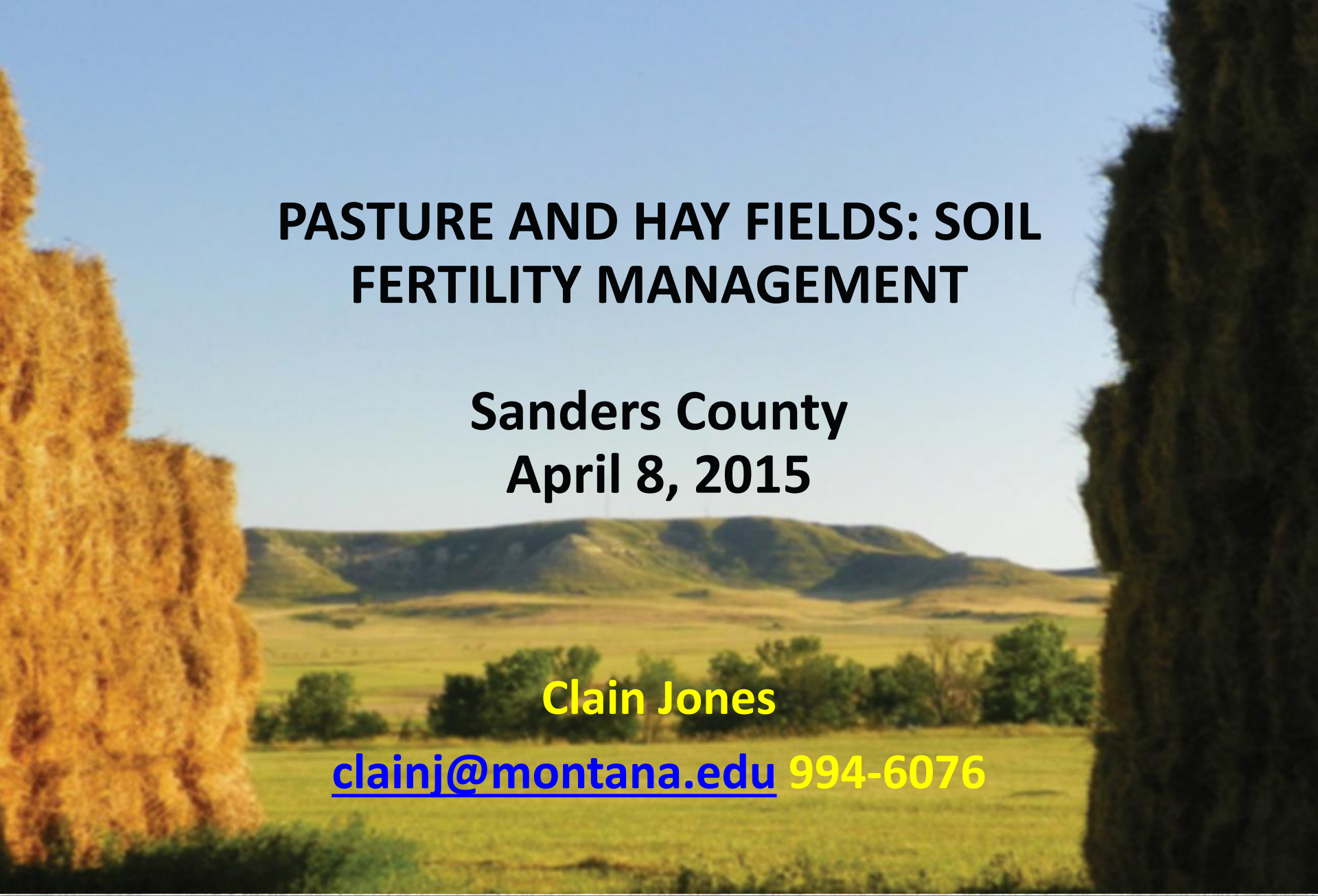

# PASTURE AND HAY FIELDS: SOIL FERTILITY MANAGEMENT

## Sanders County
## April 8, 2015


**Clain Jones**

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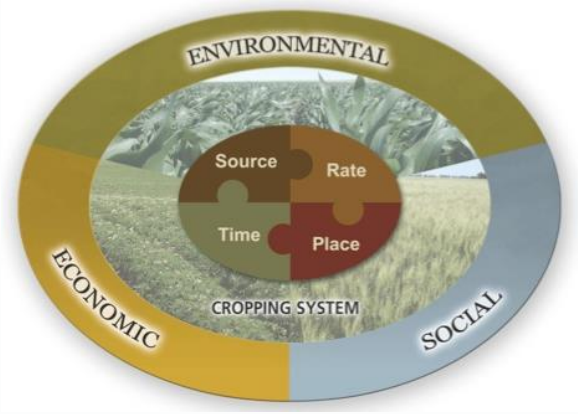
# Some questions for you

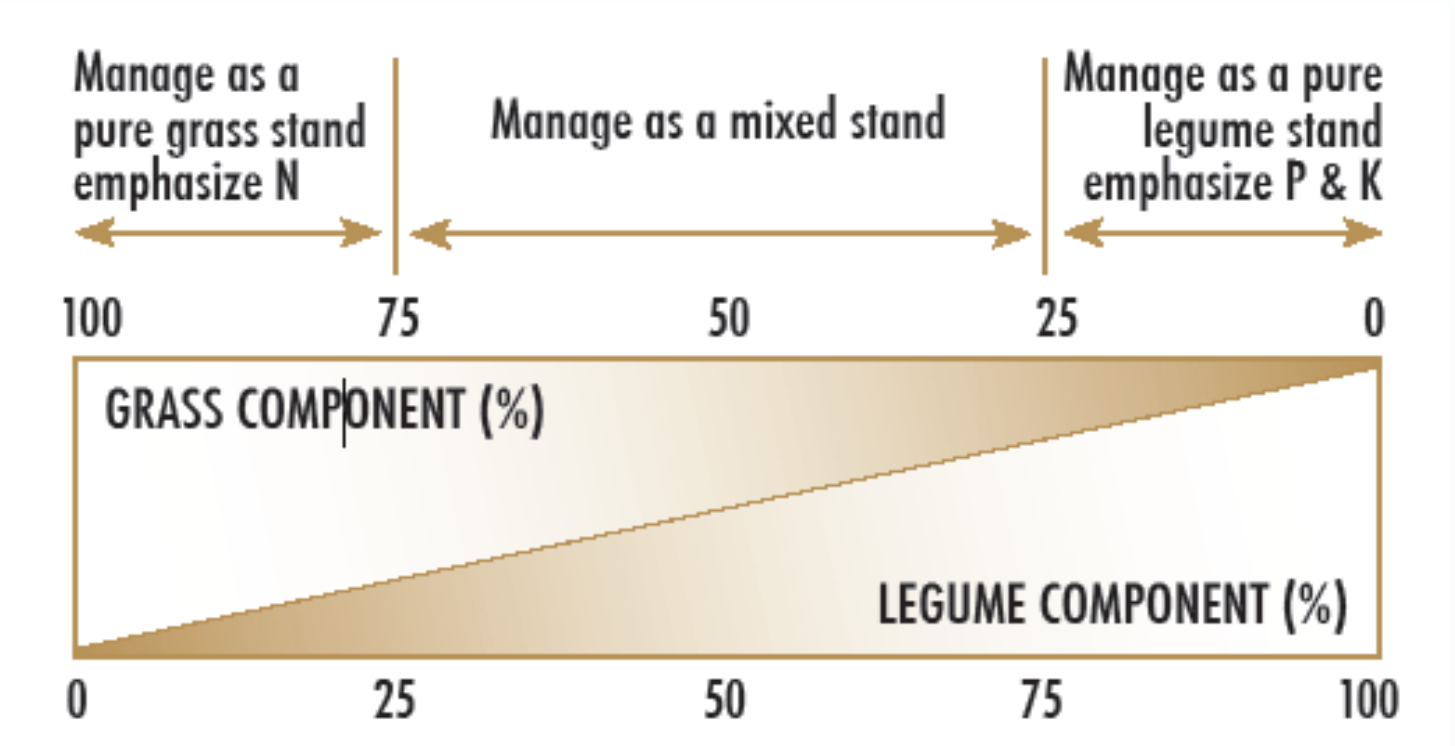
- Who raises grass hay?
- Who raises alfalfa hay?
- Who has pasture?
- Who grows annual forages (ex: Haybet barley, Willow Creek winter wheat)?
- Ok, now that we've all gotten the blood flowing….

# 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

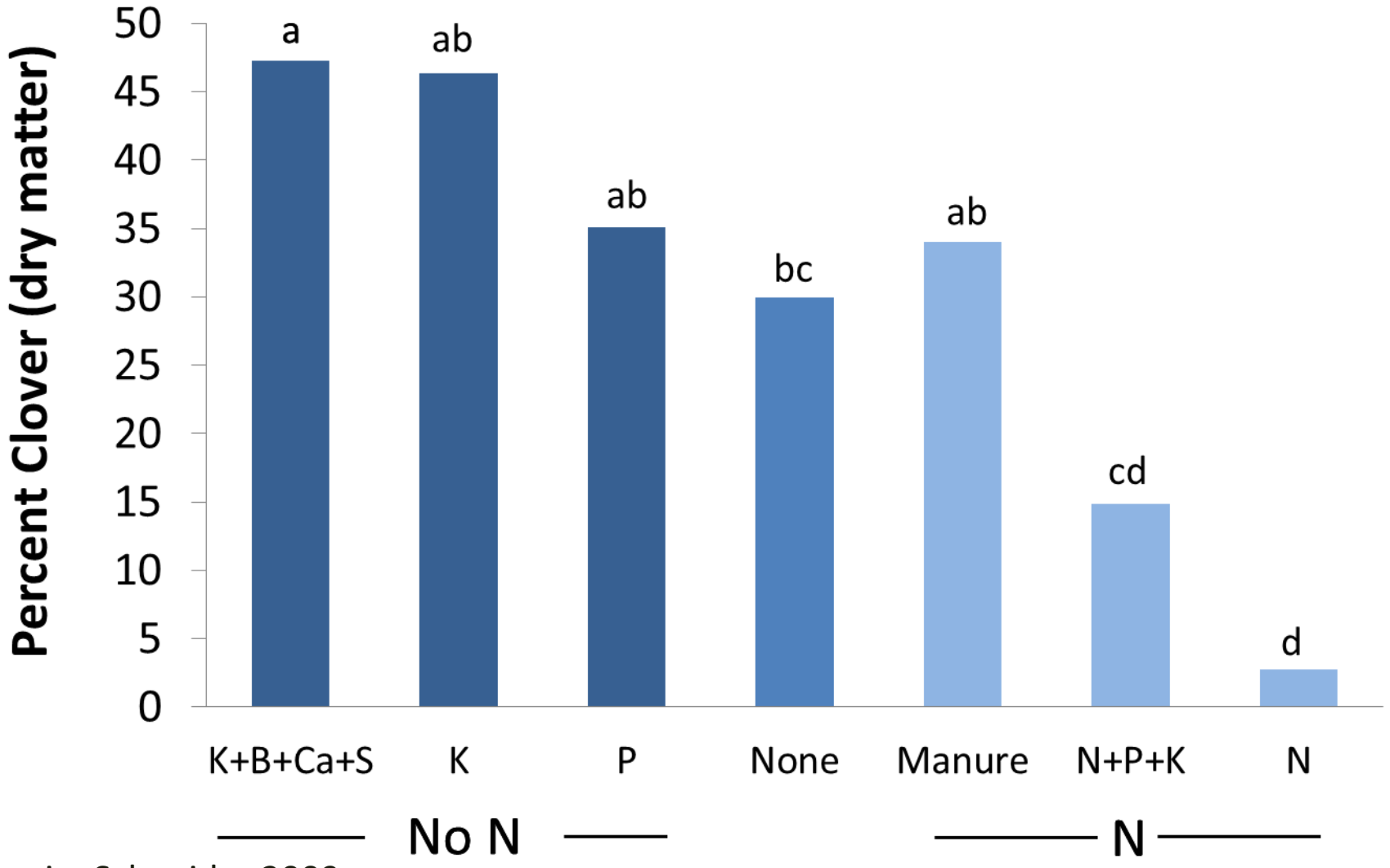


# Focus of N or P and K depends on % legume in stand




- 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 from Trout Creek, MT

| REPORT OF ANALYSIS | |
|---|---|
| YOUR SAMPLE NUMBER | HAY FIELD |
| Soil pH | 6.0 |
| Buffer Index | 6.6 |
| Excess Carbonate | VL |
| Soluble Salts mmhos/cm | 0.2 |
| Sodium ppm | 23.0 |
| % Organic Matter | 3.7 |
| ANALYSIS OF NUTRIENT ELEMENTS IS IN PARTS PER MILLION (ppm) | |
| Nitrate N | 1.0 |
| Phosphorus Bray 1 Olsen | 10 – |
| Potassium | 88 |
| Magnesium | 220 |
| Calcium | 1035 |
| Sulfate Sulfur | 8 |
| Zinc | 3.0 |
| Manganese | – |
| Copper | – |
| Iron | – |
| Boron | – |
| Bulk Density | 1.1 |

**FERTILIZER GUIDLINES IN: Lbs/Acre**

| | 1st Option Intended Crop | 2nd Option Intended Crop | 3rd Option Intended Crop |
|---|---|---|---|
| | Grass_Hay | | |
| Yield Goal | | | |
| Preceding Crop | | | |
| PLANT FOOD GUIDELINE RANGES | | | |
| N | 135.0 | | |
| $P_2O_5$ | 75.0 | | |
| $K_2O$ | 230.0 | | |
| MgO | 5.0 | | |
| S | 6.5 | | |
| Zn | 0.0 | | |
| Mn | | | |
| Cu | | | |
| Fe | | | |
| B | | | |
| Lime | 4380 | | |
| REMOVAL RATES | | | |
| N | 175 | | |
| $P_2O_5$ | 66 | | |
| $K_2O$ | 140 | | |

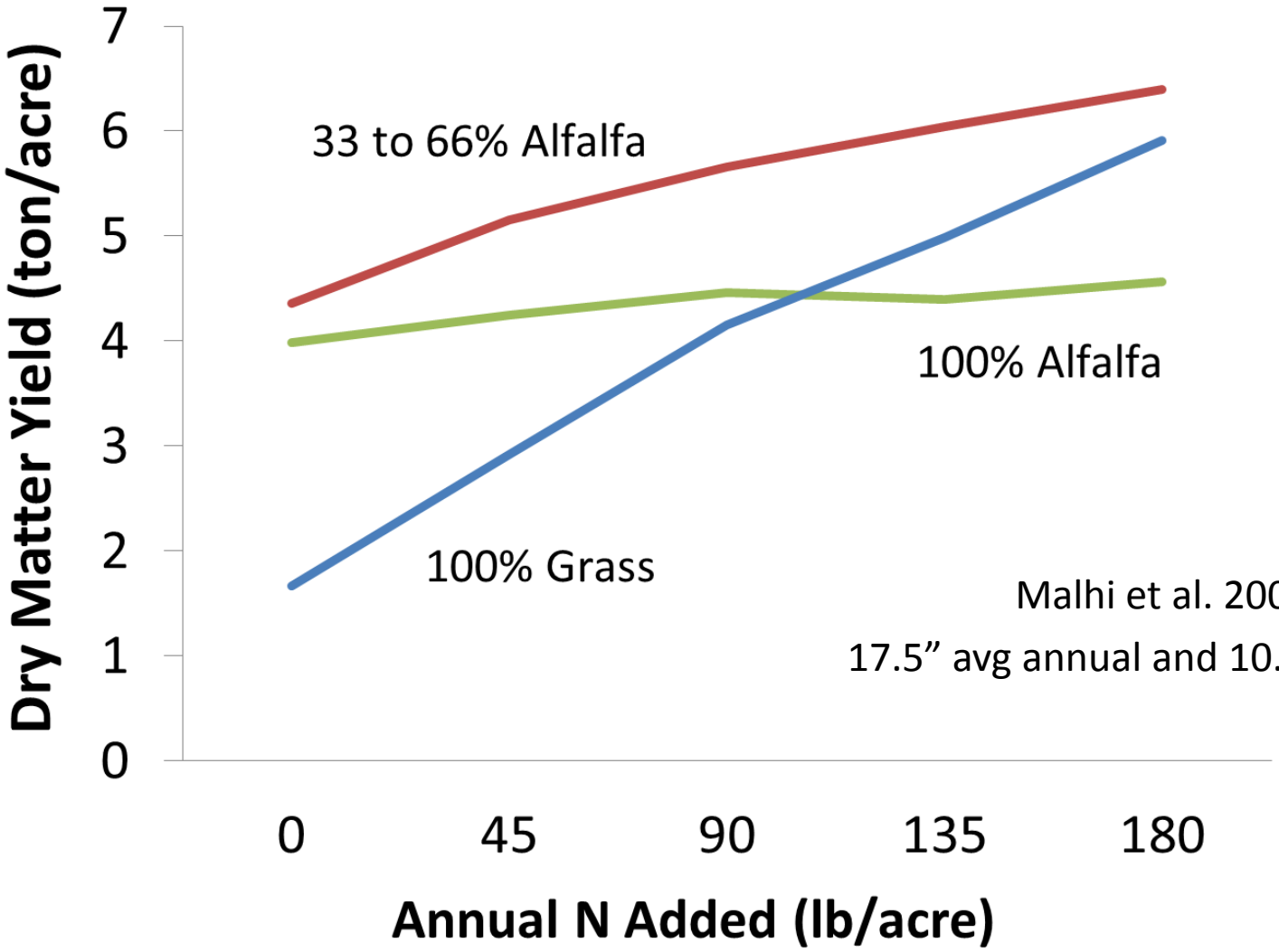
Lime Guidelines are for 100% Effective Calcium Carbonate (ECC) with a 6" Incorporation Depth.

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)

| ACTUAL AND SUGGESTED PERCENT OF TOTAL CEC (BASE SATURATION) | | | | | | | | ESTIMATED | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual % Hydrogen | Suggested Hydrogen | Actual % Potassium | Suggested Potassium | Actual % Magnesium | Suggested Magnesium | Actual % Calcium | Suggested Calcium | Actual % Sodium | Suggested Sodium | CEC for Your Soil |
| 40.5 | 0 - 5 | 1.8 | 4.1 - 7 | 14.9 | 15 - 20 | 42.0 | 65 - 75 | 0.8 | 0 - 5 | 12.3 |

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



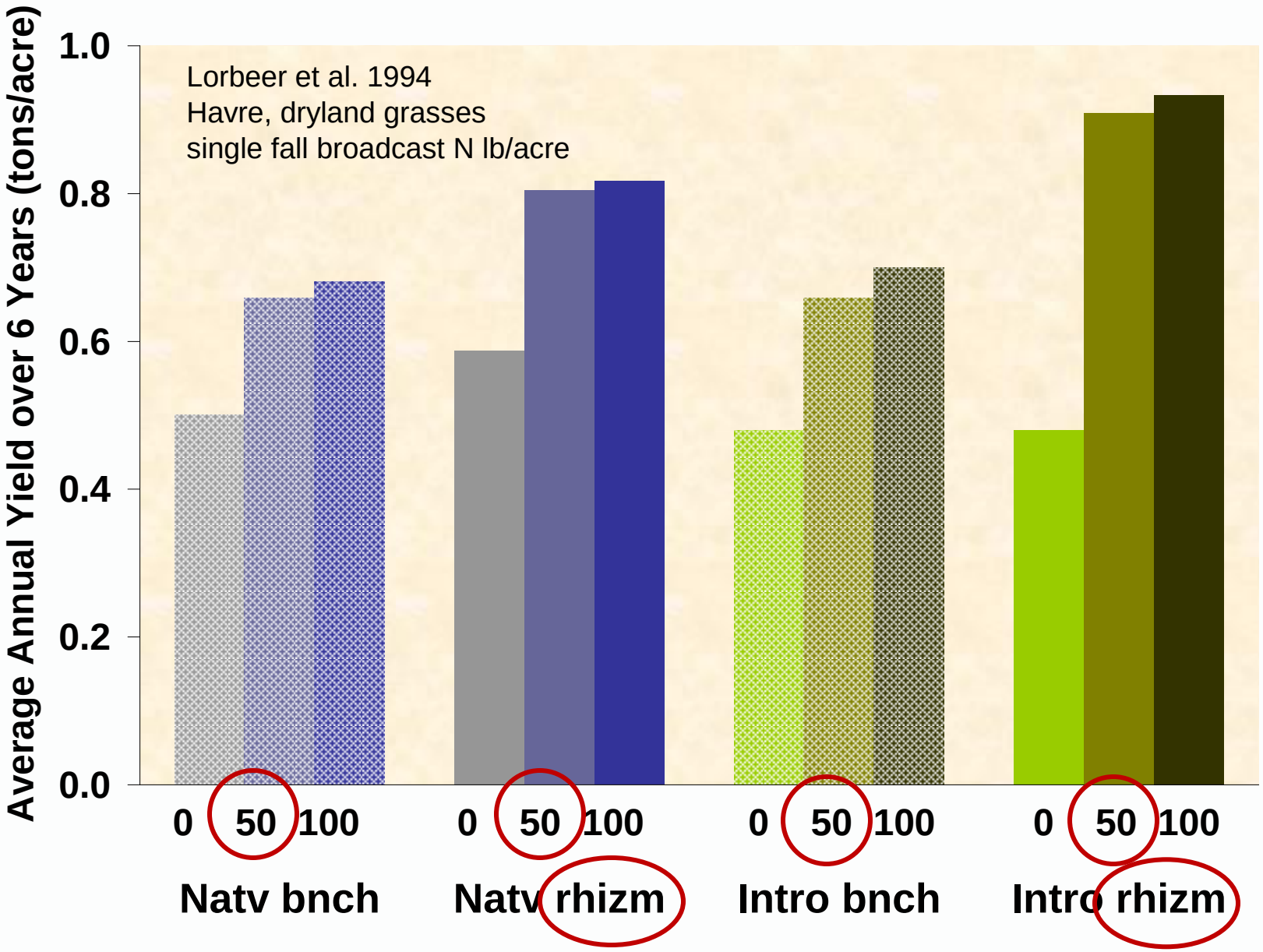

Malhi et al. 2002, Eckville, Alberta

17.5” avg annual and 10.5” May-Aug precip

# Single N application to dryland grass pasture

- near Havre, MT (Lorbeer et al. 1994)
- 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)

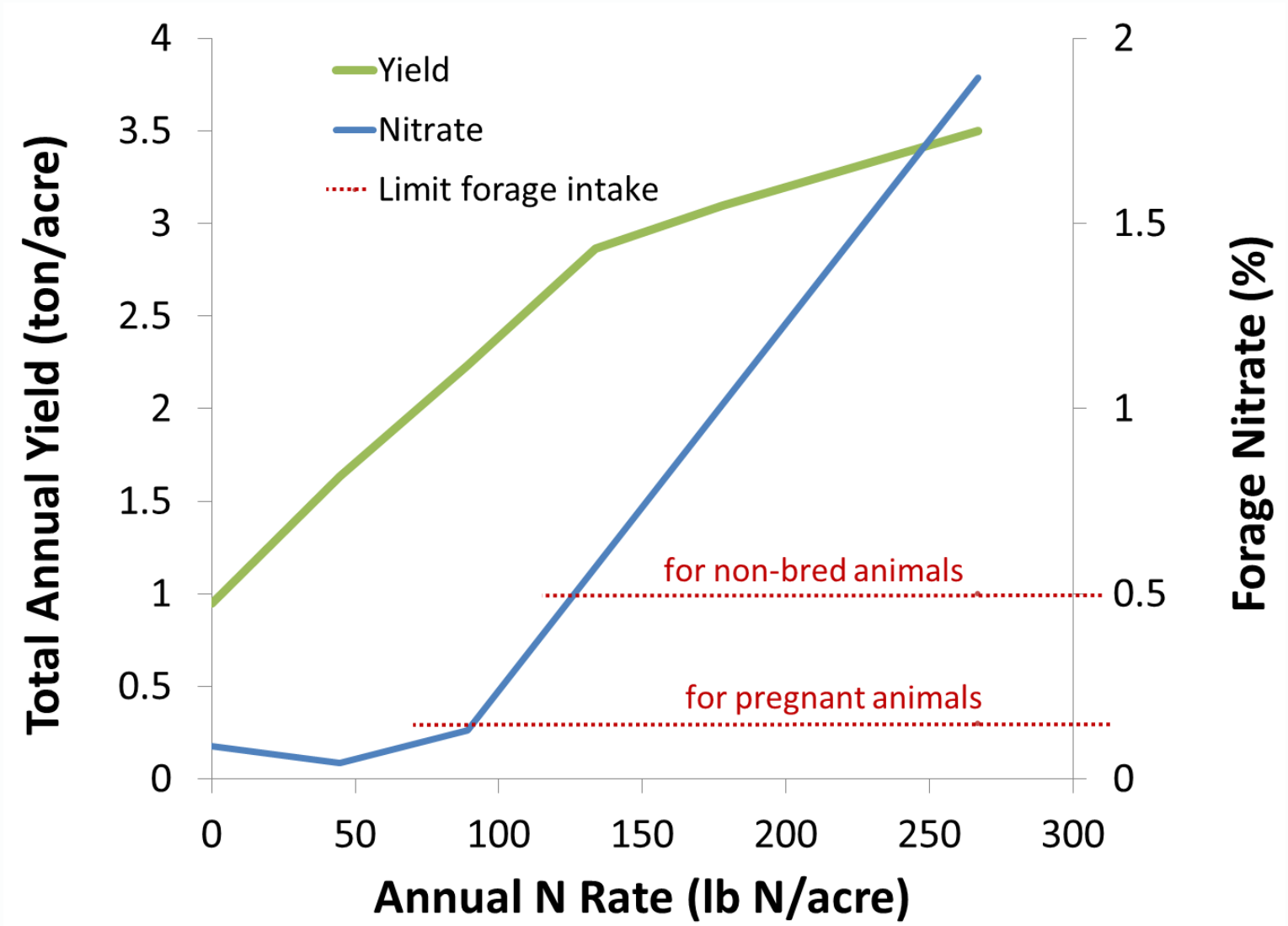
# Single N application increases dryland grass yields



# 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 ground water 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.

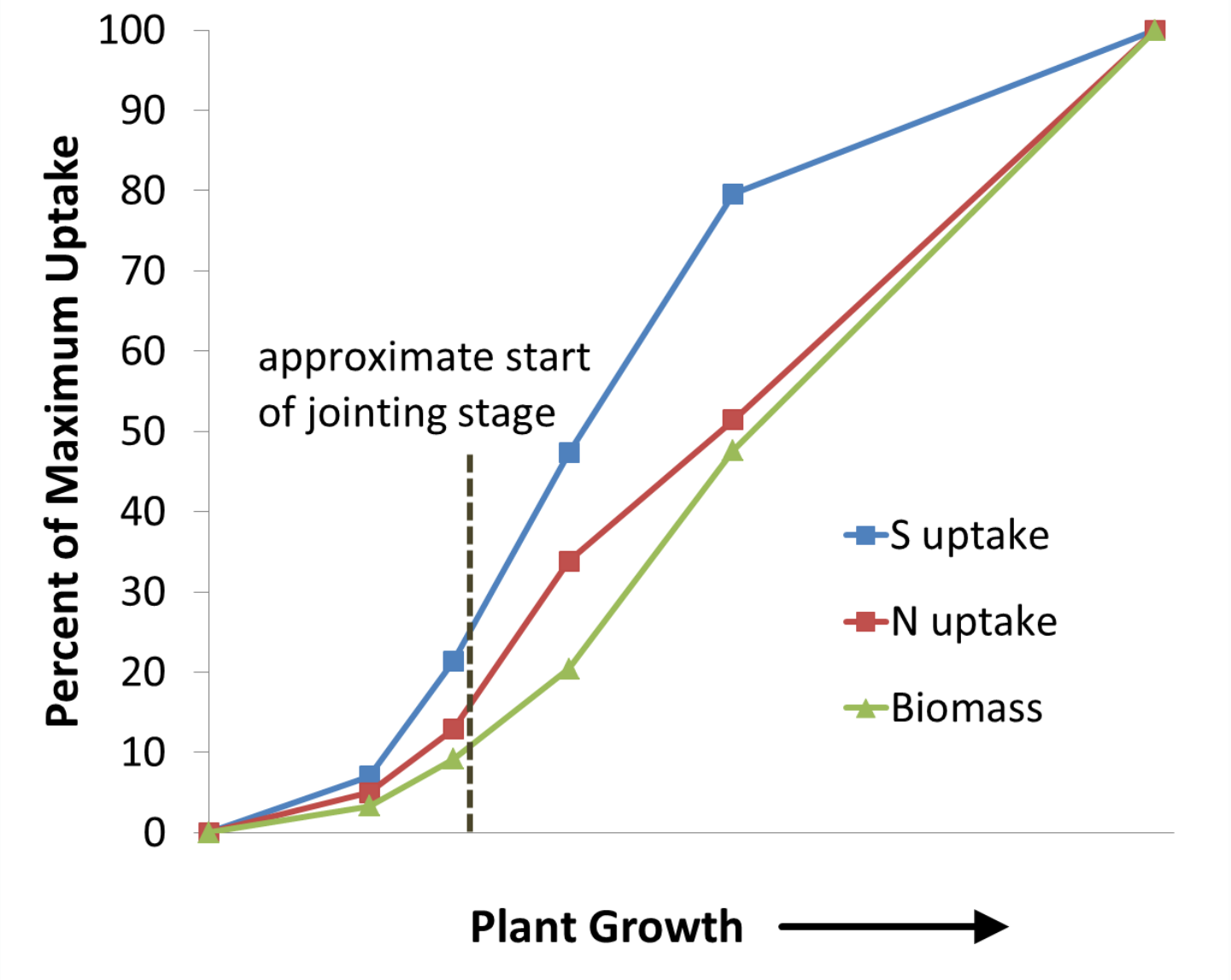
| Method | Forage Yield |
|---|---|
| Broadcast | 2.9 t/ac |
| Knife | 2.8 t/ac |
| Surface Band | 3.4 t/ac |

N. Central Regional
Extension Pub #326, KSU

# Timing

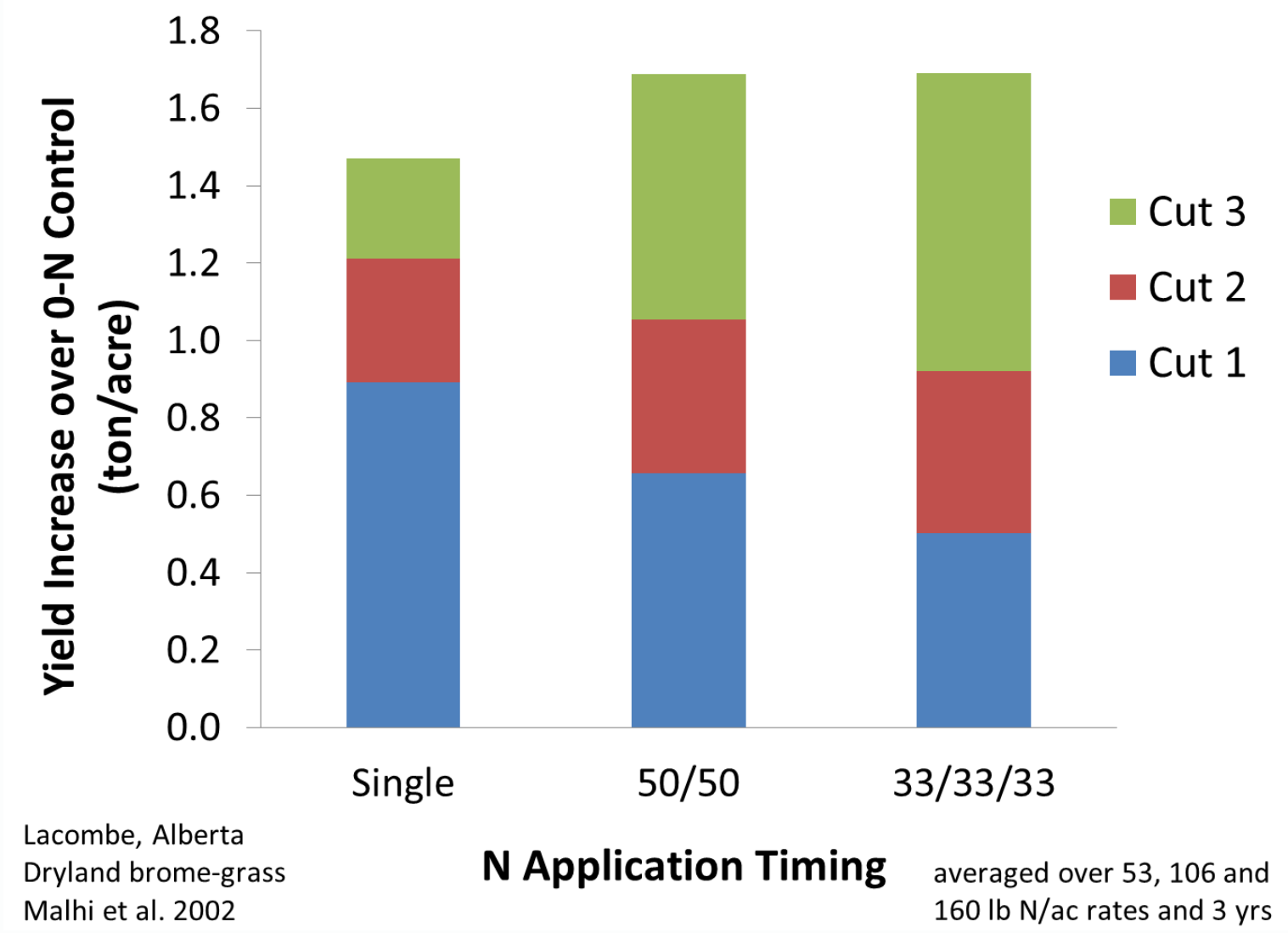
- Yield and quality are affected by timing
- Because urea may take days to weeks to become available, urea should be applied earlier than AN historically was for fast green-up.

# Provide N shortly after green-up



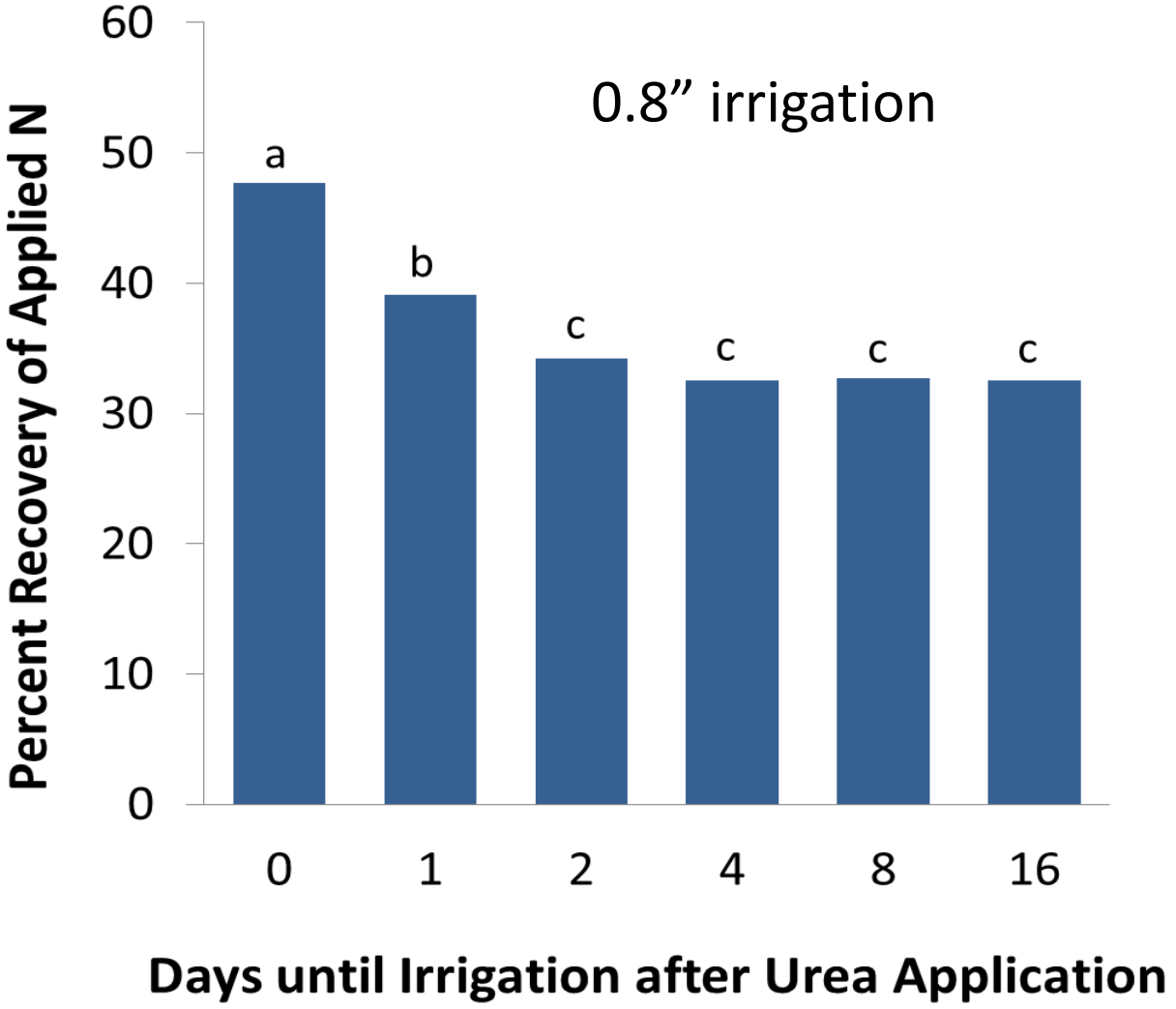

Willamette Valley, Oregon  Hart et al. 1989

# 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



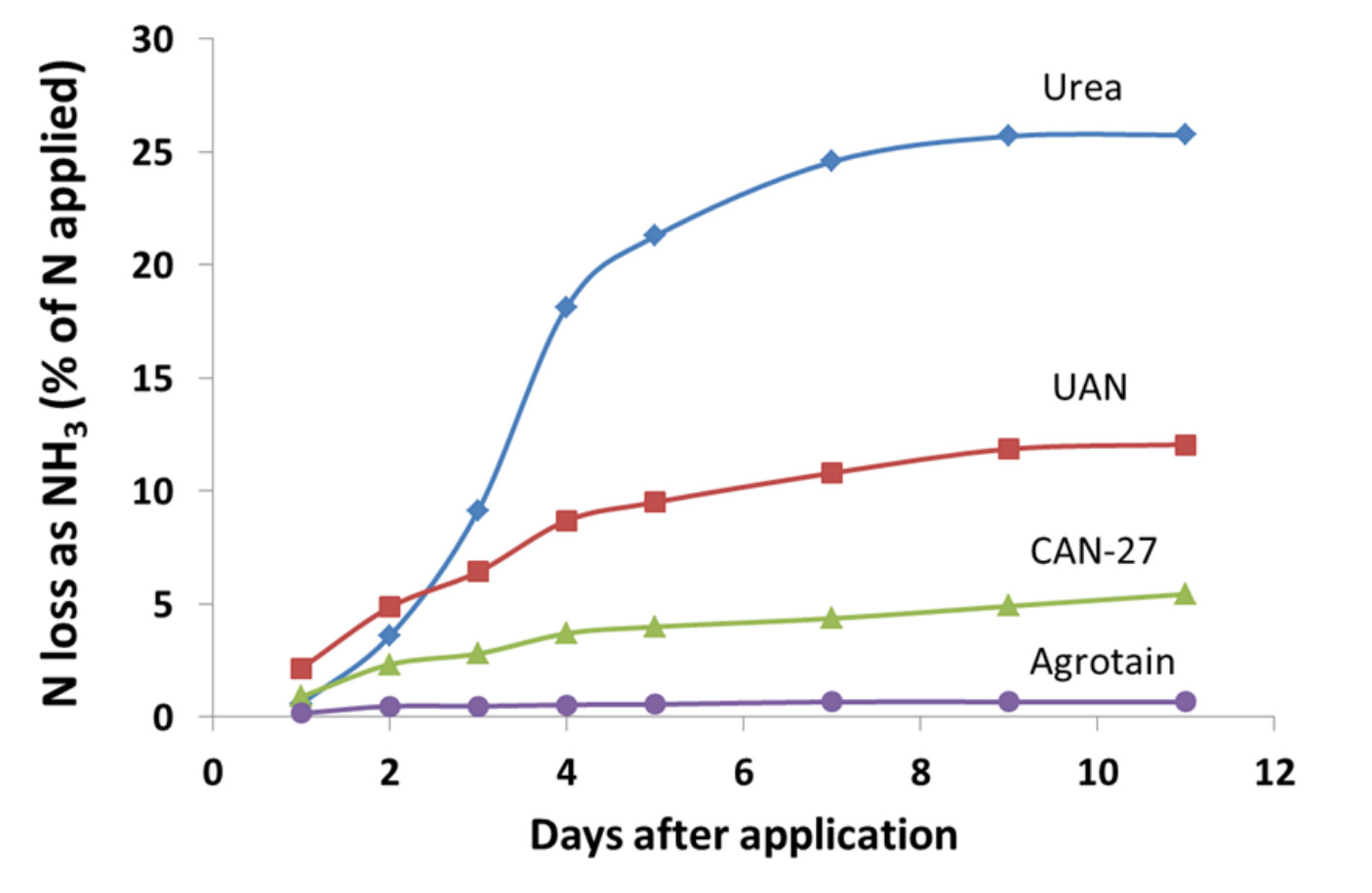

Eckville, Alberta

Bromegrass, Malhi et al. 1995

# Enhanced Efficiency Fertilizers (EEFs) and forage production

- Forage production lacks incorporation, and plant residue intercepts fertilizer, increases volatilization, and microbes 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 (Agrotain®: urease inhibitor ~ 14 days) 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

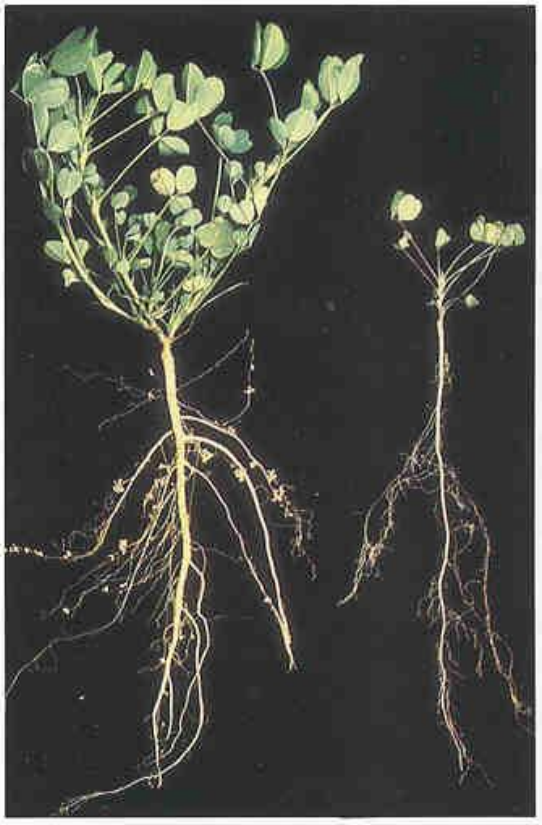
- Environmentally responsible but more $
- Conservation Stewardship Program incentive

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

Questions?

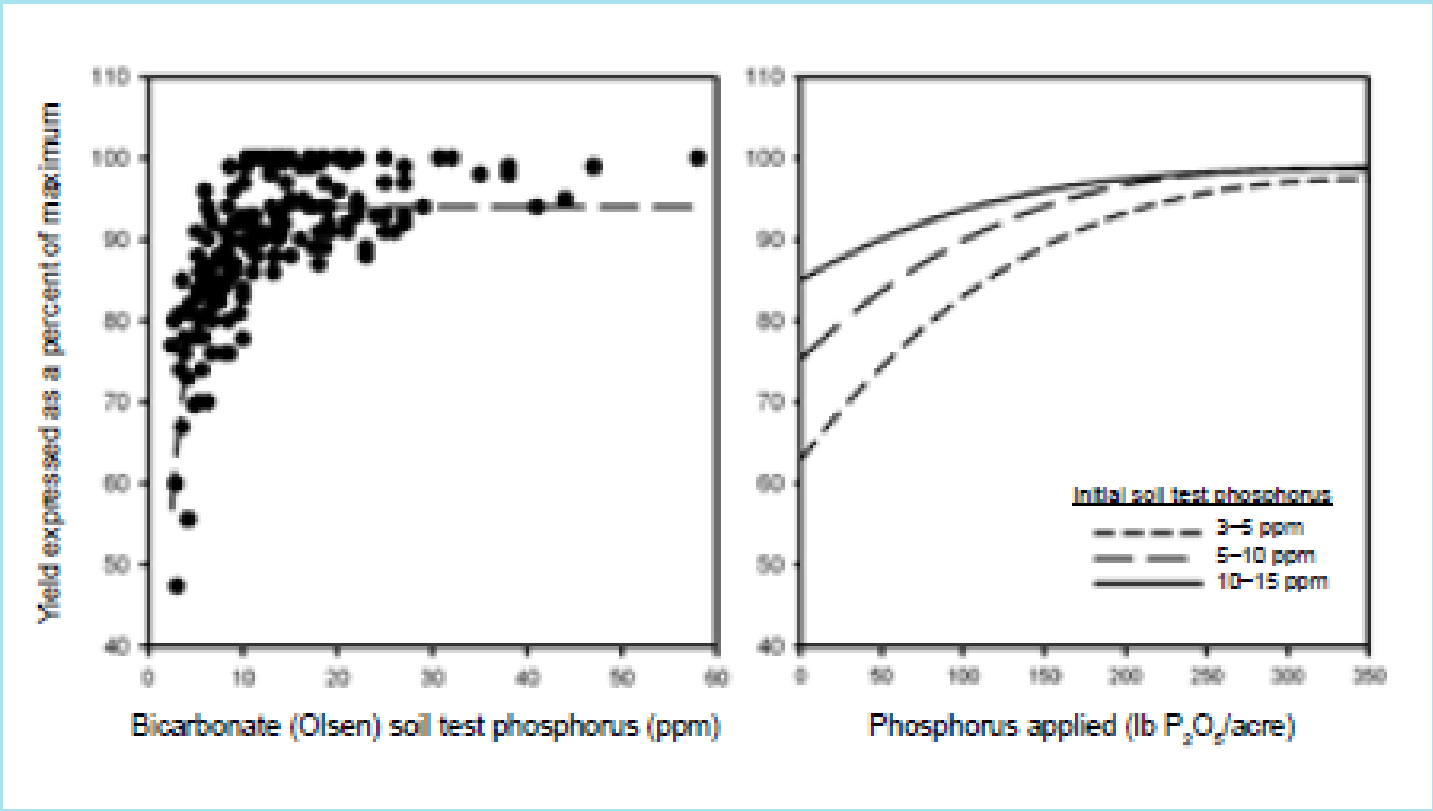
# Phosphorus (P)

- 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 from Trout Creek, MT

| REPORT OF ANALYSIS | |
|---|---|
| YOUR SAMPLE NUMBER | HAY FIELD |
| Soil pH | 6.0 |
| Buffer Index | 6.6 |
| Excess Carbonate | VL |
| Soluble Salts mmhos/cm | 0.2 |
| Sodium ppm | 23.0 |
| % Organic Matter | 3.7 |
| ANALYSIS OF NUTRIENT ELEMENTS IS IN PARTS PER MILLION (ppm) | |
| Nitrate N | 1.0 |
| Phosphorus Bray 1<br>Olsen | 10<br>– |
| Potassium | 88 |
| Magnesium | 220 |
| Calcium | 1035 |
| Sulfate Sulfur | 8 |
| Zinc | 3.0 |
| Manganese | – |
| Copper | – |
| Iron | – |
| Boron | – |
| Bulk Density | 1.1 |

**FERTILIZER GUIDLINES IN: Lbs/Acre**

| 1st Option Intended Crop | 2nd Option Intended Crop | 3rd Option Intended Crop |
|---|---|---|
| Grass_Hay | | |
| Yield Goal | Yield Goal | Yield Goal |
| | | |
| Preceding Crop | Preceding Crop | Preceding Crop |
| | | |

| PLANT FOOD GUIDELINE RANGES | | CROP REMOVAL RATES |
|---|---|---|
| N | 135.0 | 175 |
| $P_2O_5$ | 75.0 | 66 |
| $K_2O$ | 230.0 | 140 |
| MgO | 5.0 | |
| S | 6.5 | |
| Zn | 0.0 | |
| Mn | | |
| Cu | | |
| Fe | | |
| B | | |
| Lime | 4380 | |

| 2nd Option Intended Crop | | |
|---|---|---|
| N | | |
| $P_2O_5$ | | |
| $K_2O$ | | |
| MgO | | |
| S | | |
| Zn | | |
| Mn | | |
| Cu | | |
| Fe | | |
| B | | |
| Lime | | |

| 3rd Option Intended Crop | | CROP REMOVAL RATES |
|---|---|---|
| MgO | | |
| S | | |
| Zn | | |
| Mn | | |
| Cu | | |
| Fe | | |
| B | | |
| Lime | | |

Lime Guidelines are for 100% Effective Calcium Carbonate (ECC) with a 6" Incorporation Depth.

MSU guidelines are based on Olsen P

| ACTUAL AND SUGGESTED PERCENT OF TOTAL CEC (BASE SATURATION) | | | | | | | | ESTIMATED | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual % Hydrogen | Suggested Hydrogen | Actual % Potassium | Suggested Potassium | Actual % Magnesium | Suggested Magnesium | Actual % Calcium | Suggested Calcium | Actual % Sodium | Suggested Sodium | CEC for Your Soil |
| 40.5 | 0 - 5 | 1.8 | 4.1 - 7 | 14.9 | 15 - 20 | 42.0 | 65 - 75 | 0.8 | 0 - 5 | 12.3 |

# 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

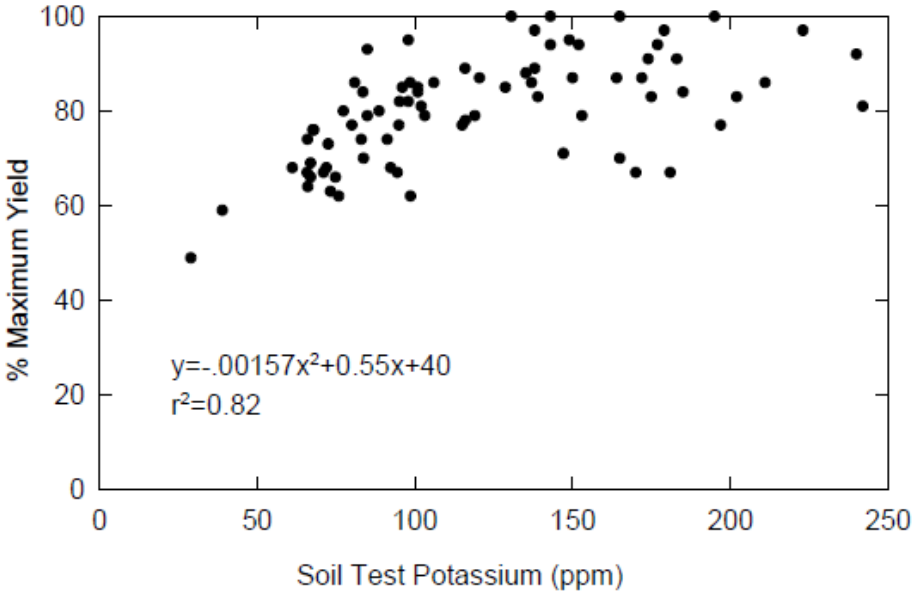
- Improved alfalfa stand persistence, shoots per plant and rhizobia activity
- Reduces leaf drop of alfalfa
- Improved resistance to plant diseases

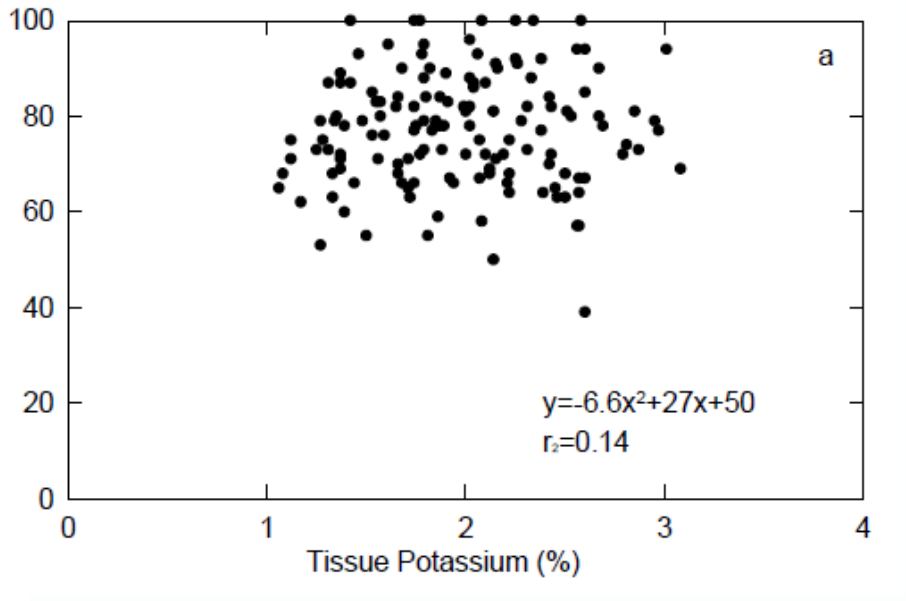
## Needed in Montana?

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 from Trout Creek, MT

| REPORT OF ANALYSIS | |
|---|---|
| YOUR SAMPLE NUMBER | HAY FIELD |
| Soil pH | 6.0 |
| Buffer Index | 6.6 |
| Excess Carbonate | VL |
| Soluble Salts mmhos/cm | 0.2 |
| Sodium ppm | 23.0 |
| % Organic Matter | 3.7 |
| ANALYSIS OF NUTRIENT ELEMENTS IS IN PARTS PER MILLION (ppm) | |
| Nitrate N | 1.0 |
| Phosphorus Bray 1 | 10 |
| Olsen | – |
| Potassium | 88 |
| Magnesium | 220 |
| Calcium | 1035 |
| Sulfate Sulfur | 8 |
| Zinc | 3.0 |
| Manganese | – |
| Copper | – |
| Iron | – |
| Boron | – |
| Bulk Density | 1.1 |

**FERTILIZER GUIDLINES IN: Lbs/Acre**

| 1st Option Intended Crop | | | 2nd Option Intended Crop | | | 3rd Option Intended Crop | | |
|---|---|---|---|---|---|---|---|---|
| Grass_Hay | | | | | | | | |
| Yield Goal | | | Yield Goal | | | Yield Goal | | |
| | | | | | | | | |
| Preceding Crop | | | Preceding Crop | | | Preceding Crop | | |
| | | | | | | | | |
| PLANT FOOD GUIDELINE RANGES | | CROP REMOVAL RATES | PLANT FOOD GUIDELINE RANGES | | CROP REMOVAL RATES | PLANT FOOD GUIDELINE RANGES | | CROP REMOVAL RATES |
| N | 135.0 | 175 | | | | N | | |
| $P_2O_5$ | 75.0 | 60 | P | | | $P_2O_5$ | | |
| $K_2O$ | 230.0 | 140 | K | | | $K_2O$ | | |
| MgO | 5.0 | | Mg | | | MgO | | |
| S | 6.5 | | S | | | S | | |
| Zn | 0.0 | | Zn | | | Zn | | |
| Mn | | | Mn | | | Mn | | |
| Cu | | | Cu | | | Cu | | |
| Fe | | | Fe | | | Fe | | |
| B | | | B | | | B | | |
| Lime | 4380 | | Lime | | | Lime | | |

Lime Guidelines are for 100% Effective Calcium Carbonate (ECC) with a 6" Incorporation Depth.

Compare to MSU guidelines

| ACTUAL AND SUGGESTED PERCENT OF TOTAL CEC (BASE SATURATION) | | | | | | | | ESTIMATED | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual % Hydrogen | Suggested Hydrogen | Actual % Potassium | Suggested Potassium | Actual % Magnesium | Suggested Magnesium | Actual % Calcium | Suggested Calcium | Actual % Sodium | Suggested Sodium | CEC for Your Soil |
| 40.5 | 0 - 5 | 1.8 | 4.1 - 7 | 14.9 | 15 - 20 | 42.0 | 65 - 75 | 0.8 | 0 - 5 | 12.3 |

# 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**

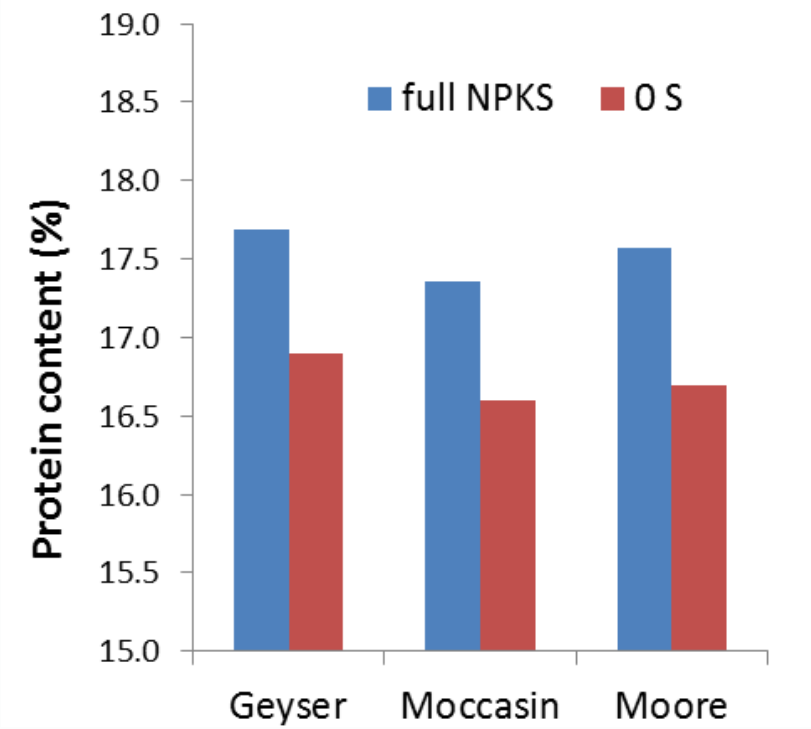
# Sulfur (S)

- 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.

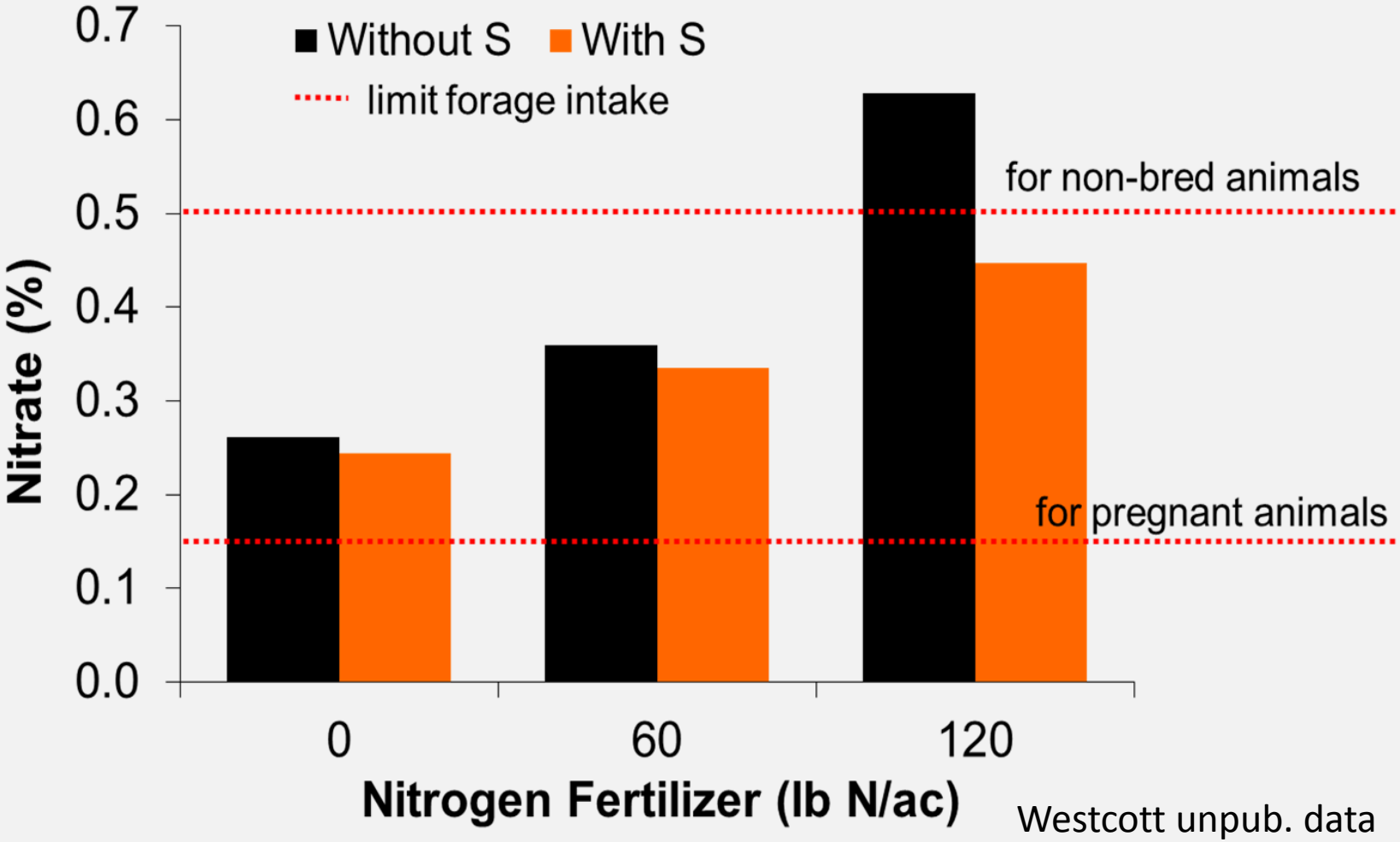
- S > 0.30% can cause livestock health problem

# 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)

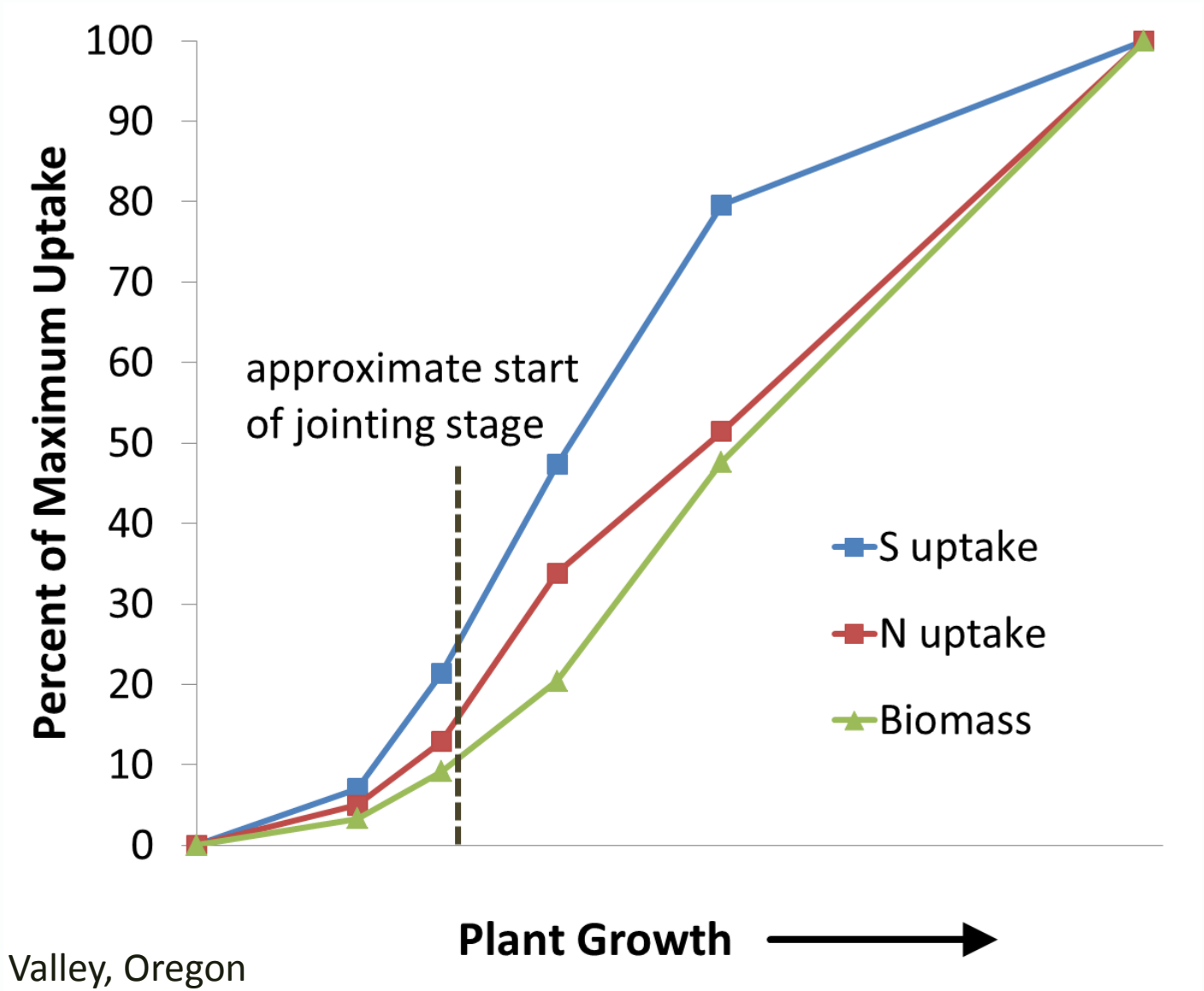


# S influence on annual forage quality
## (western Montana)



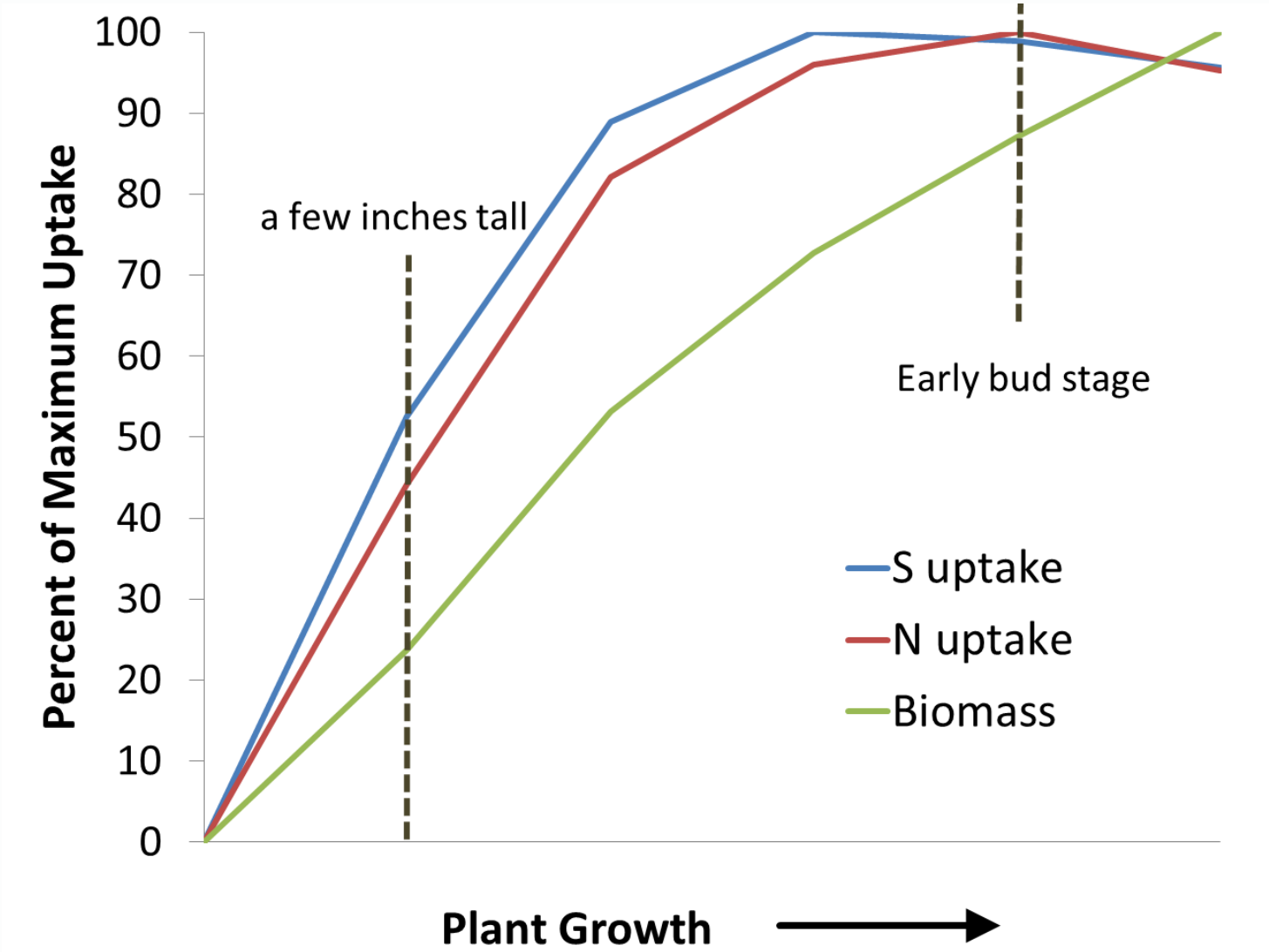

Westcott unpub. data

# 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

Questions?

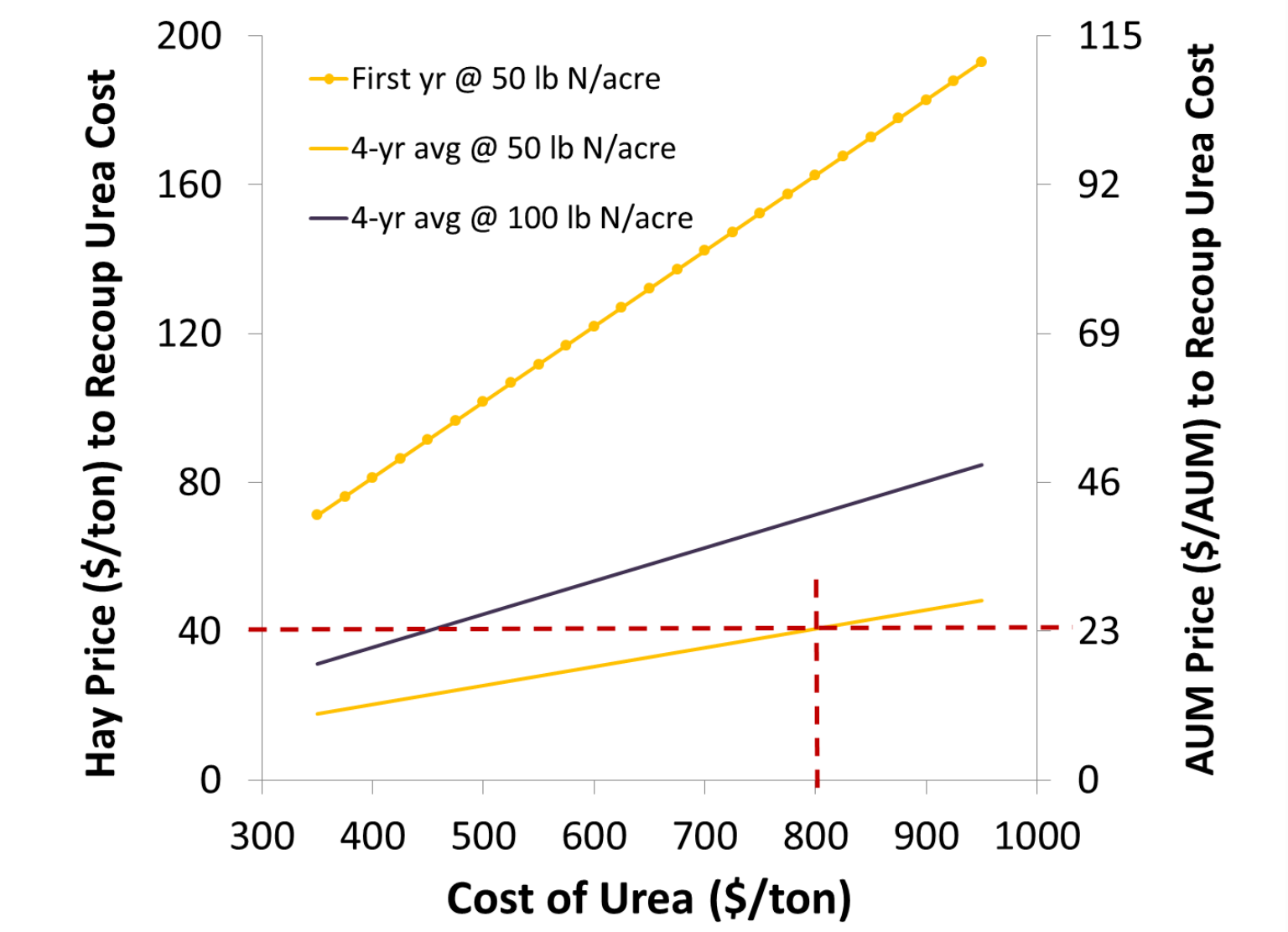
# General timing considerations for forage fertilization

- 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

# N Fertilization Economics: dryland introduced sod-forming grass




Havre, MT, Jacobsen et al. 1996

# 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).

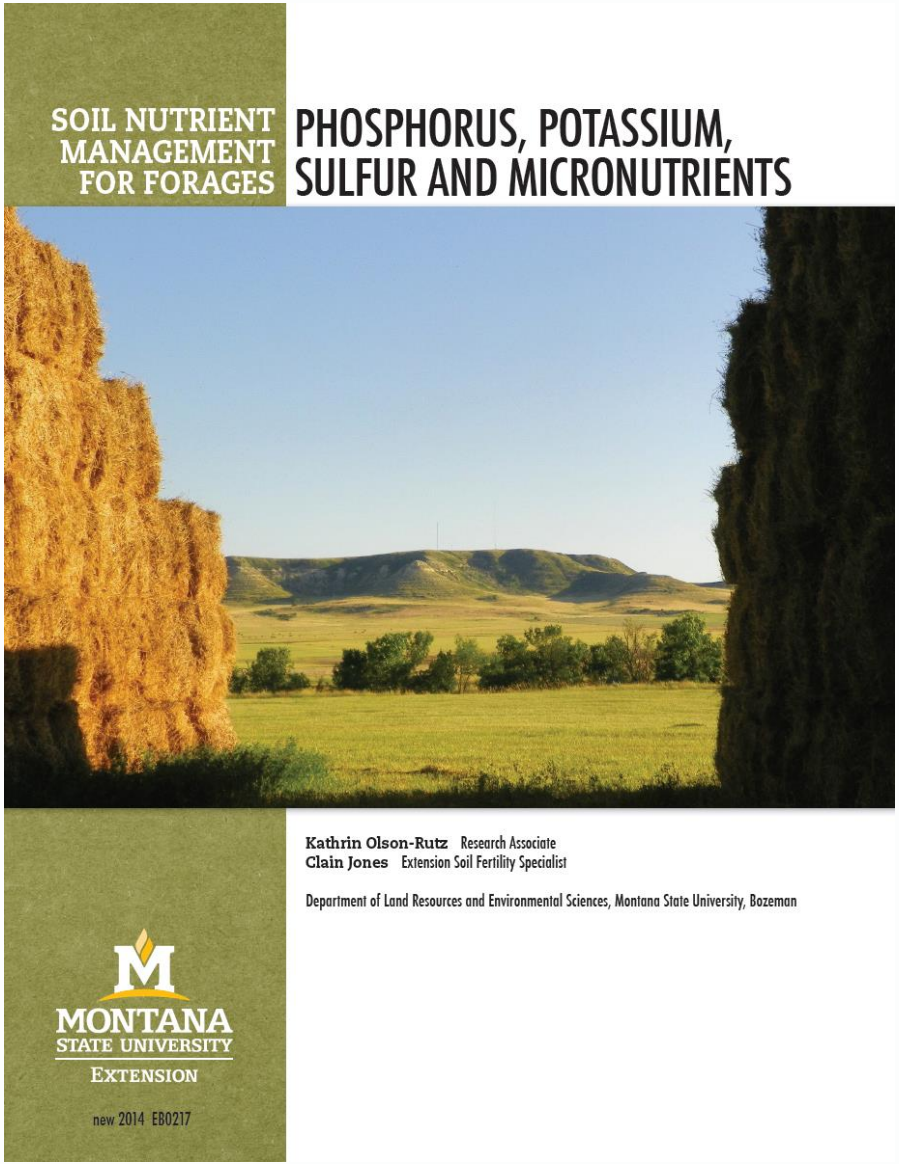
# N, P, K for new seedings

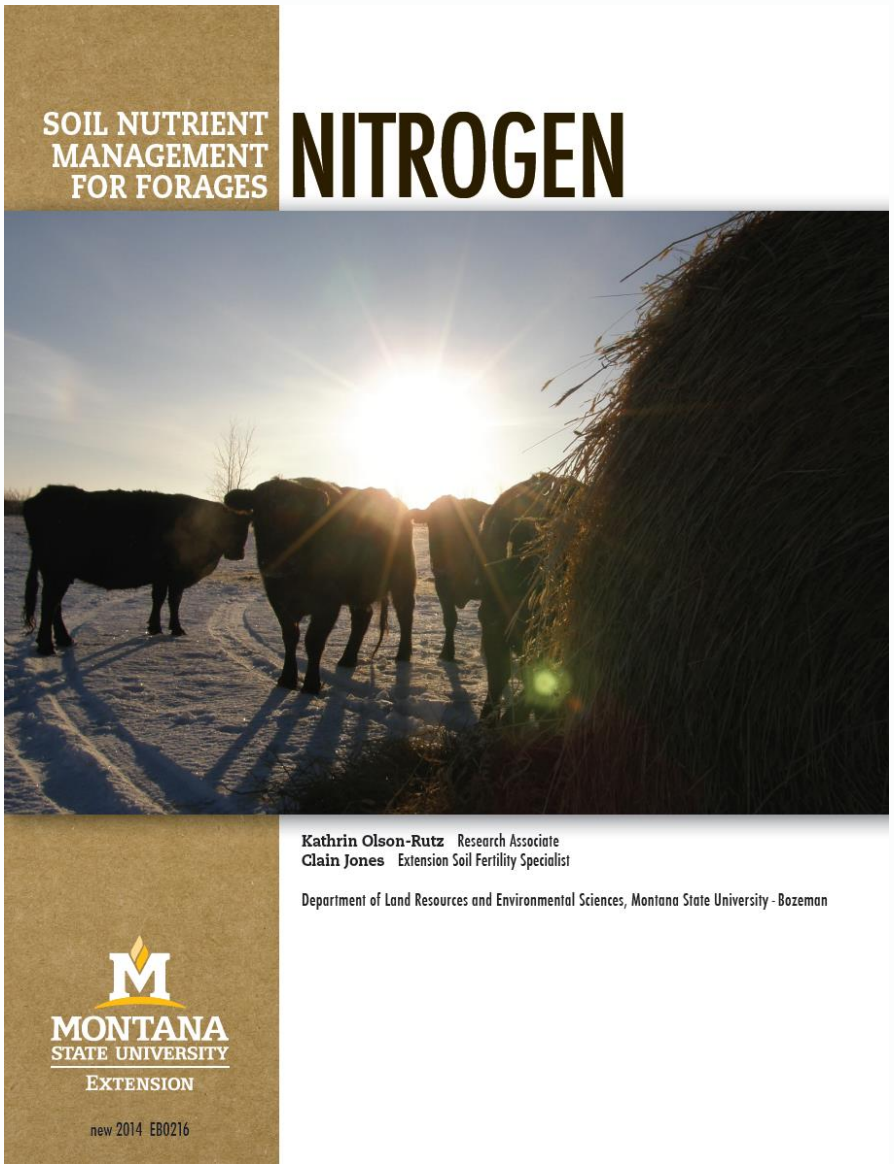
- Base N, P, K rates on soil tests
- If seeding on fallow, OM >3% provides adequate N for 2-3 years
- Do not exceed 60 lb N/acre in the first year
- If N is banded or seed placed do not exceed 10-15 lb N, P as 11-52-0, or (N + $K_2O$)/acre to reduce risk to seedlings
- Build up soil P and K levels prior 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:
http://landresources.montana.edu/soilfertility