Soil Building Practices and Forage Nutrient Management

Pondera County Workshop

January 28, 2016

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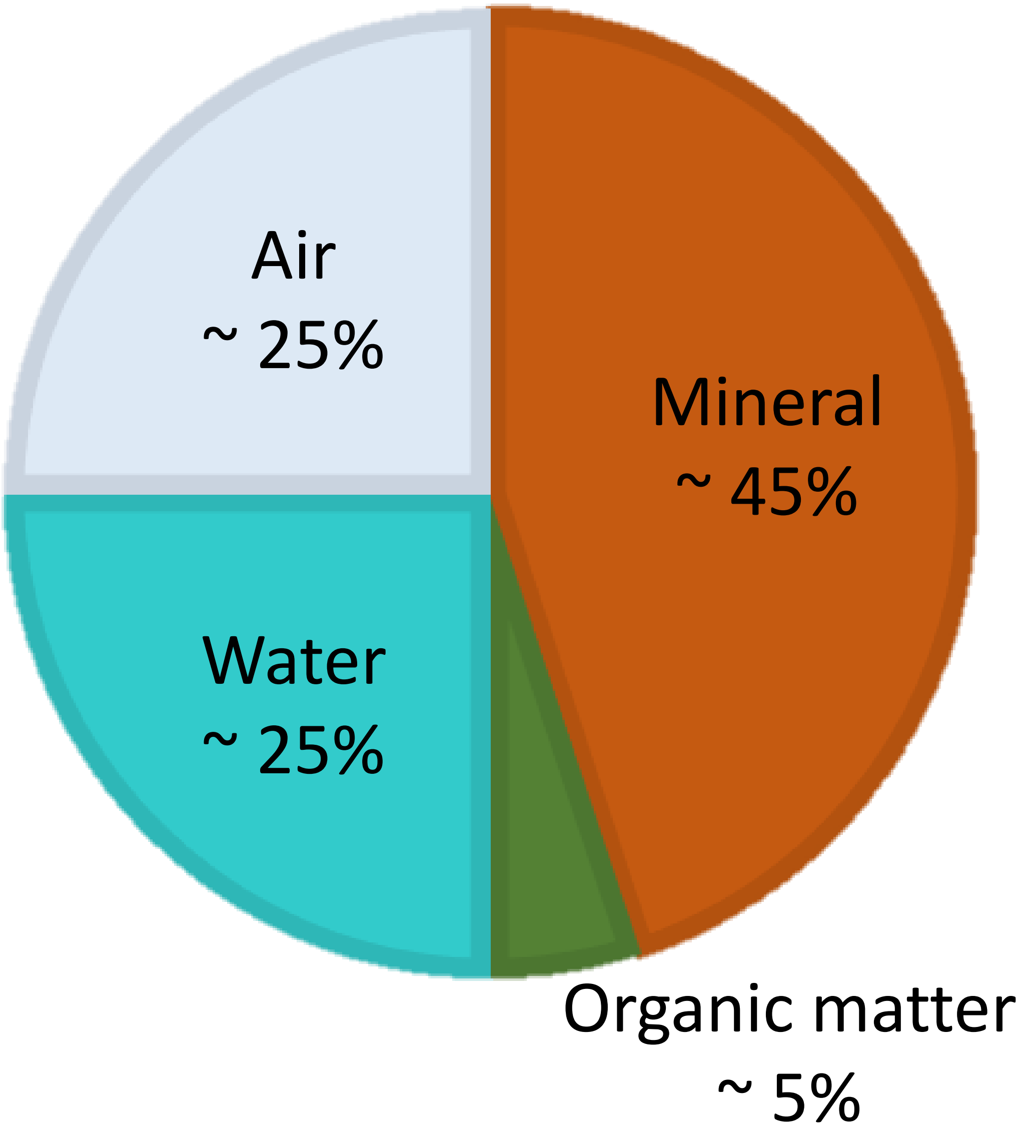
MONTANA STATE UNIVERSITY

MSU Soil Fertility Extension

Today's objectives

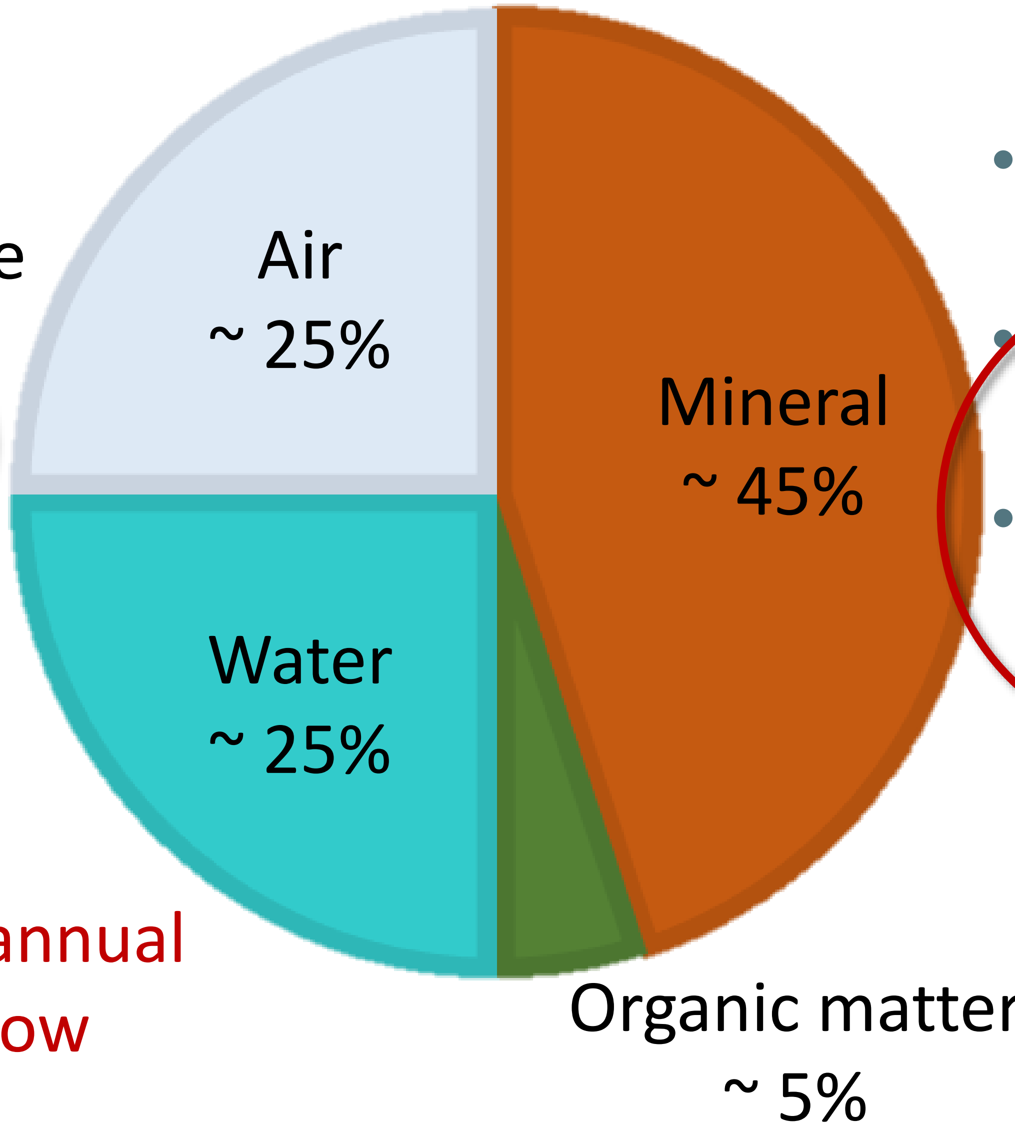
- Management practices to benefit soils
- Potential benefits from cover crops
- Cover crop management for optimal benefits
- Forage nutrient management
  - N, P, K, and S
  - Sources
  - Application for high use efficiency
  - Economic considerations

Average Soil Components



Practices to benefit soil

- Minimize disturbance
- Keep soil surface covered



- Nutrient mgt (soil test; 4Rs)
- Increase diversity
- Keep living root in soil

Perennial >> annual
Recrop >> fallow
Cover crops?

Soil Quality vs Soil Health

Soil Quality = properties that change little, if at all, with land use management practices

- Texture
- pH
- Cation Exchange Capacity

Which is more likely to be influenced by cover crops?

Soil Health = dynamic properties which may be subjective to measure

- Aggregation
- Microbial activity
- Tilth
- Nutrient availability
- Water holding capacity
- Compaction

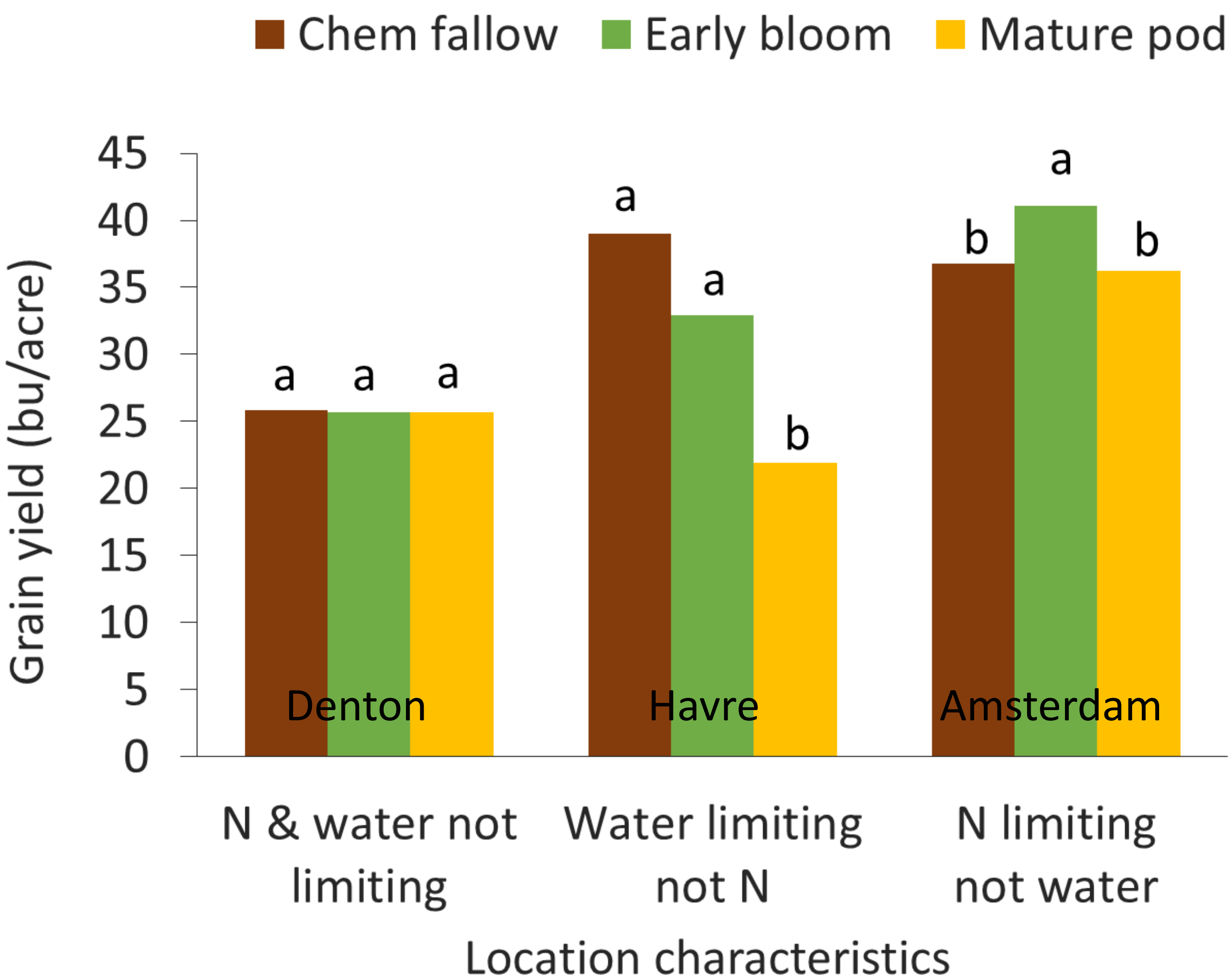
MSU single species cover crop research since 1999 has found higher grain yields and/or protein after cover crops when:

1. Seeding winter legumes (vs spring legumes)
2. Seeding spring cover crops early (vs late)
3. Terminating at first bloom (vs pod)
4. Tilling cover crop (vs spraying)

Why?

- More N fixed (1)
- More time for soil water to be recharged and N to become released from residue (1, 2, 3)
- Faster N release and fewer N losses (4)

Our MT studies confirmed early Saskatchewan studies that termination timing is key, when water is limiting



Haying cover crop at early bloom produced higher sp. wheat yields the following year than harvesting pea when water or N limiting (Miller et al 2006)

Species diversity: does it increase benefits?

Nitrogen Fixers
Spring Pea
Common Vetch
Lentil

Increase nitrogen

Add soil carbon

Fibrous Root
Oats
Italian ryegrass
Proso millet

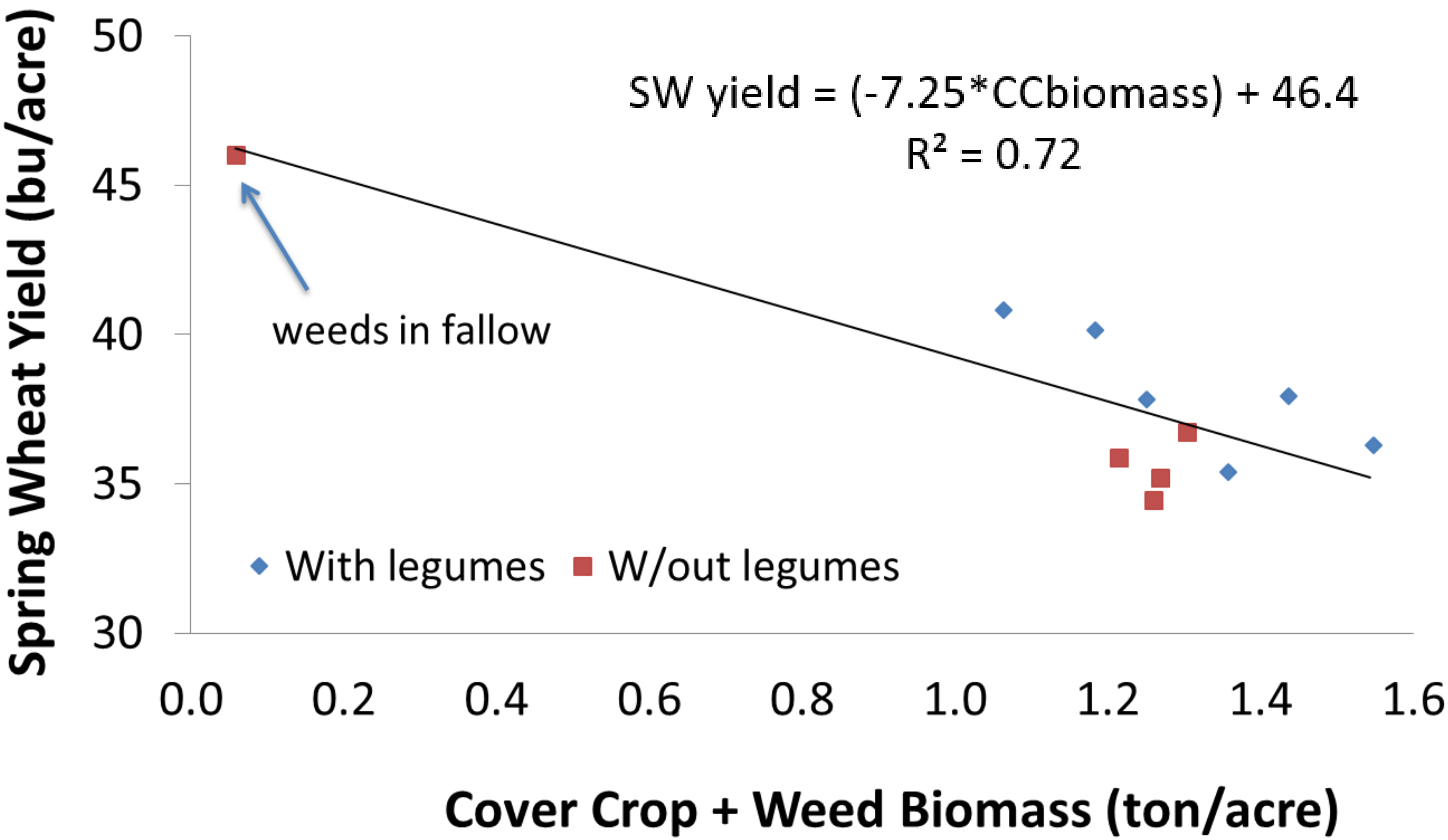
Reduce compaction, move nutrients upward

Potential disease control

Tap Root
Purple top turnip
Safflower

Brassica
Daikon radish
Winter canola
Camelina

Spring wheat yield at Dutton vs previous year total biomass (cc + weed)

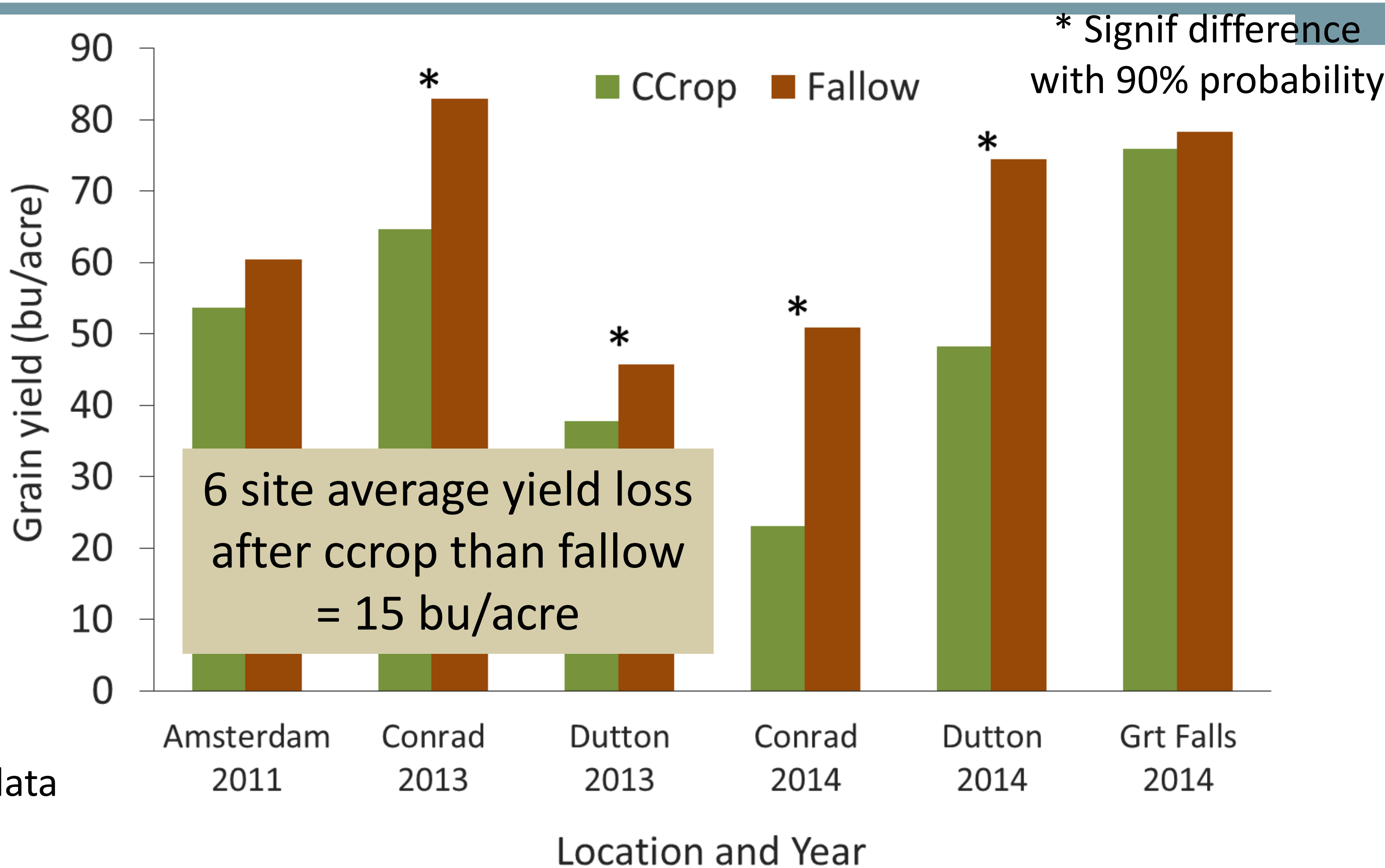


Housman, Tallman, et al., unpub data, Dutton

Cover Crop Cocktails Plot Study: Take home messages on yield and soil quality

- After one cycle, spring wheat grain yields higher after pea and N fixers than most other mixes.
- Higher cover crop biomass correlated with lower spring wheat yield, likely b/c of more water and N use.
- Relatively few soil health differences between pea and 8-species mix after one cycle; not unexpected.
- After two cycles, no soil health differences between pea and 8-species mix, but CCs increased microbial activity.

Cover Crop Cocktail Farm Study: 1 rotation of mixed CC reduced grain yield in 4 of 6 production years



P. Miller unpub data

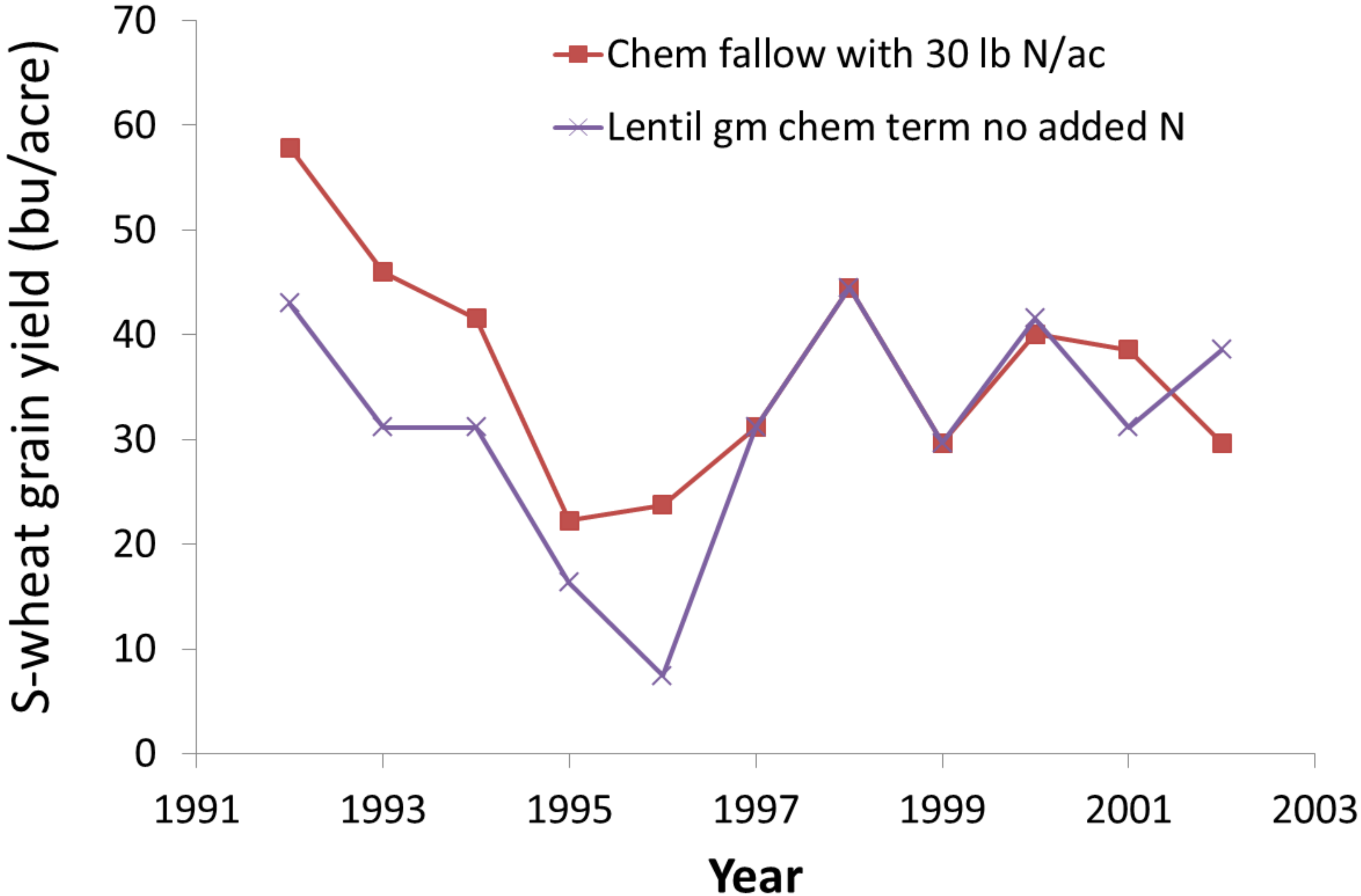
Yield less after mixed cover crops on farmers' fields, likely due to late termination and high water & N use by CCrop

Cover Crop Cocktails Farm Study: Take home messages on yield and protein

- Spring wheat grain yield was lower after CC than fallow in four of six field-scale studies, protein results were varied.
- High water use from late termination was likely cause of yield differences.

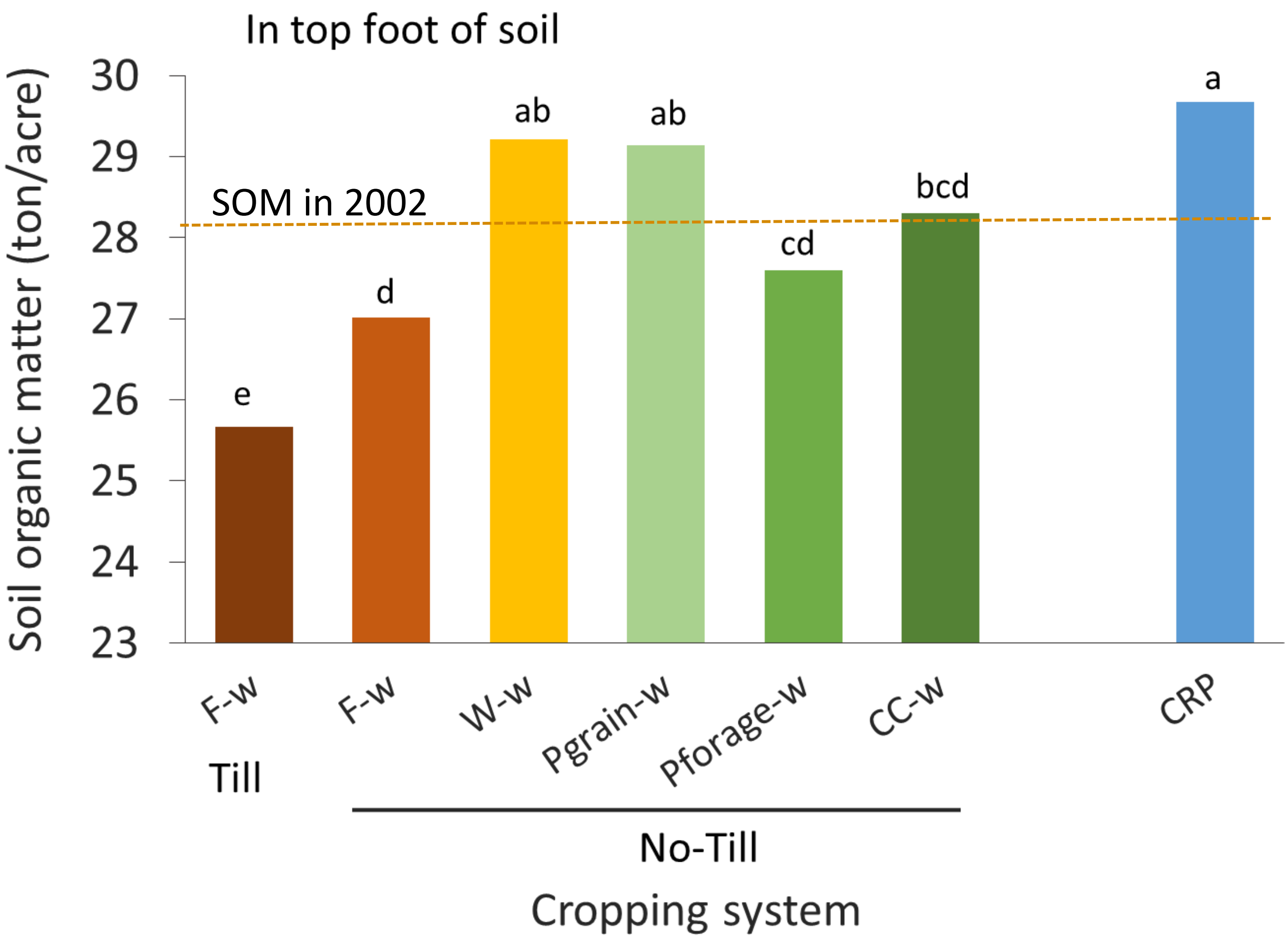
Questions?

Legume cover crops: They take time to influence subsequent wheat yield



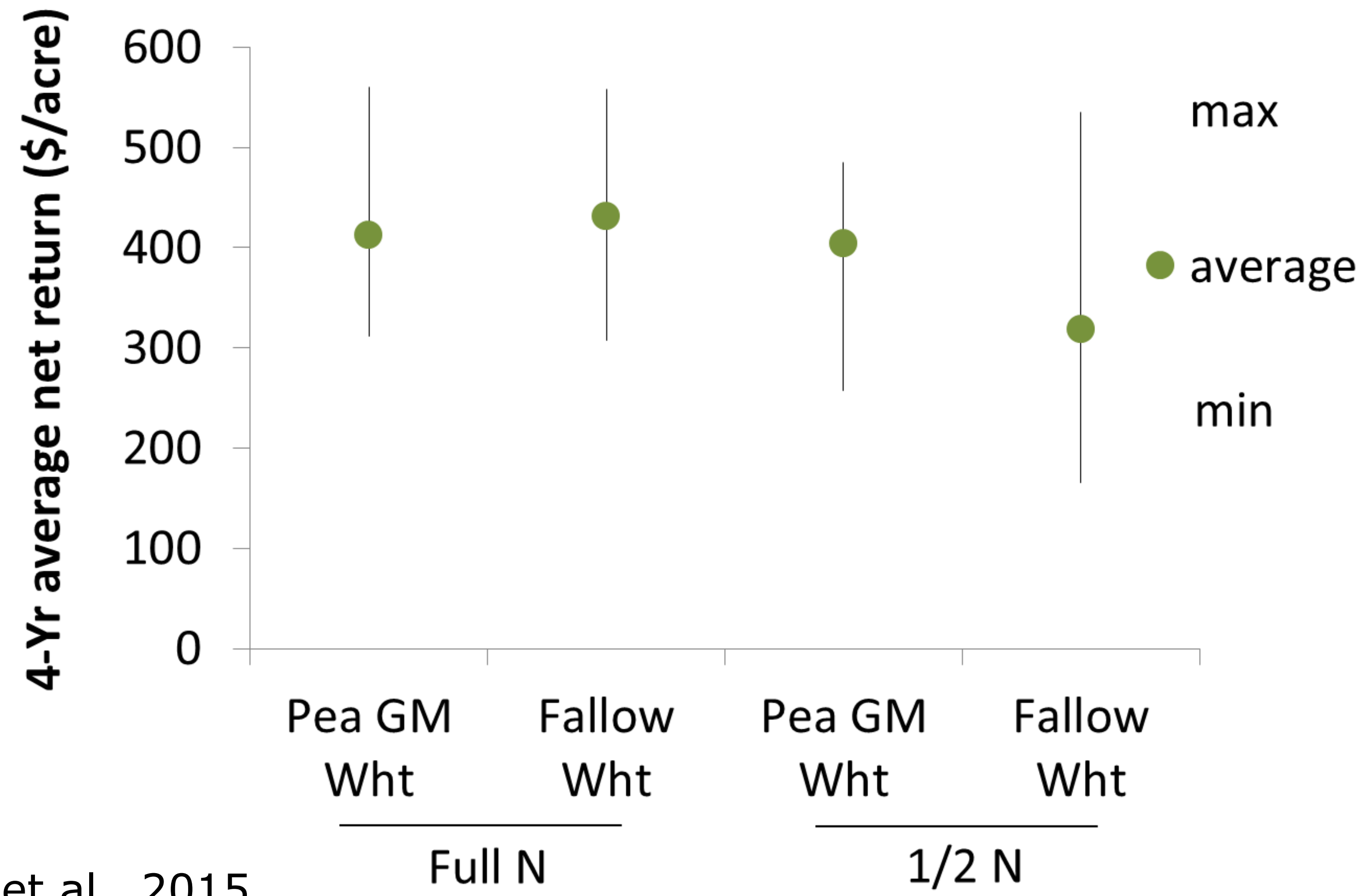
Allen et al., 2011, Culbertson

SOM is lost after 10 years of fallow cropping



Engel, unpub data, MSU Post Farm, 2012

After 4 rotations pea GM provides same net return as fallow, with less N



Miller et al., 2015

Economic options

- Grazing may provide more immediate economic return and increase the rate of change in soil health. Currently under study at MSU-Northern.

- NRCS provides incentives for growing cover crops

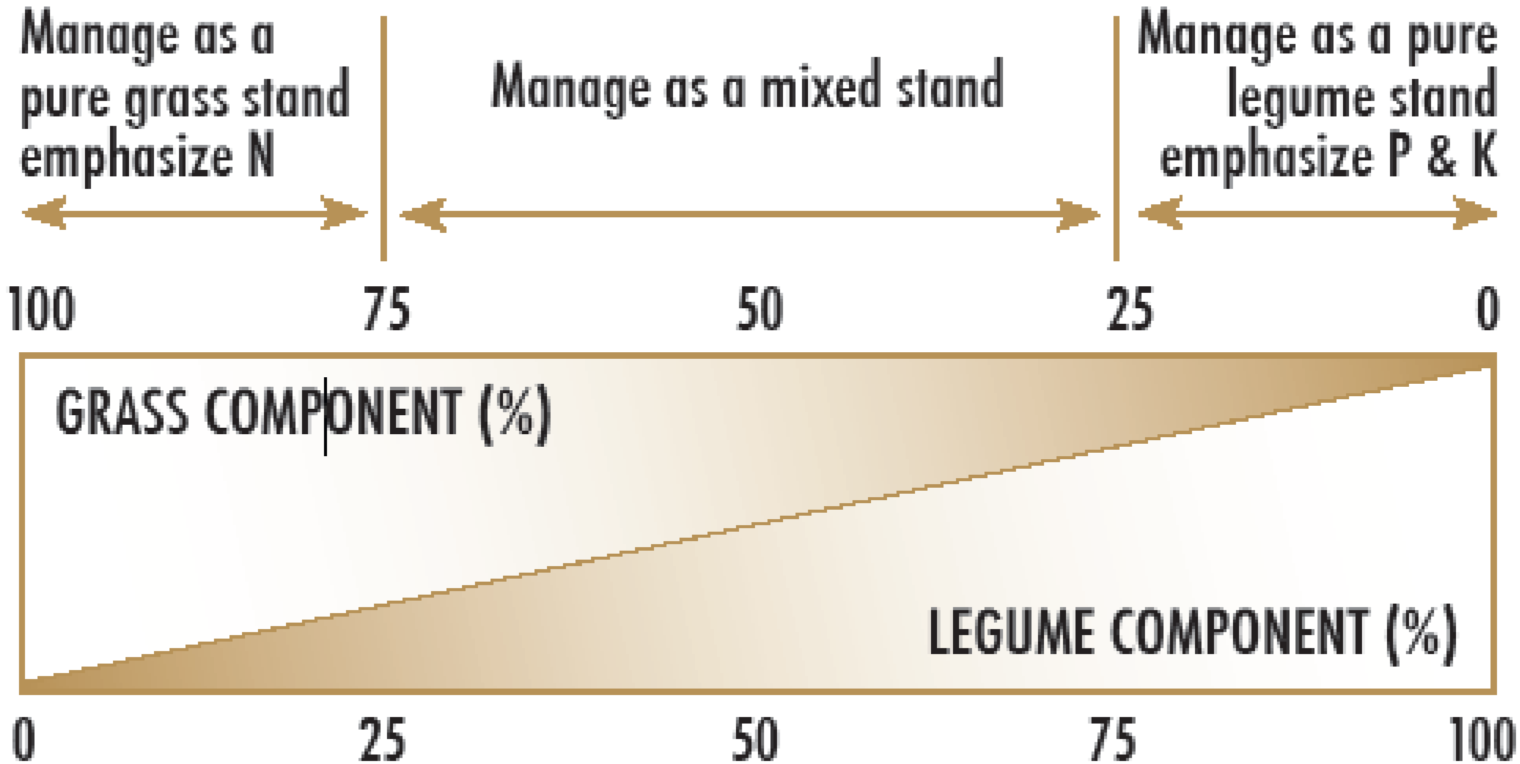
Conclusions

- In short term (1 CC-cycle studies), grain yield and protein are generally equal or less than after fallow.
- Early termination (by ~ first pea bloom) is key to preventing yield and protein losses.
- In short term studies, there does not appear to be yield or soil quality advantages of mixes over pea.
- In long term (4+ cycles), yield, protein, and net revenue can be higher after cover crops than fallow, especially at low N rates, likely from more available N.
- Cover crops provide resilience to uncontrollable factors such as weather and markets
- Cover crop value to soil health, subsequent crops, and possibly land value is expected to increase over time.

Questions?

On to *fertilizing forages*

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

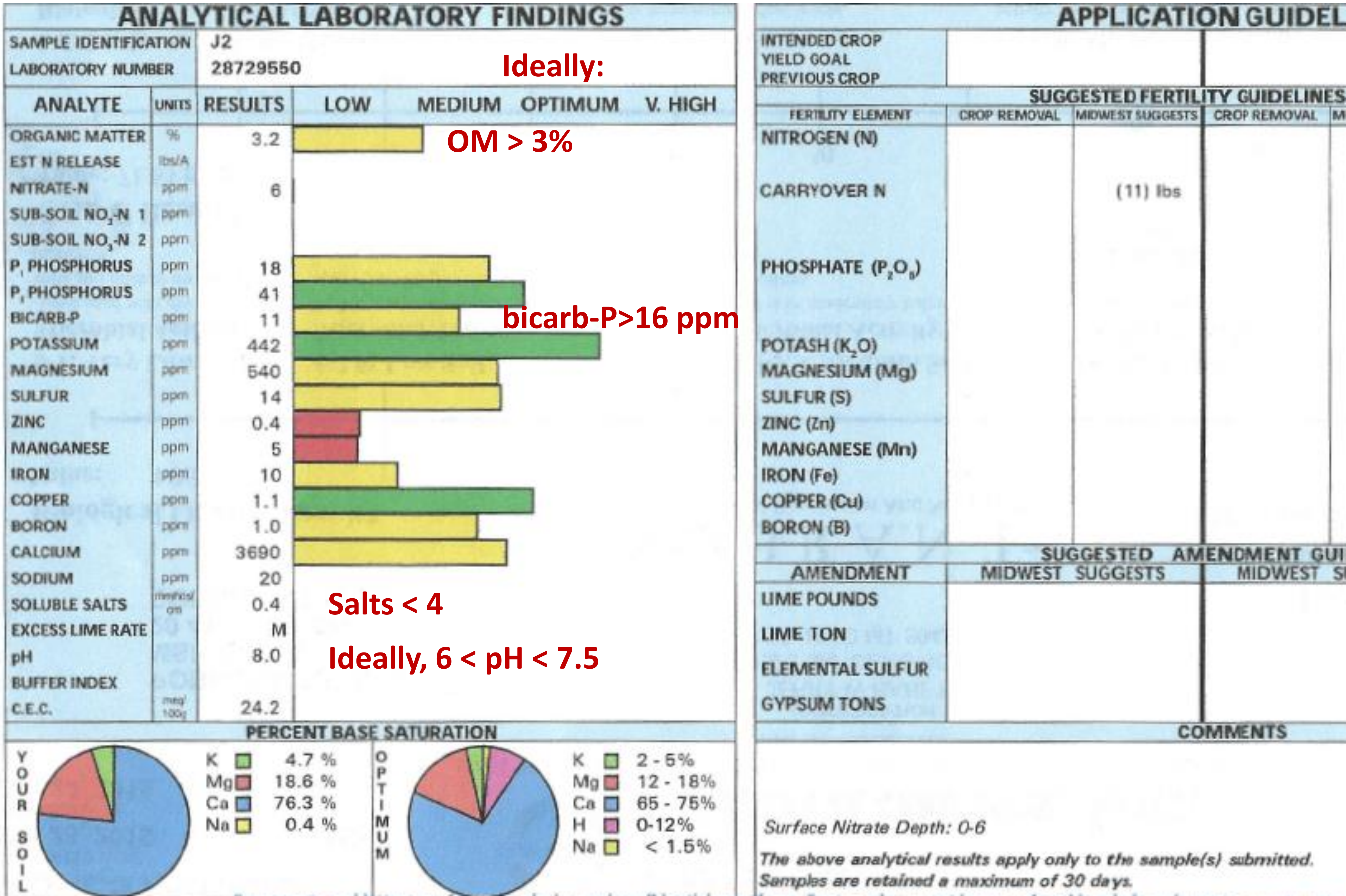


Yield increases and net returns greatest if < 36% alfalfa in stand and soil N < 5 lb N/acre (Malhi et al. 2004)

MT guidelines for forages

- Based on yield goal and soil tests
  - Recommendations by testing lab
  - Or tables given in *Fertilizer Guidelines for MT Crops* (EB0161)

Example soil test report – Conrad, MT, October 2015

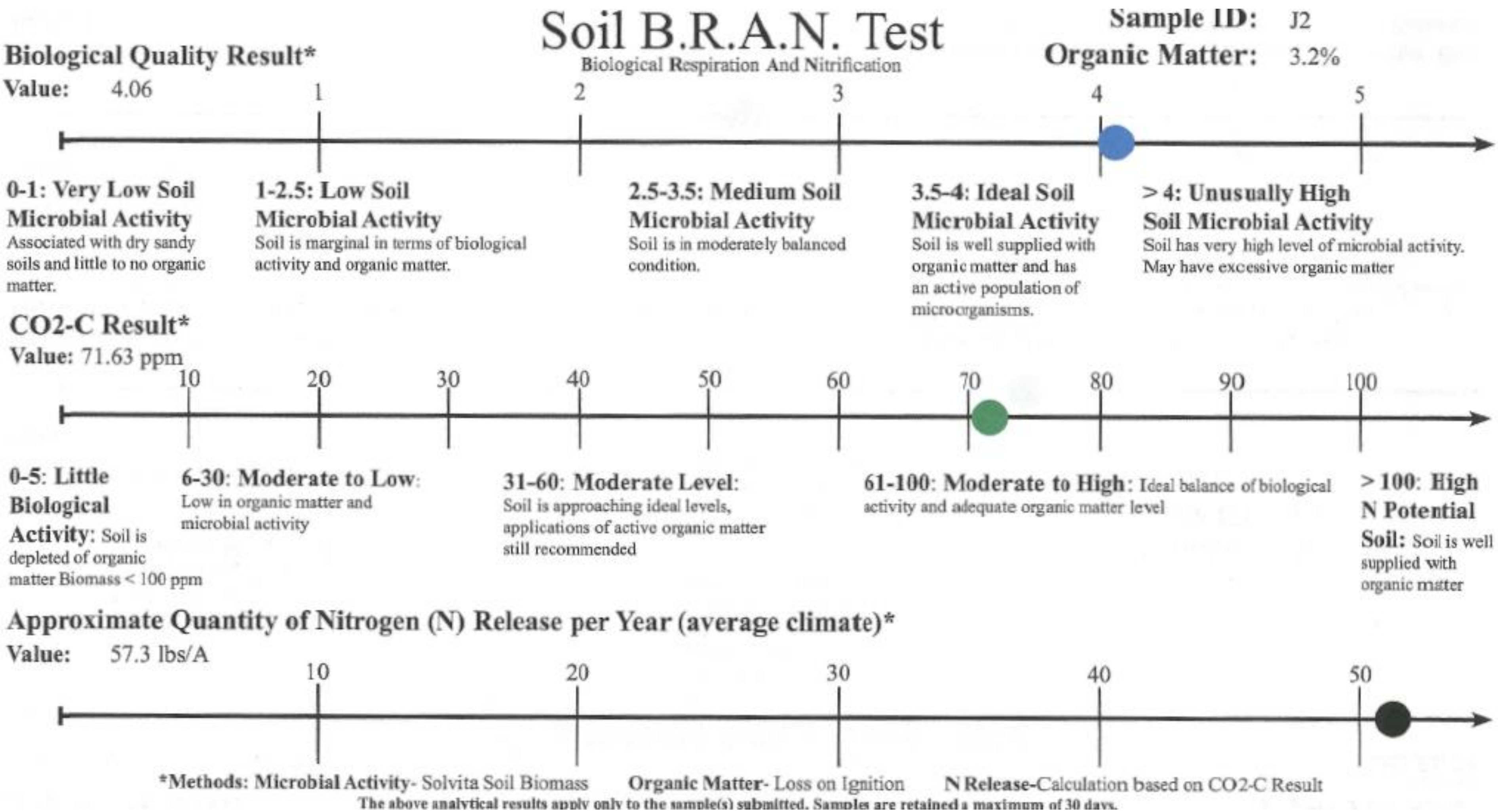


ANALYTICAL LABORATORY FINDINGS

SAMPLE IDENTIFICATION: J2
LABORATORY NUMBER: 28729550

ANALYTE	UNITS	RESULTS
ORGANIC MATTER	%	3.2
EST N RELEASE	lbs/A	
NITRATE-N	ppm	6
SUB-SOIL NO_3-N 1	ppm	
SUB-SOIL NO_3-N 2	ppm	
P_1 PHOSPHORUS	ppm	18
P_2 PHOSPHORUS	ppm	41
BICARB-P	ppm	11
POTASSIUM	ppm	442
MAGNESIUM	ppm	540
SULFUR	ppm	14
ZINC	ppm	0.4
MANGANESE	ppm	5
IRON	ppm	10
COPPER	ppm	1.1
BORON	ppm	1.0
CALCIUM	ppm	3690
SODIUM	ppm	20
SOLUBLE SALTS	mmhos/cm	0.4
EXCESS LIME RATE		M
pH		8.0
BUFFER INDEX		
C.E.C.	meq/100g	24.2

Example soil biological activity test report – Conrad, MT, October 2015



Soil B.R.A.N. Test

Biological Respiration And Nitrification

Sample ID: J2

Organic Matter: 3.2%

Biological Quality Result*

Value: 4.06

0-1: Very Low Soil Microbial Activity Associated with dry sandy soils and little to no organic matter.

1-2.5: Low Soil Microbial Activity Soil is marginal in terms of biological activity and organic matter.

2.5-3.5: Medium Soil Microbial Activity Soil is in moderately balanced condition.

3.5-4: Ideal Soil Microbial Activity Soil is well supplied with organic matter and has an active population of microorganisms.

> 4: Unusually High Soil Microbial Activity Soil has very high level of microbial activity. May have excessive organic matter

CO2-C Result*

Value: 71.63 ppm

0-5: Little Biological Activity: Soil is depleted of organic matter Biomass < 100 ppm

6-30: Moderate to Low: Low in organic matter and microbial activity

31-60: Moderate Level: Soil is approaching ideal levels, applications of active organic matter still recommended

61-100: Moderate to High: Ideal balance of biological activity and adequate organic matter level

> 100: High N Potential Soil: Soil is well supplied with organic matter

Approximate Quantity of Nitrogen (N) Release per Year (average climate)*

Value: 57.3 lbs/A

***Methods: Microbial Activity**- Solvita Soil Biomass **Organic Matter**- Loss on Ignition **N Release-**Calculation based on CO2-C Result

The above analytical results apply only to the sample(s) submitted. Samples are retained a maximum of 30 days.

REPORT NUMBER
15-288-1033

COMPLETED DATE
Oct 19, 2015

ACCOUNT
11534

RECEIVED DATE
Oct 15, 2015

Midwest Laboratories, Inc.

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www.midwestlabs.com

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TODAY'S DATE
Oct 19, 2015

PONDERA COUNTY
MSU EXT SVC
20 4TH AVE SW
CONRAD MT 59425-

IDENTIFICATION
PONDERA CO EXTENSION

Should be higher than 16

Should be less than 15. These 3 are sodic.

SOIL ANALYSIS REPORT

LAB NUMBER *285*	SAMPLE IDENTIFICATION	ORGANIC MATTER L.O.I. percent	RATE	PHOSPHORUS P1 (WEAK BRAY) 1:7 ppm	RATE	P2 (STRONG BRAY) 1:7 ppm	RATE	OLSEN BICARBONATE P ppm	RATE	POTASSIUM K ppm	RATE	MAGNESIUM Mg ppm	RATE	CALCIUM Ca ppm	RATE	SODIUM Na ppm	RATE	pH SOIL pH 1:1	BUFFER INDEX	CATION EXCHANGE CAPACITY C.E.C. meq/100g	% K	% Mg	% Ca	% H	% Na
69246	ROY B	2.6	M	44	VH	104	VH	50	VH	544	VH	819	VH	3227	M	1095	VH	8.1		29.1	4.8	23.5	55.3	0.0	16.4
69247	FELIX 1	2.6	M	28	H	79	VH	19	H	196	L	2409	VH	1546	VL	1385	VH	7.8		34.3	1.5	58.5	22.4	0.0	17.6
69248	FELIX 2	2.8	M	63	VH	106	VH	46	VH	429	VH	2837	VH	4429	L	4648	VH	8.8		67.1	1.6	35.2	33.1	0.0	30.1
69249	SPARLEDER	4.3	H	6	VL	76	VH	9	L	332	VH	1084	VH	3517	M			7.6		27.5	3.1	32.8	64.1	0.0	

LAB NUMBER *285*	NITRATE-N (FIA) SURFACE ppm	lb/A	depth (in)	SUBSOIL 1 ppm	lb/A	depth (in)	SUBSOIL 2 ppm	lb/A	depth (in)	Total lb/A	SULFUR S ICAP ppm	RATE	ZINC Zn DTPA ppm	RATE	MANGANESE Mn DTPA ppm	RATE	IRON Fe DTPA ppm	RATE	COPPER Cu DTPA ppm	RATE	BORON B ppm	RATE	EXCESS LIME RATE	SOLUBLE SALTS	RATE
69246	24	43	0-6							43														3.0	H
69247	26	47	0-6							47														6.9	H
69248	11	20	0-6							20														12.9	H
69249	2	4	0-6							4														1.0	L

Should be less than 4. Middle 2 are saline.

REV. 12/03

The above analytical results apply only to the sample submitted. Samples are retained a maximum of 30 days.
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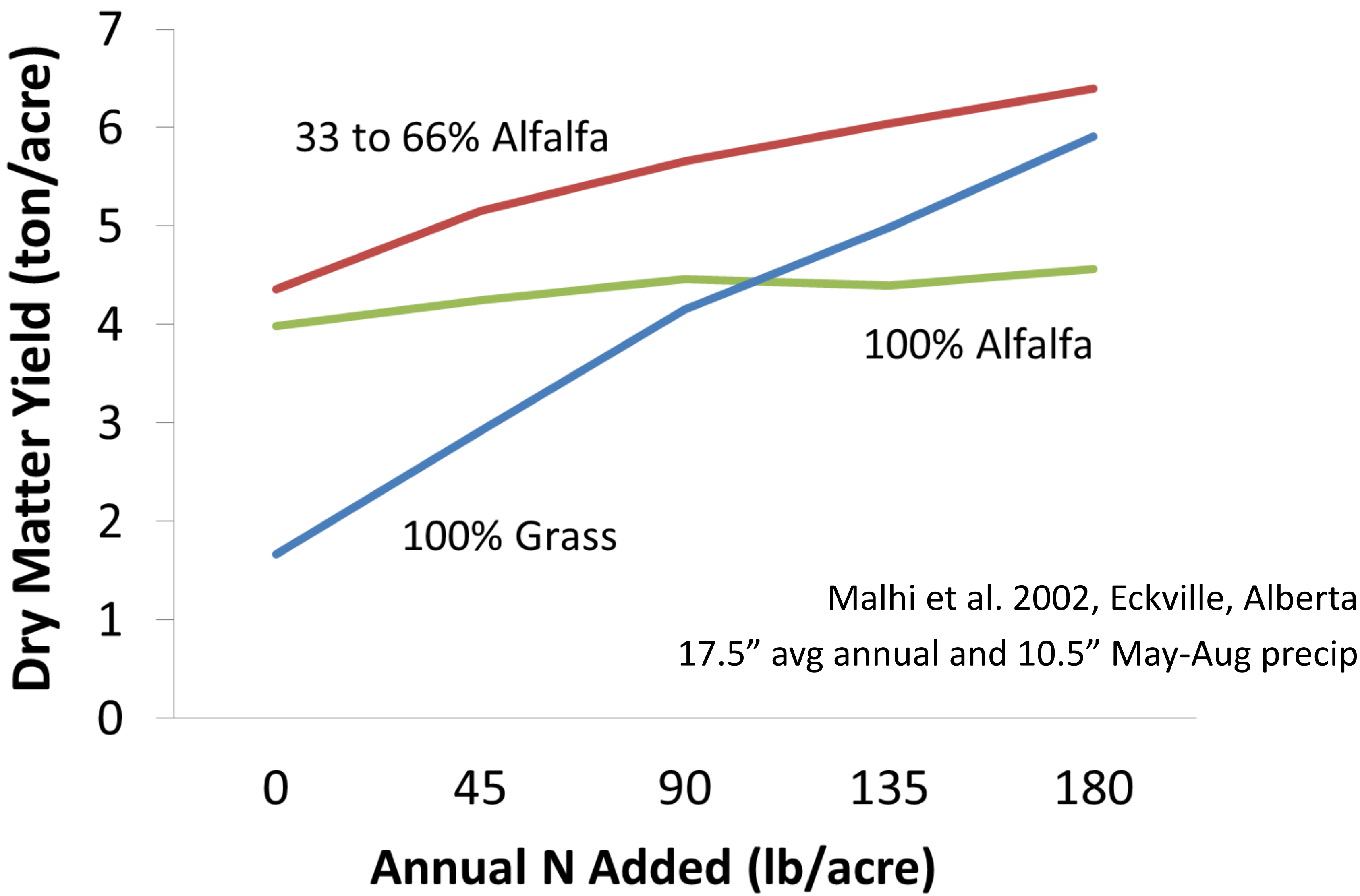
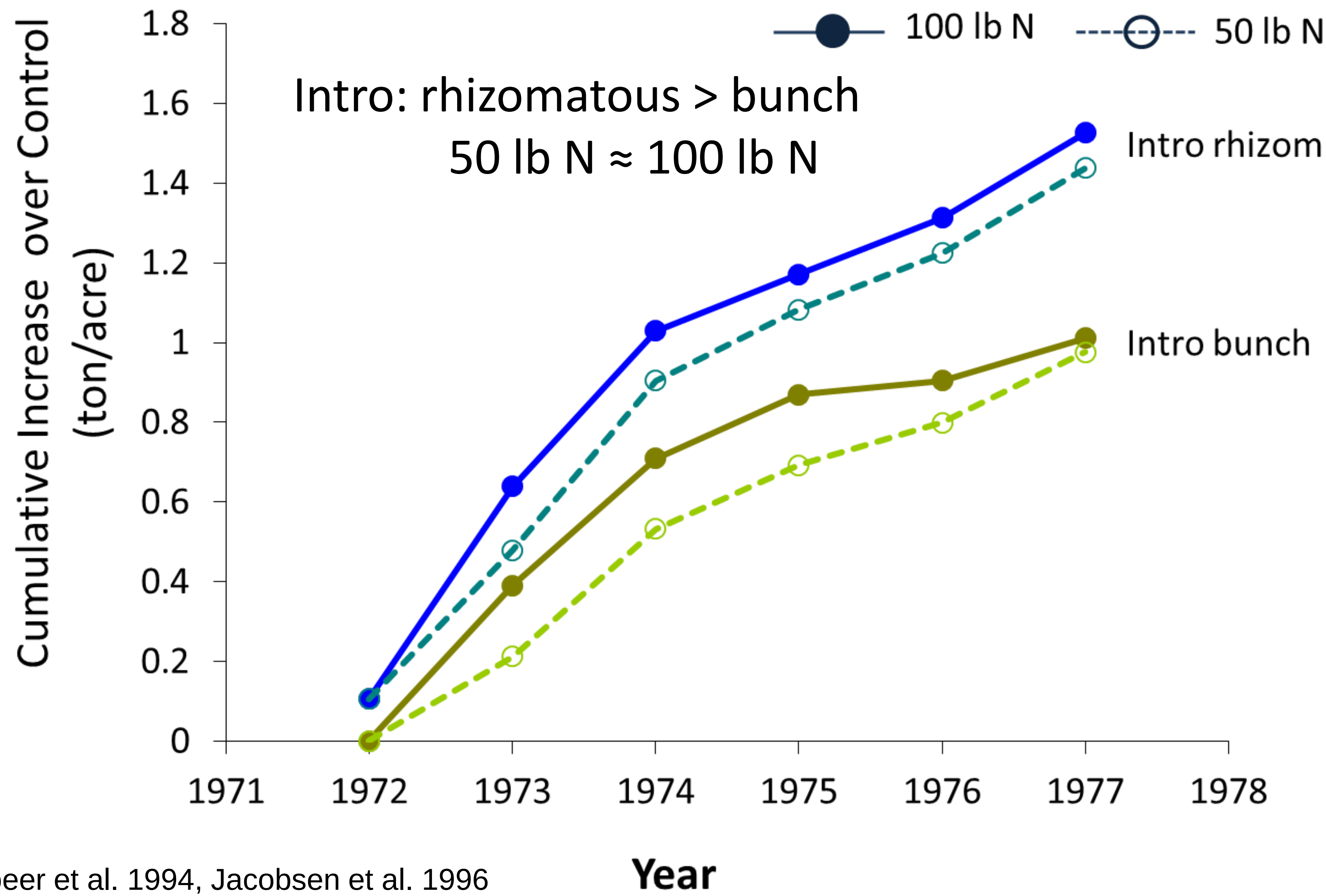
Adding N – having alfalfa in mix may be best source of N

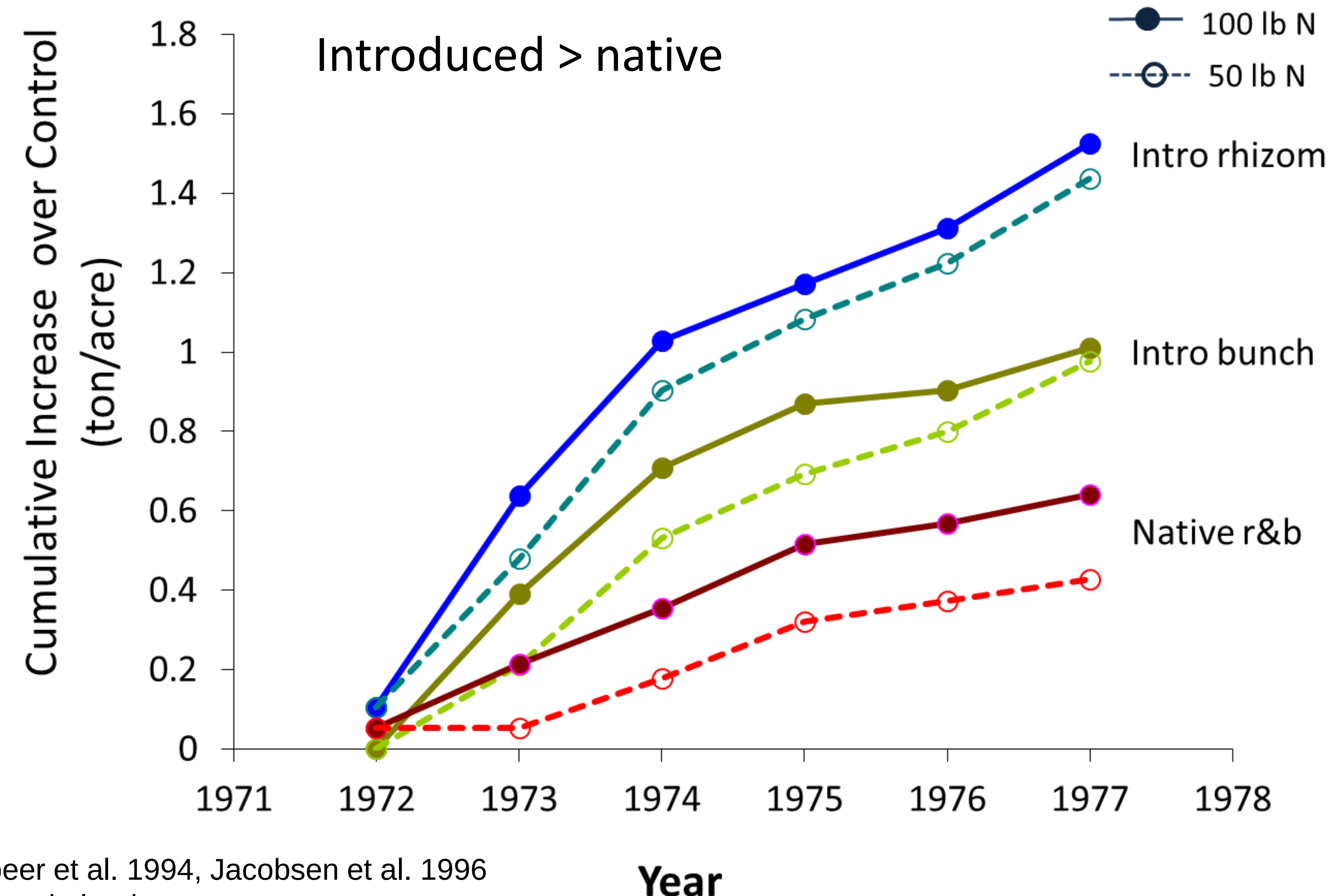


Dryland grass response to single N application



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

Dryland grass response to single N application

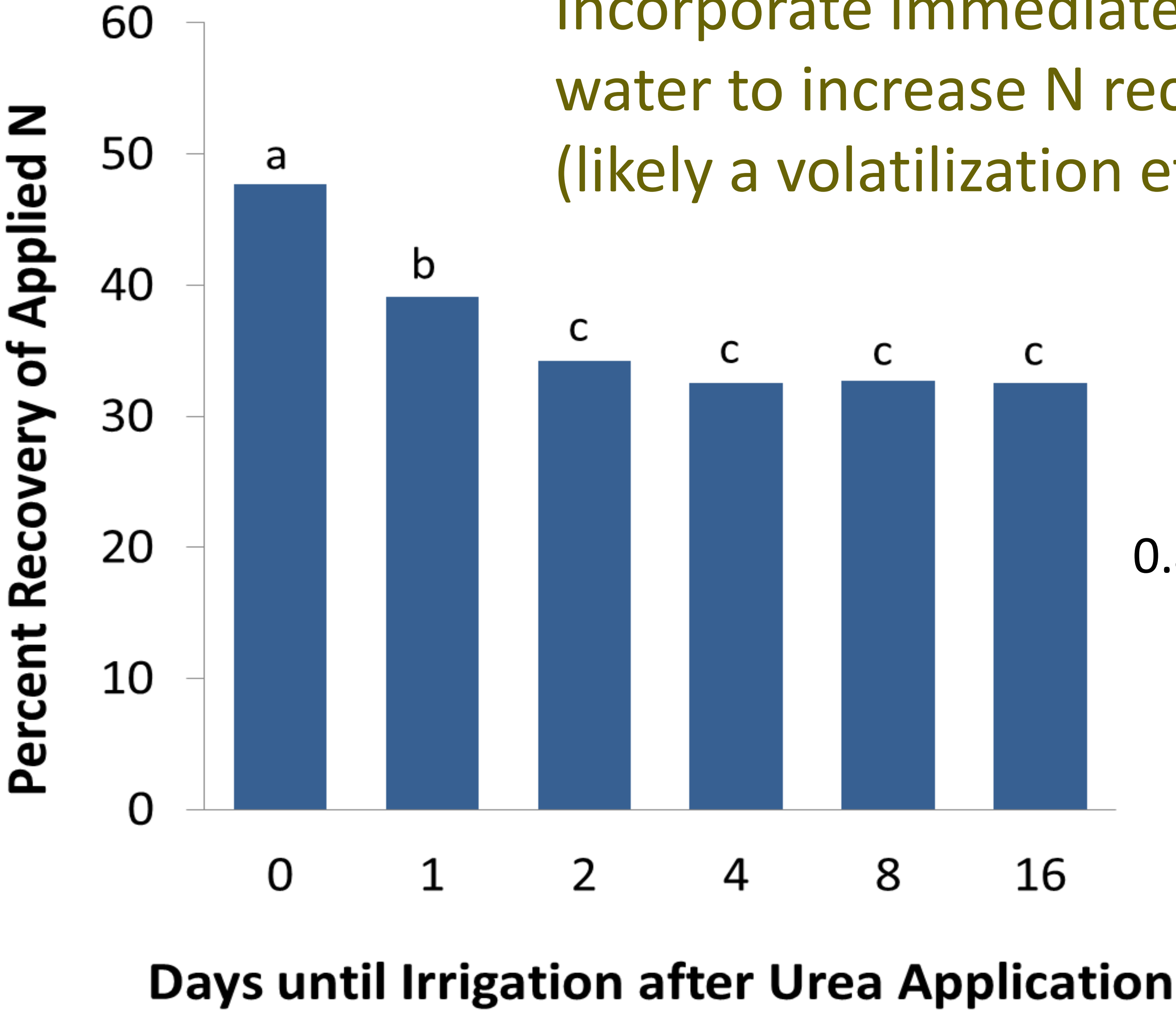


Lorbeer et al. 1994, Jacobsen et al. 1996
Havre, dryland grasses
single fall broadcast N lb/acre

Challenges to high N use efficiency in perennial systems

- Difficult to incorporate N
- Plant residue
  - intercepts fertilizer
  - increases volatilization
  - can tie up N

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

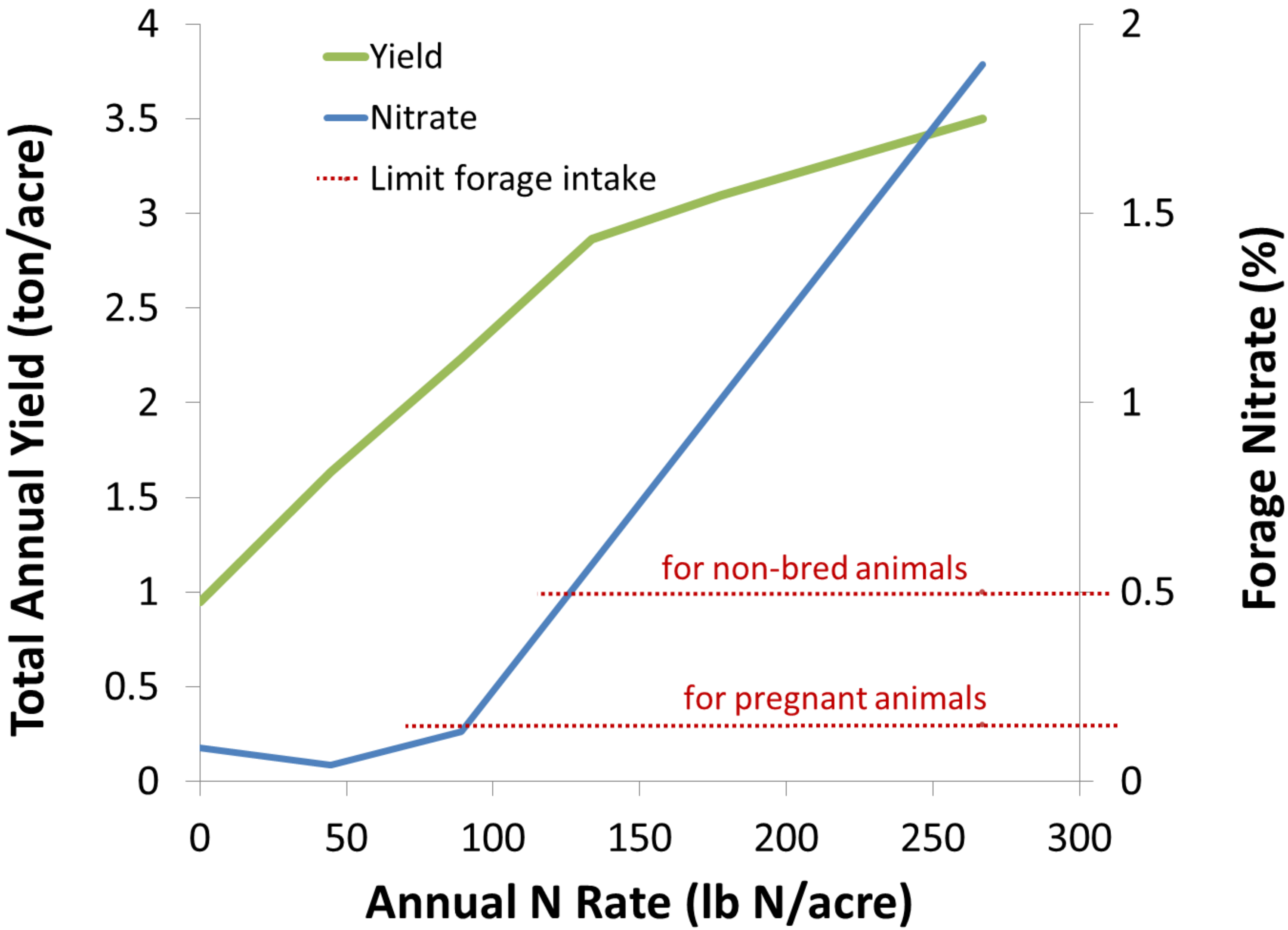


0.8” irrigation

Eckville, Alberta

Bromegrass, Malhi et al. 1995

Trade-off between yield and forage nitrate



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

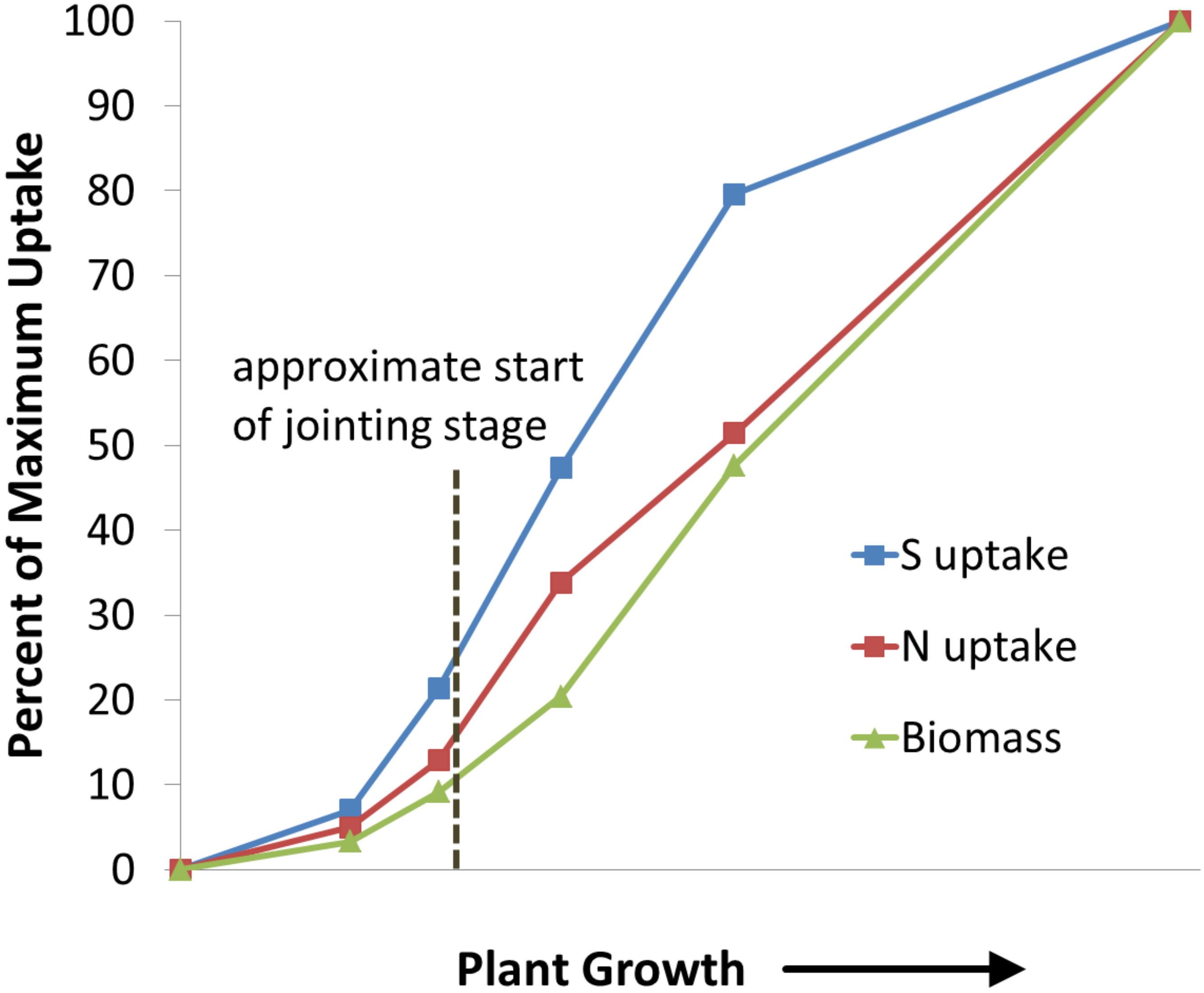
Questions?

On to *Timing*

Timing depends on source

- Readily available [urea (46–0–0), urea ammonium nitrate (28–0–0)]
  - Grass: shortly after green up
- Slowly available (manure, slow-release N)
  - take time to become available
  - apply well before needed – e.g. fall

Grass: provide N shortly after green-up



Willamette Valley, Oregon Hart et al. 1989

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

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 and timing

Resources

On soil fertility website under *Extension Publications*

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

- *Nutrient Management for Forages: N* (EB0217);
- *Nutrient Management for Forages: PKSMicros* (EB0216)
- *Enhanced Efficiency Fertilizers* (EB0188)

Questions?

Photo by Ann Ronning

Additional info at:

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