Soil Fertility Management of Hay and Pasture

Prepared for

2007 Granite County Herdsmanship School

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http://landresources.montana.edu/soilfertility

MONTANA STATE UNIVERSITY | EXTENSION

Some questions for you

How many of you raise alfalfa-hay?

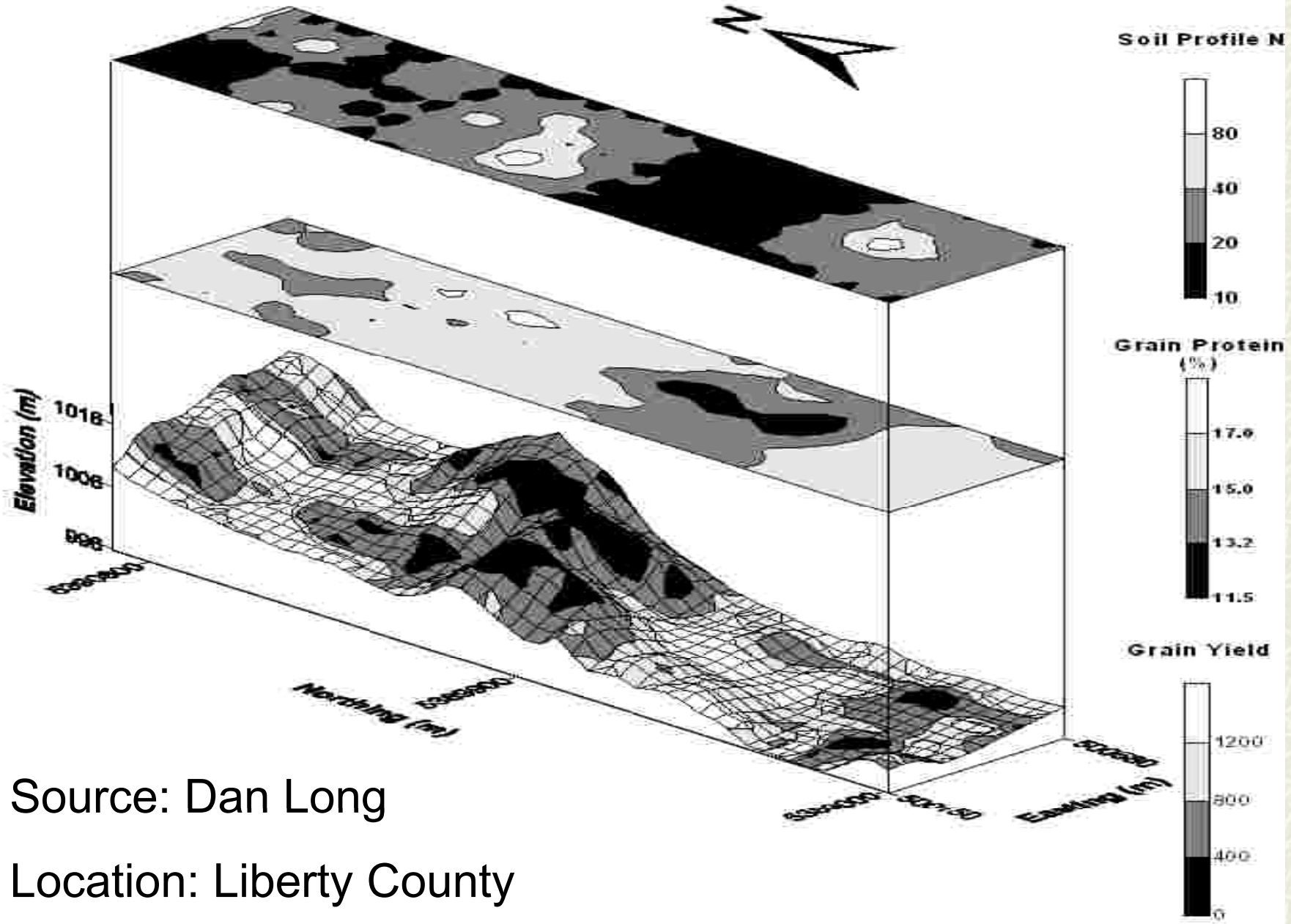
How many grow grass for hay (w/o alfalfa)?

Who has grown annual forages (ex: Haybet barley)?

Can you buy ammonium nitrate in Granite County?

Goals

1. To better understand soil and nutrient variability, and nutrient deficiency symptoms
2. To understand fertilizer options (ammonium nitrate, urea, UAN, and ammonium sulfate), and how timing and placement of fertilizer affect nutrient losses
3. To learn benefits of phosphorus, potassium, and sulfur on forages



Source: Dan Long

Location: Liberty County

How could you get a feeling for soil variability in a field without mapping it yourself?

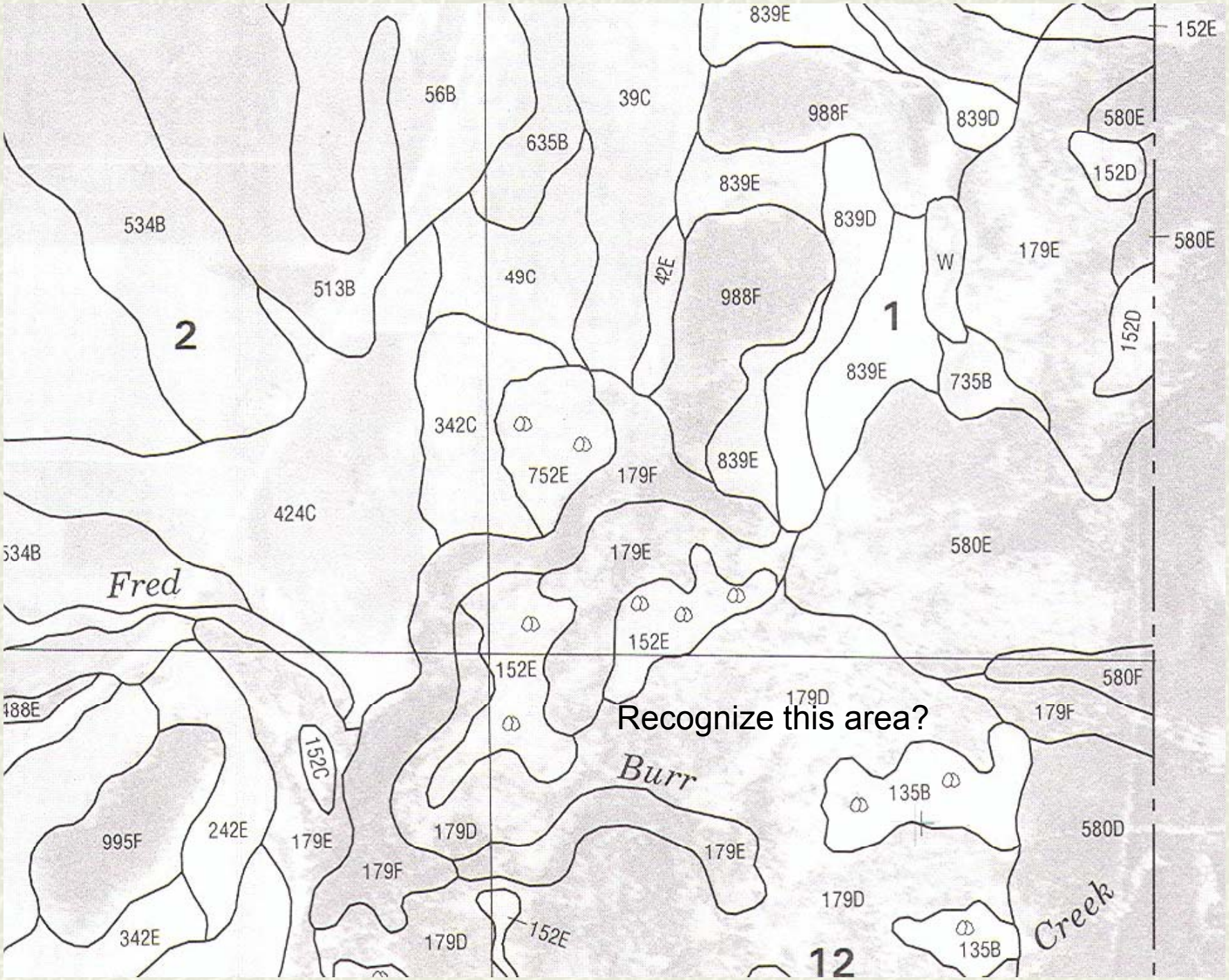
NRCS Soil Series Maps

Most are now digital and available on internet

http://maps2.nris.state.mt.us/mapper/PLSSSearch.asp

Enter township/range, then click on land information, then NRCS maps. (data file large and more difficult to download than maps-can obtain maps/data at Extension offices).

Most have not been verified but are based on topographic and vegetation similarities with known soil series.


839E
152E
56B
39C
988F
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49C
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988F
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424C
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Recognize this area?
152C
Burr
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179F
179D
342E
179D
152E
135B
Creek
12

Information Available in Soil Surveys that Relates to Soil Fertility

- Soil depth-relates directly to Plant Available Water which affects yield potential
- Texture and water holding capacity (available water)
- Soil pH-affects phosphorus (P) availability-lowest near pH 8.0, highest near pH 6.5
- Cation Exchange Capacity (CEC: ability to bind cations such as ammonium and potassium)
- Calcium carbonate – more P is needed when this number is above 0 in the upper layer


839E
152E
56B
39C
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839D
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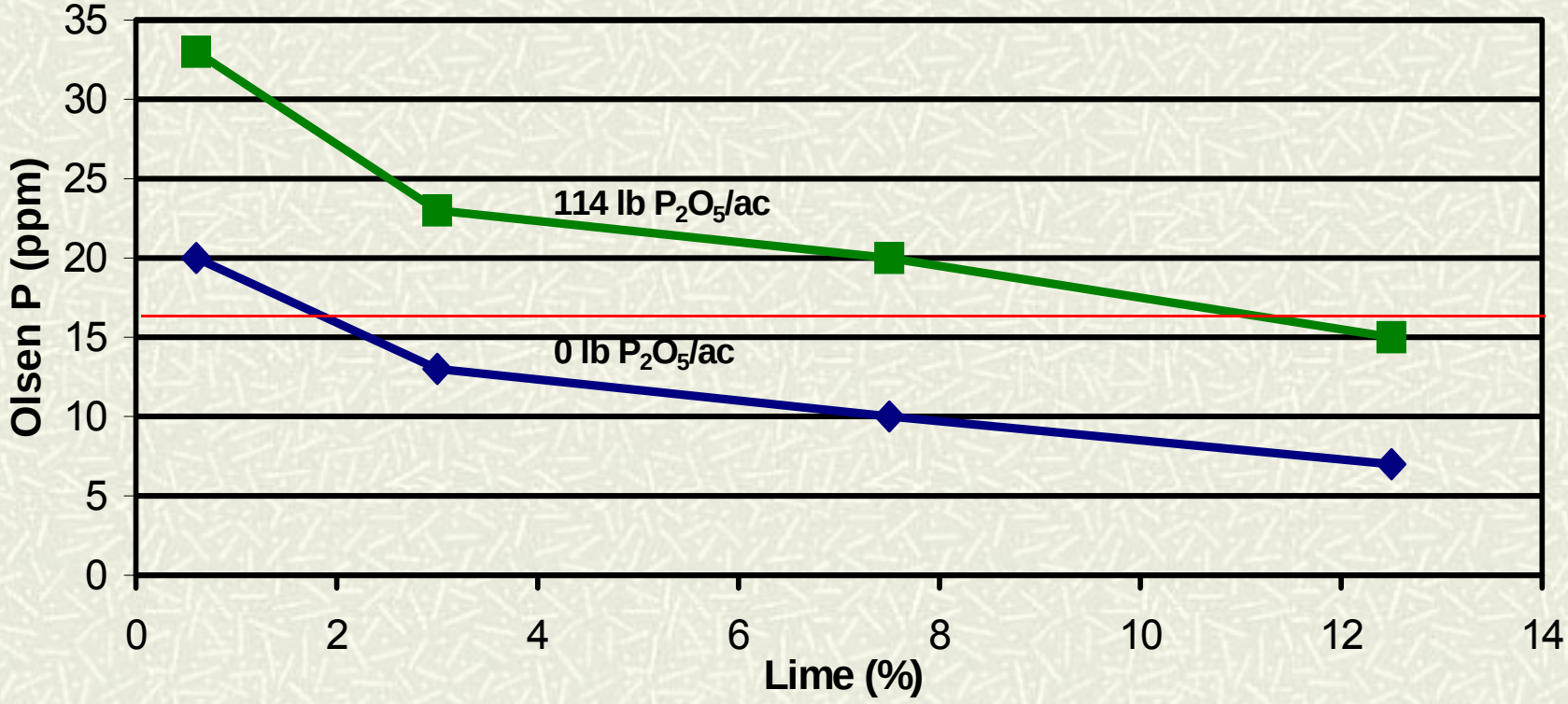
179D
152E
135B
Creek
12

Example soil data

	534B Gregson Silt Loam	**513B Windlass-Nirling**
Soil Depth	More than 60 in.	More than 60 in.
Texture	Silt loam	Loam-Cobbly loam
Avail. water	6.5 in.	2.6-3.6 in.
Soil pH	6.6-7.8	6.6-7.8
Cation Exch. Cap.	15-30	10-20
Calcium Carb.	---	0

Effect of soil lime content on available P (Olsen P) level

What is ‘critical level’ for Olsen P in Montana? 16 ppm



Adapted from Westermann (1992)

Take home message

Soil Series maps can tell you about available water on your property and help you manage fields differently depending on soil properties.

QUESTIONS?

What nutrients are required by all plants?

There are 14 mineral nutrients that have been found to be essential for growth of most plants:

Macronutrients	Micronutrients
Nitrogen (N)	Copper (Cu)
Phosphorus (P)	Iron (Fe)
Potassium (K)	Nickel (Ni)
Calcium (Ca)	Manganese (Mn)
Magnesium (Mg)	Zinc (Zn)
Sulfur (S)	Boron (B)
	Chloride (Cl)
	Molybdenum (Mo)

The macronutrients are simply needed in larger amounts by the plant than the micronutrients. I'll focus on N, P, K, and S.

Nitrogen (N)

Major Forms in Soil?

Plant available

Nitrate (very soluble/mobile)

Ammonium (binds weakly to clay)

Plant unavailable

Organic N (slowly supplies available ammonium to soil solution)

Factors decreasing N availability

1. Low organic matter
2. Poor nodulation of legumes (ex: alfalfa)
3. Excessive leaching
4. Cool temperatures, dry

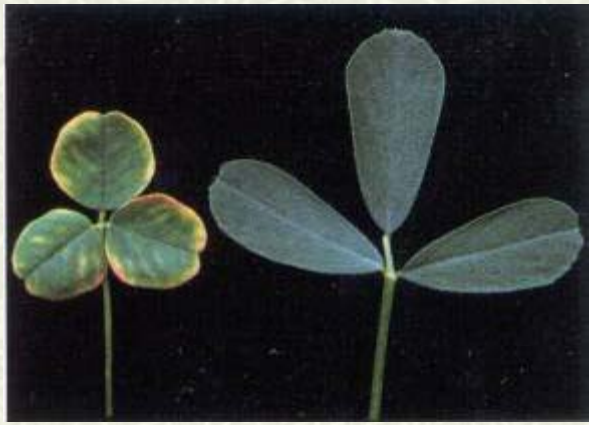
N Deficiency Symptoms

1. Pale green to yellow lower (older) leaves Why lower leaves?

   N is MOBILE in plant

2. Stunted, slow growth
3. Few tillers in small grains

Alfalfa



Corn

Tomato

N Management

-N Rate
-N Source
-Placement
-Timing

How much N should be applied to alfalfa-grass stands?

Can use Fertilizer Guidelines for Montana Crops (EB 161)

ALFALFA/GRASS				
Yield Potential (t/a)*	80/20	60/40	40/60	20/80
	———N fertilizer (lbs/a)———			
1	5	10	15	20
2	10	20	30	40
3	15	30	45	60
4	20	40	60	80
5	25	50	75	100
6	30	60	90	120

Need to divide by fraction of N in fertilizer to find total fertilizer need

Why not use more nitrogen to boost yield?

- Favors grass, potentially decreasing protein and requiring more frequent alfalfa reseeding.

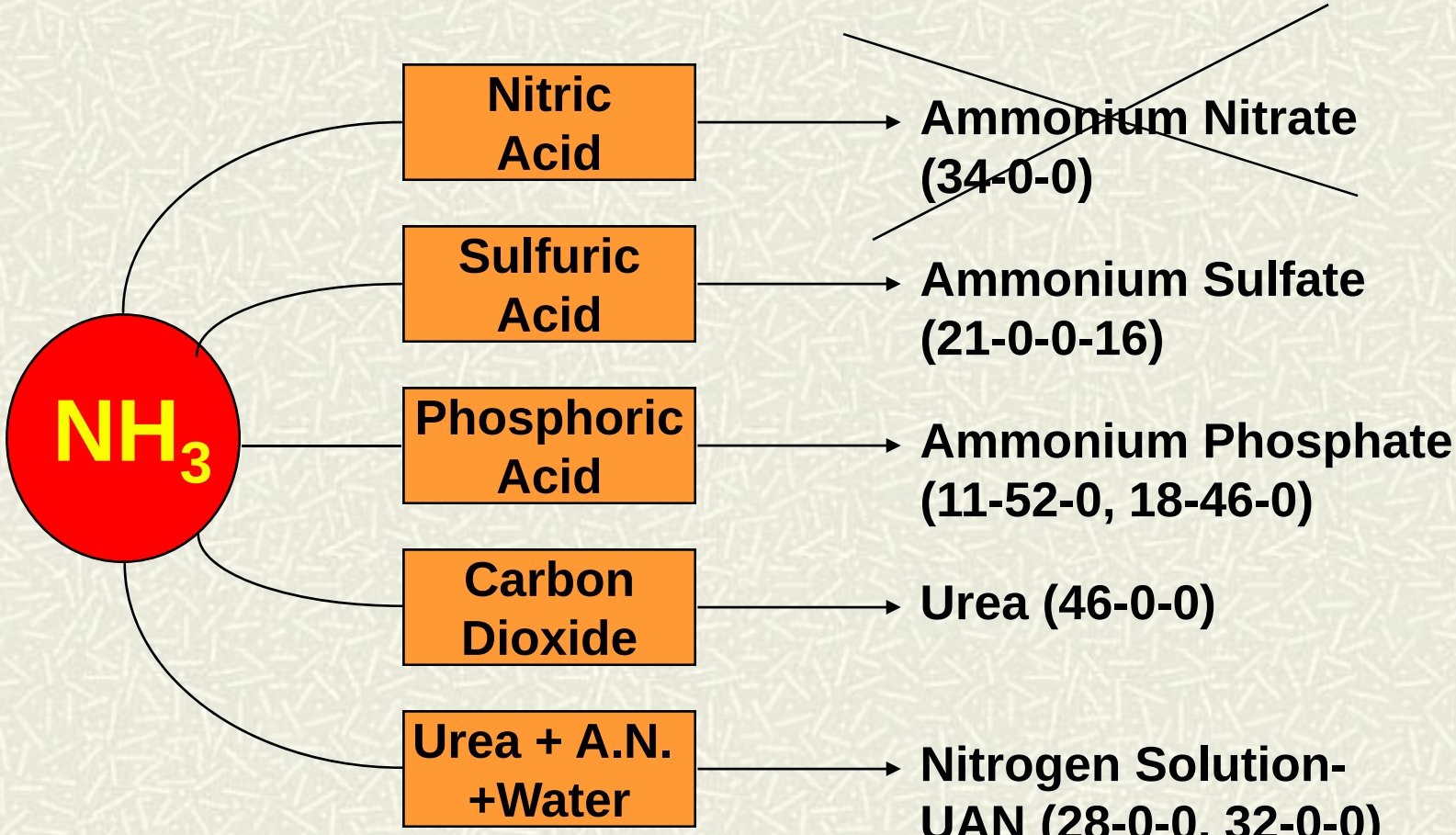
How much N should be applied to grass?

Fertilizer Guidelines for Montana Crops (EB 161):

GRASS	
Yield Potential (t/a) *	Available N (lbs/a) **
1	25
2	50
3	75
4	100
5	125

For other crops and nutrients, go to:
http://www.montana.edu/wwwpb/pubs/eb161.html

Anhydrous Ammonia - The Base Material



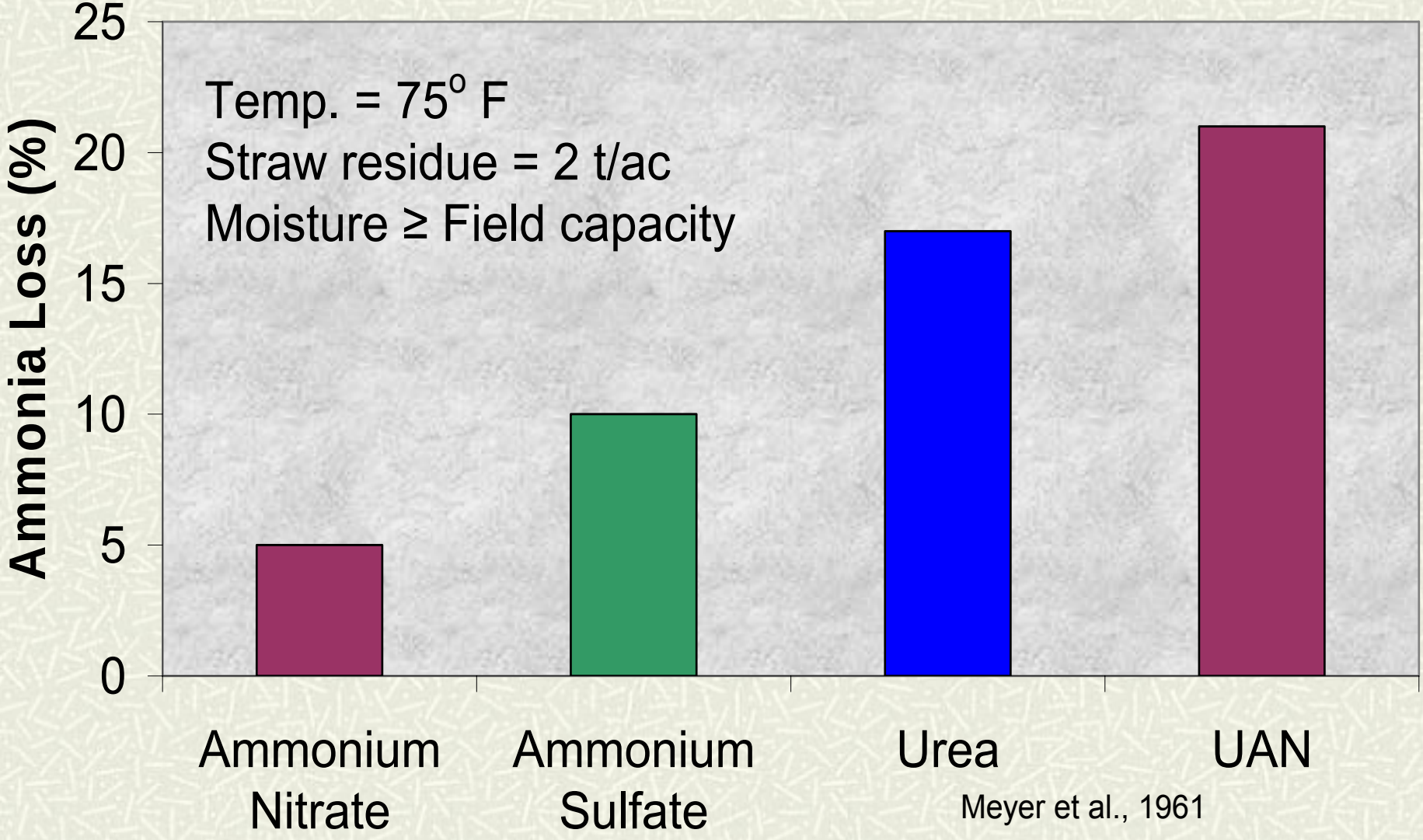
N Source

- “A pound of N is a pound of N”-cost per unit of N and available equipment to apply N are likely 2 most important factors in selecting N. Beware of those who say differently.
- Exceptions to above rule: N source affects

  - volatilization if broadcast

  - volatilization and availability if coatings or inhibitors

Ammonia Volatilization Losses from a Calcareous Soil



Meyer et al., 1961

Why differences in volatilization?

- UAN, Urea, and Ammonium Sulfate cause larger pH increases than Ammonium Nitrate. High pH favors volatilization.
- ½ of N in Ammonium Nitrate is nitrate which can't volatilize

Factors Increasing Volatilization

1. High Soil pH and Temperature
2. High Wind
3. Low Cation Exchange Capacity (CEC). WHY?
4. Low Buffering (resistance to pH change)
5. High Soil Moisture/humidity
6. Light Rainfall/Irrigation Following Fertilization
7. High Ground Cover/Vegetation/Residue.
8. Low Soluble and Exchangeable Calcium

Bottom line: Large number of factors make volatilization amounts VARIABLE and difficult to predict.

6. Rainfall/Irrigation

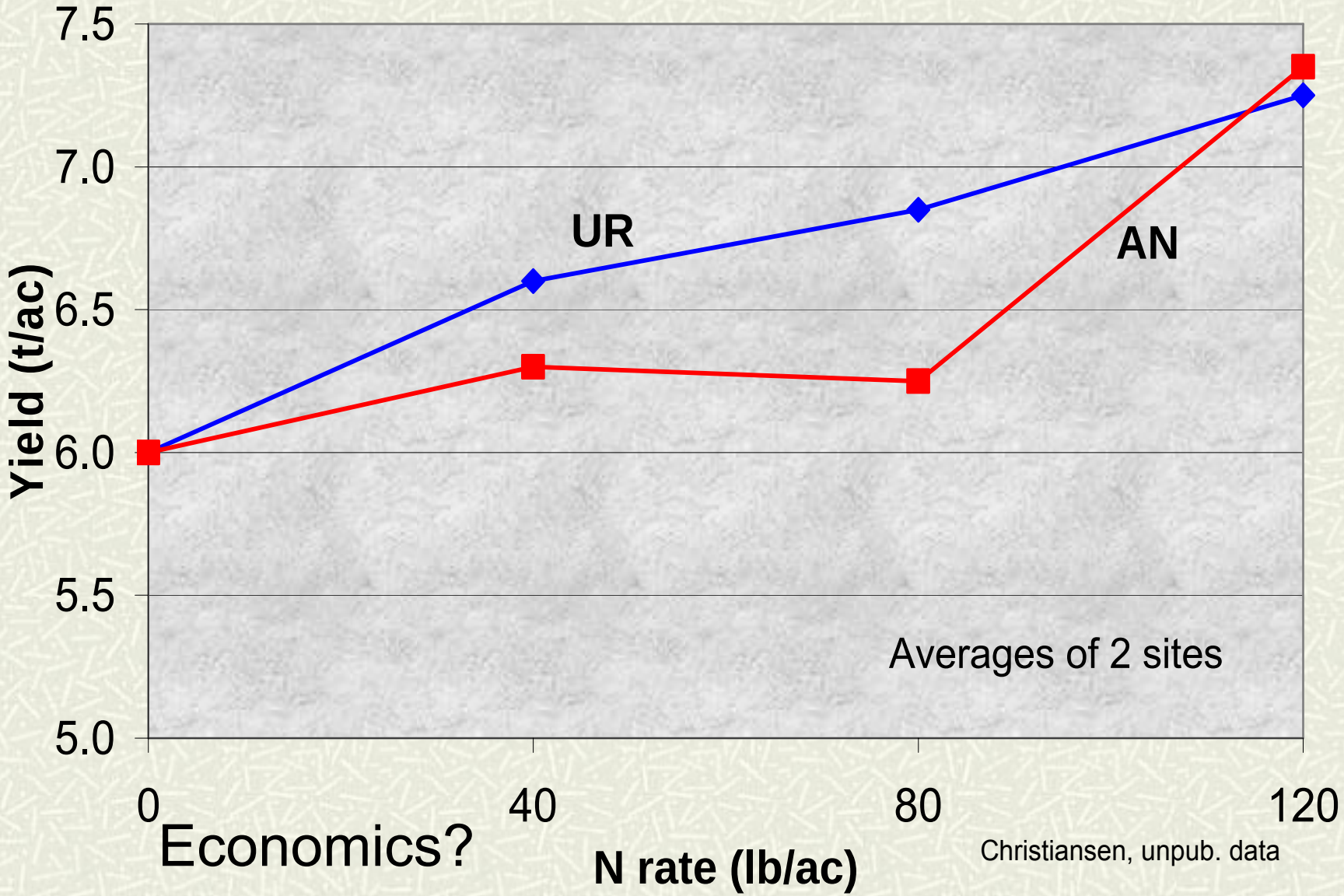
- 1/10 inch of rain/irrigation dissolves fertilizer, allowing volatilization.
- 1/2 inch of rain/irrigation pushes dissolved fertilizer about 2 in. into soil, essentially stopping volatilization if within about 2 days of fertilization.

Granular N Sources

Effect on Yield-Montana Research Results

Note: No journal-published data in Montana on effect of N source on volatilization and only one known published study on yield

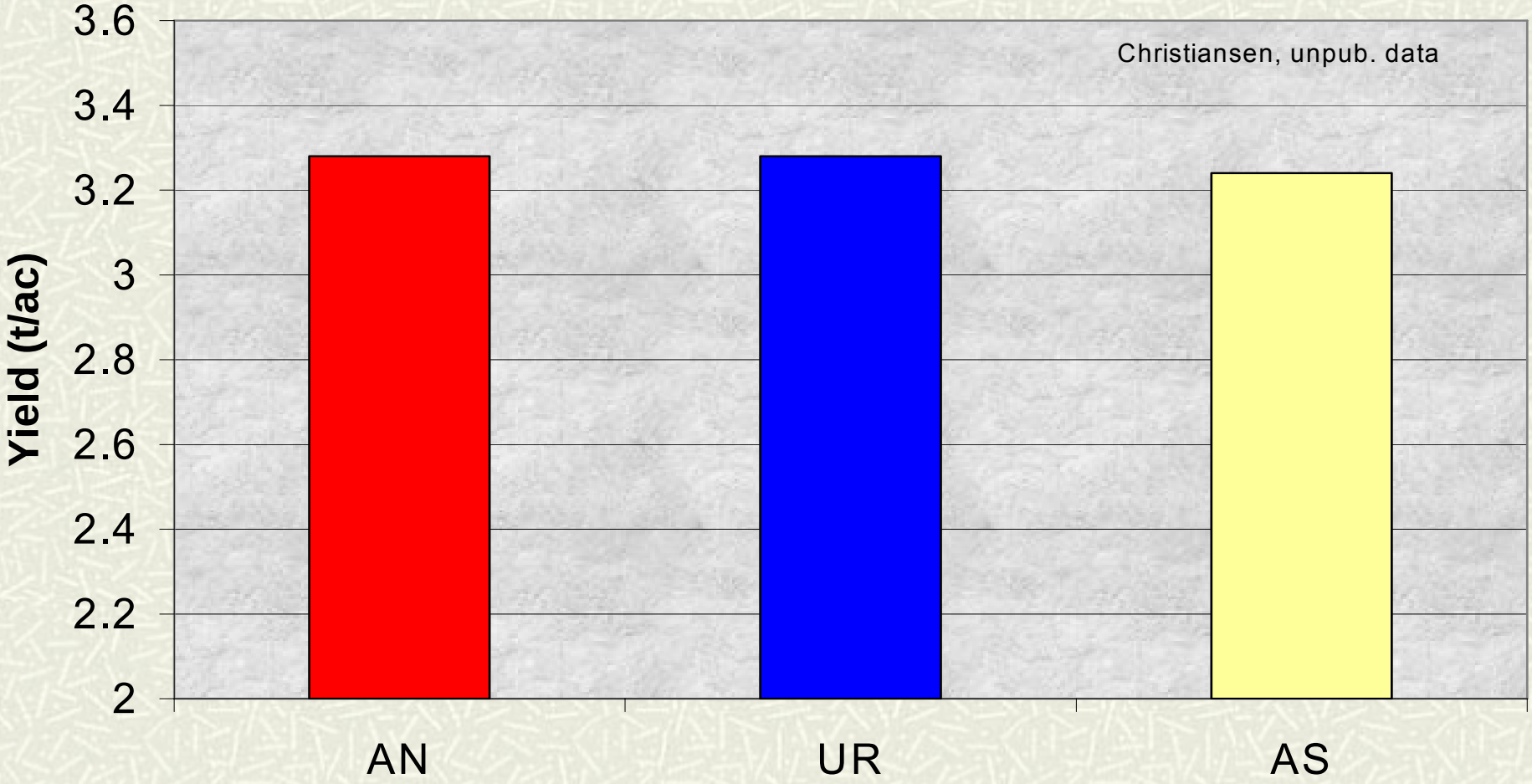
Effect of N Rate and Source
70% Orchardgrass/30% Alfalfa, W. Montana



Economics?

Christiansen, unpub. data

Effect of N Source on Irrigated W. Wheatgrass Yield Averaged over 4 N Rates, Blaine County



Still, need to apply when cool, calm or some ammonia will volatilize, especially from UR and AS.

Summary: Urea volatilization can happen, but in Montana studies it generally did not have a significant effect on hay yield compared to other granular N fertilizers

Liquid Fertilizers

- Advantages

  -can more easily top-dress if have equipment

  -some N can be absorbed through leaves?
- Disadvantage

  - mainly cost

  - volatilization can be higher than granular

Urease Inhibitors

- Agrotain (NBPT) is main product. Delays hydrolysis by up to 14 days

  -advantage: allows more chance for rain or irrigation to push N into ground

  -disadvantage: will delay time to become available, volatilization can still occur, and cost (adds ~$50/t-urea).

Research Results: Few studies on forages. One showed NBPT significantly reduced ammonia volatilization (Watson, C.J. et al., 1994) on grassland and one showed Kentucky bluegrass yield increased 15% (Joo et al., 1991).

Use? Would need to compare Agrotain cost with urea cost (increases urea cost by 20%), and consider potential for volatilization, including weather.

QUESTIONS?

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

Foliar Application

- Some N can be absorbed through leaves
- However, most foliar applied N ends up being washed off and taken up by roots:

  -Only 8-11% of foliar applied liquid urea was taken up by leaves, whereas 37-67% of soil-applied N was taken up by plant in same study (Rawluk et al., 2000).
- Risk of burn? Likely not an issue due to low rates applied (~25 lb N/t). Has anyone seen grass ‘burn’?

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 (AN simply dissolves, UR requires a chemical reaction to become available).

Timing, continued

- Fall vs Spring

  Generally better to apply near peak uptake to avoid losses (volatilization, denitrification, leaching, immobilization). However, weather conditions (temp., precip.) in first few days after application combined with soil texture may be more important.

1. Ex: Shallow, coarse soil. Fall or Spring? Spring
2. Ex: Cool Fall temps with ability to irrigate, or warmer spring temps before irrigation water delivered. Fall or Spring? Fall

QUESTIONS?

Phosphorus (P)

Why often deficient in Montana soils?

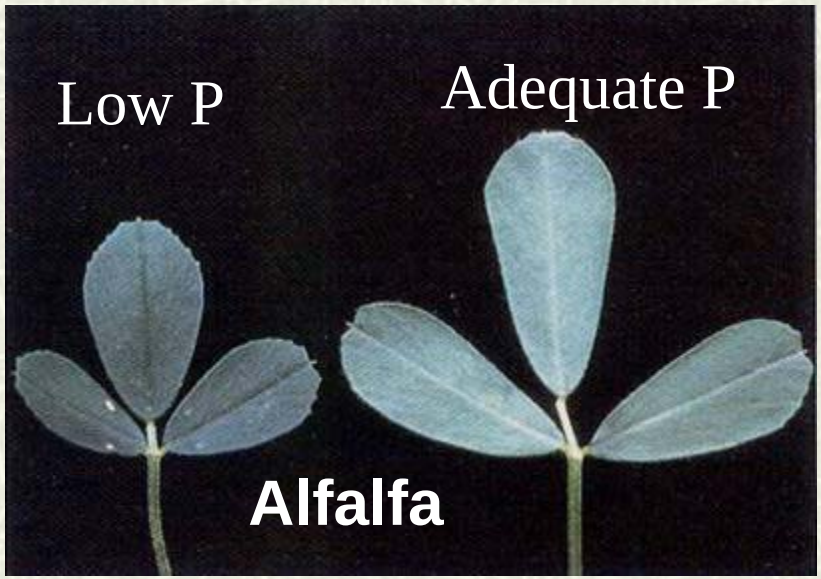
Binds with calcium to form calcium phosphate minerals

Factors decreasing P availability

1. Soil pH below 6.0 or above 7.5
2. Cold, wet weather
3. Calcareous soils
4. Leveled soils
5. Highly weathered, sandy soils

P Deficiency Symptoms

1. Dark green, often purple
2. Lower leaves sometimes yellow
3. Upward tilting of leaves may occur in alfalfa
4. Often seen on ridges of fields



Corn

Advantages of phosphorus fertilization on alfalfa-grass stand?

- Helps with N fixation in nodules
- Favors alfalfa over grass

QUESTIONS?

Potassium (K)

Needed in Montana?

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

Which crops have largest K needs?

Table 1. K removal amounts in harvested portions of selected agricultural crops.

Crop	Assumed yield per acre	K_2O removal (lb/ac)
Alfalfa	2.5 t	150
Barley	50 bu	80
Brome	1.5 t	95
Corn silage	20 t	167
Orchard grass	1.5 t	75
Potatoes	300 cwt	330
Sugar beets	25 t	460
Timothy	1.5 t	94
Wheat	40 bu	80

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

Factors decreasing K availability

1. Cold, dry soils
2. Poorly aerated soils
3. High calcium and magnesium levels
4. Sandy, low clay soils
5. Low soil organic matter, or high amounts of available N

K deficiency symptoms

1. Alfalfa – white spots on leaf edges
2. Corn and grasses – chlorosis and necrosis on *lower* leaves first. WHY?

   K is mobile in plant

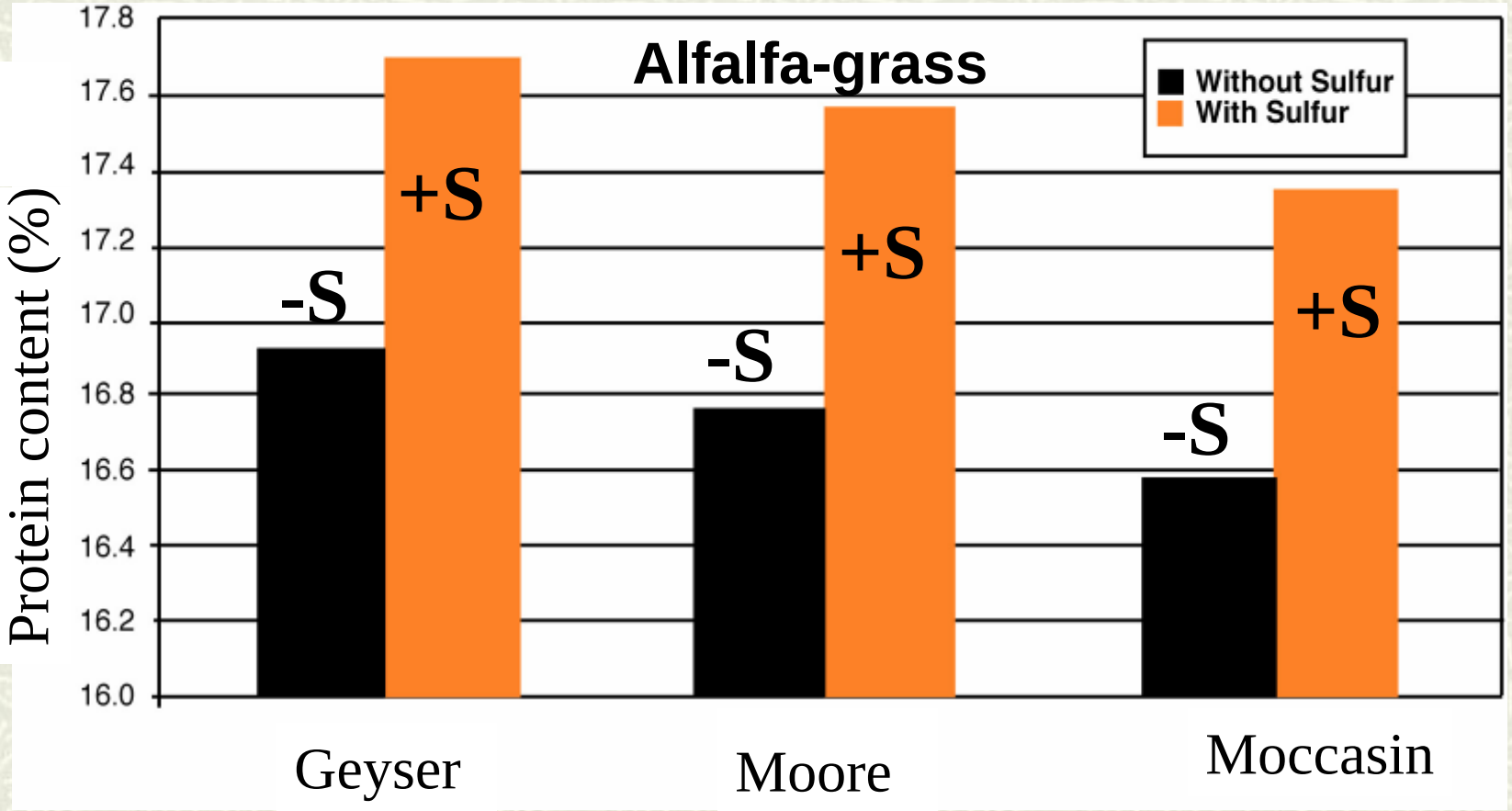
3. Weakening of straw- lodging in small grains, breakage in corn.

4. Wilting, stunted, shortened internodes.

QUESTIONS ON NITROGEN, PHOSPHORUS, OR POTASSIUM?

Sulfur (S)

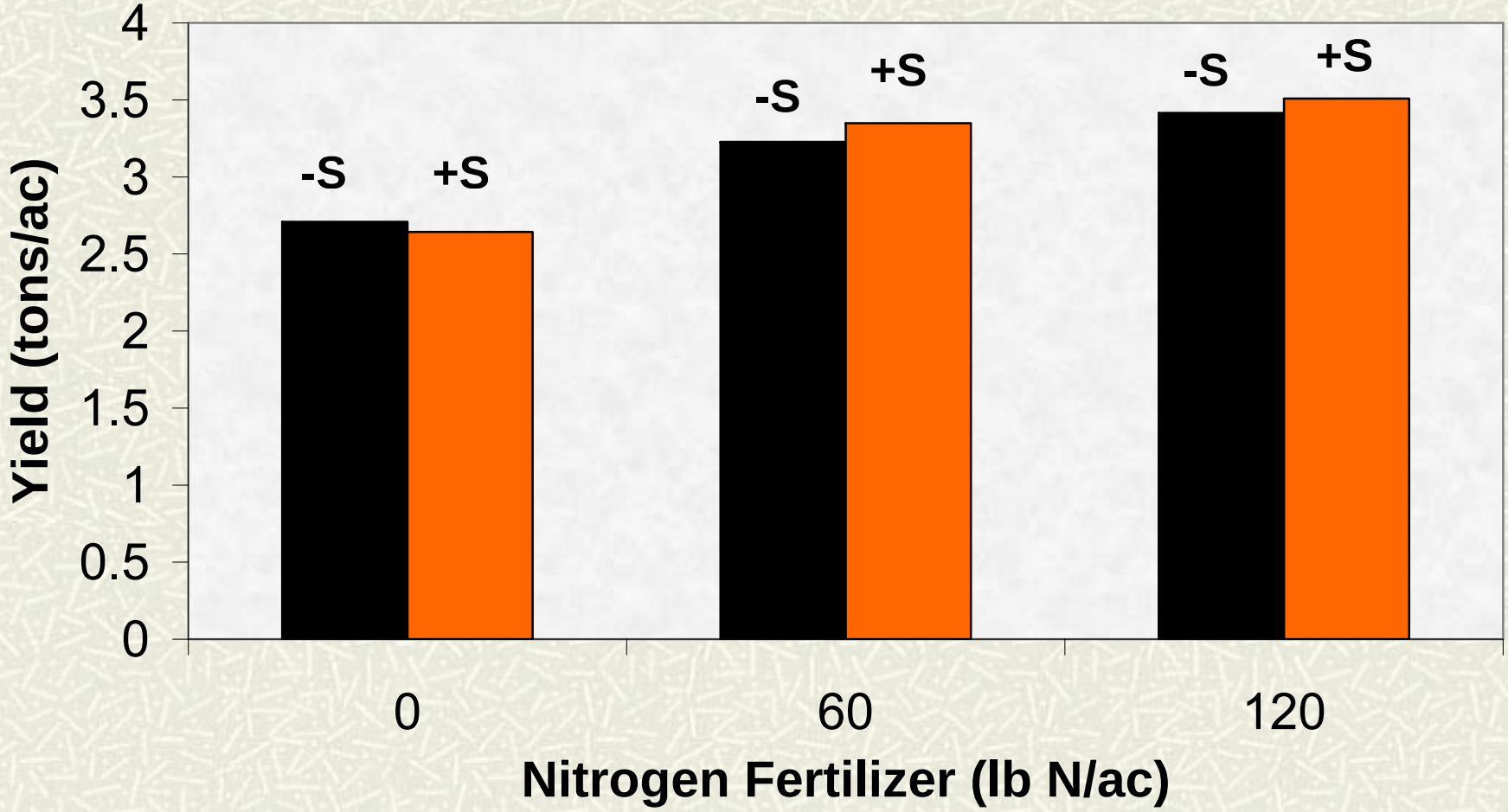
Responses seen in alfalfa-grass fields?



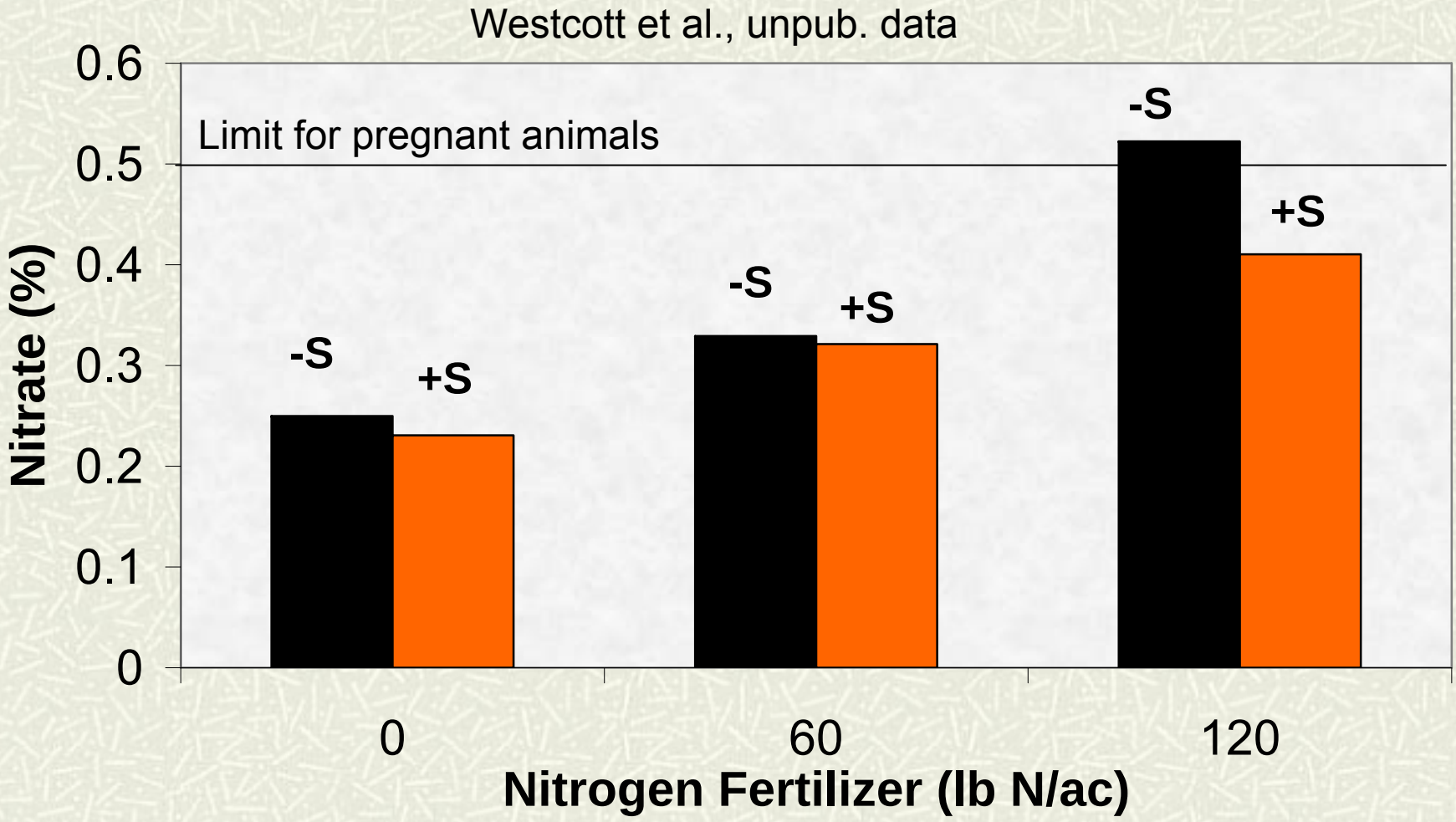
Note: Yield increased 30% at Moccasin (See Fert. Fact 27)

Effect of S on Haybet forage yield
Creston and Corvallis, 2002-2004

Westcott et al., unpub. data



Effect of S on Haybet Nitrate
Creston and Corvallis, 2002-2004



Factors decreasing S availability

1. Irrigated with low S in irrigation water
2. Sandy, acidic, or low organic matter soils
3. Cold soils
4. Soils formed from minerals low in S or far from industrial sources

S deficiency symptoms

1. Upper leaves light green to yellow. WHY?

   S is immobile in plant
2. Small, thin stems
3. Low protein
4. Delayed maturity
5. No characteristic spots or stripes

QUESTIONS ON SULFUR?

Beware Pseudo-deficiencies

What else can cause symptoms that look like nutrient deficiency symptoms?

1. Herbicides
2. Disease
3. Insects
4. Moisture stress
5. Salinity

Advantages of soil testing (even if only occasionally)

- Allows you to optimize fertilizer rates, especially in case where soil nutrient availability has been depleted or is in excess
- Can increase yield and/or save on fertilizer costs (which are near record highs)

CONCLUSIONS

- Optimizing fertilizer use is becoming more important with increased fertilizer costs
- Nitrogen, phosphorus, potassium, and sulfur can all produce growth responses in Montana forages.
- Urea can be a good replacement for ammonium nitrate if managed well.
- Recognizing nutrient deficiencies can help with fertilizer decisions
- Soil testing is useful for determining fertilizer needs

Questions?

Additional info at
http://landresources.montana.edu/soilfertility