Pulse Crop Fertilizer Needs

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NE MT Pulse Crop Tour, Richland

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Goals for today

- Identify major nutrient needs for pulse crops
- Provide rate and placement suggestions
- Describe potential benefits of pulse crops in rotations

Nitrogen: Generally not needed due to N fixation

Poor N fixation if:

- Improper inoculant , low temps, drought or excess moisture, > 35 lb total available N/ac
- Low availability of other nutrients including phosphorus, potassium, sulfur, and iron

Too much early N can produce excess vegetation and reduce seed yield

If soil N < 15 lb N/ac, 10-15 lb starter N to the side of the seed or top-dressed may be helpful

Without healthy nodules, legumes don’t fix N


Not Fertilized
Fertilized w/ P, K, and S
ORG1 # 308 CDR
Winter Pea, Bozeman, 5/17/07

Phosphorus, Potassium and Sulfur Uptake

Nutrient	Peas, Lentils, Chickpeas	Wheat
	lb/bu (lb/ton hay)	
Phosphorus	0.67 (11)	0.62
Potassium	0.87 (32)	0.38
Sulfur	0.15 (?)	0.08

P levels are often low in Montana (due to calcareous soils).

K levels are often moderate to high in Montana. No research located on K and legumes in region.

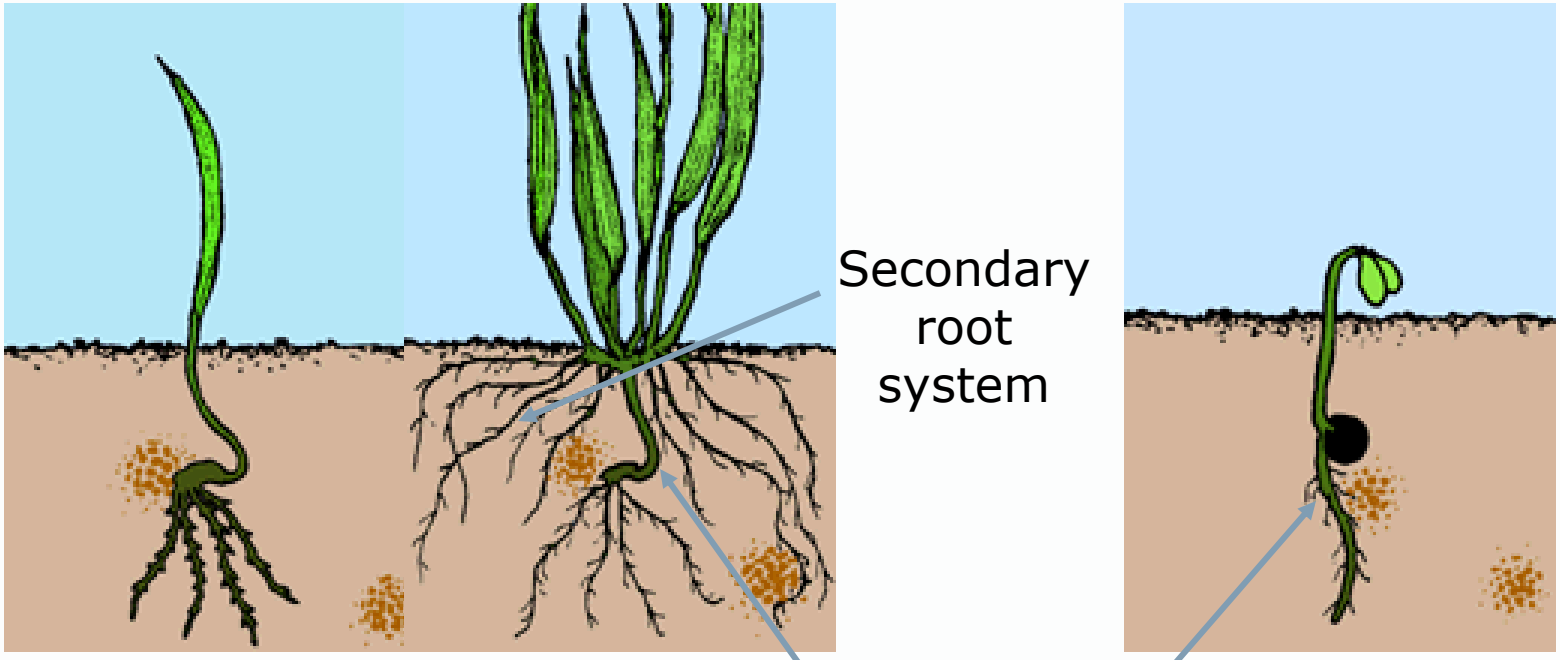
BOTH P and K needed for N fixation!

S is need for efficient use of N

Rooting patterns and starter and deep band fertilizer placement comparing wheat to legumes

Wheat

Legumes



Montana Phosphorus Fertilizer Guidelines for Annual Legumes

Olsen P (ppm) 0 to 6 inches	Application rate (lb P_2O_5/acre)
4	30
8	25
12	20
16	15
Above 16	0 up to crop removal*

* Assume 2/3 lb P_2O_5 per bushel of grain

Why are P needs of annual legumes somewhat less than for small grains and oilseeds?

- Lower yields
- Annual legumes root shallower:

  Better able to take advantage of higher P levels in upper 6 inches
- Legumes lower soil pH, mobilizing P, however this benefit does not appear to carry over to the next crop (Rick et al. 2011)

Legumes actively fixing N can acidify root zone

- Small grains increase soil pH making P less available
- Legumes decrease soil pH making P more available

Phosphorus placement

P placement depends on :

- Source
  - MAP < 20 lb P_2O_5/acre
  - TSP < 26 lb P_2O_5/acre
  - DAP use CAUTION = toxic to seedlings
- Soil
  - Safe rates higher in heavy clay soils, soils with high SOM
  - Safe rates lower in coarse and drier soils
- Equipment
  - Use seeding/fertilizer equipment with wide openers if possible to disperse seed and fertilizer granule in the seed bed.

Phosphorus placement

- If P required is higher than safe seed placed – broadcast and incorporate before seeding or sub-surface side band next to seed.
- Consider applying more P with alternate crop to bank P for the pulse crop year.

P response

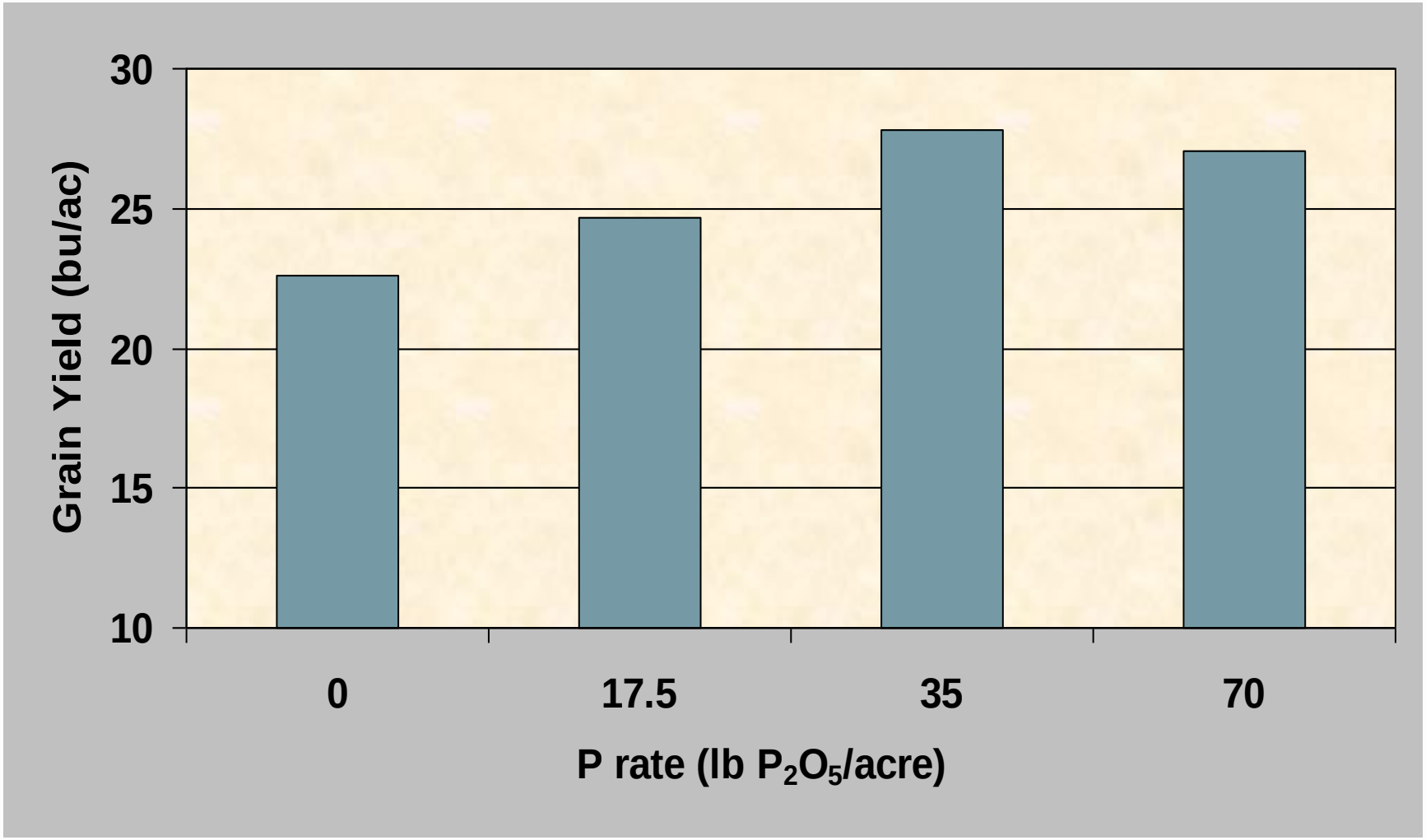
- P response better when soil P is low
- 2 Studies in west-central Alberta
  1. Max yield with 40 lb P_2O_5/ac and no response when Olsen P > 9 ppm
  2. Max yield with 26 lb P_2O_5/ac and no response when Olsen P > 13 ppm
- P response was higher on loam than clay loam soils (Karamanos et al. 2003)

P increases N fixation and biomass

Using soil collected near Scobey, MT
(Olsen P = 6)

- P added at 16 and 32 lb P_2O_5/ac approximately tripled N fixation over non P fertilized peas
- P added at 16 and 32 lb P_2O_5/ac increased aboveground pea biomass by 45 and 60%, respectively (likely due to increases in both N and P).

Effect of P on Spring Pea Yield (2004-2005) Sidney, MT



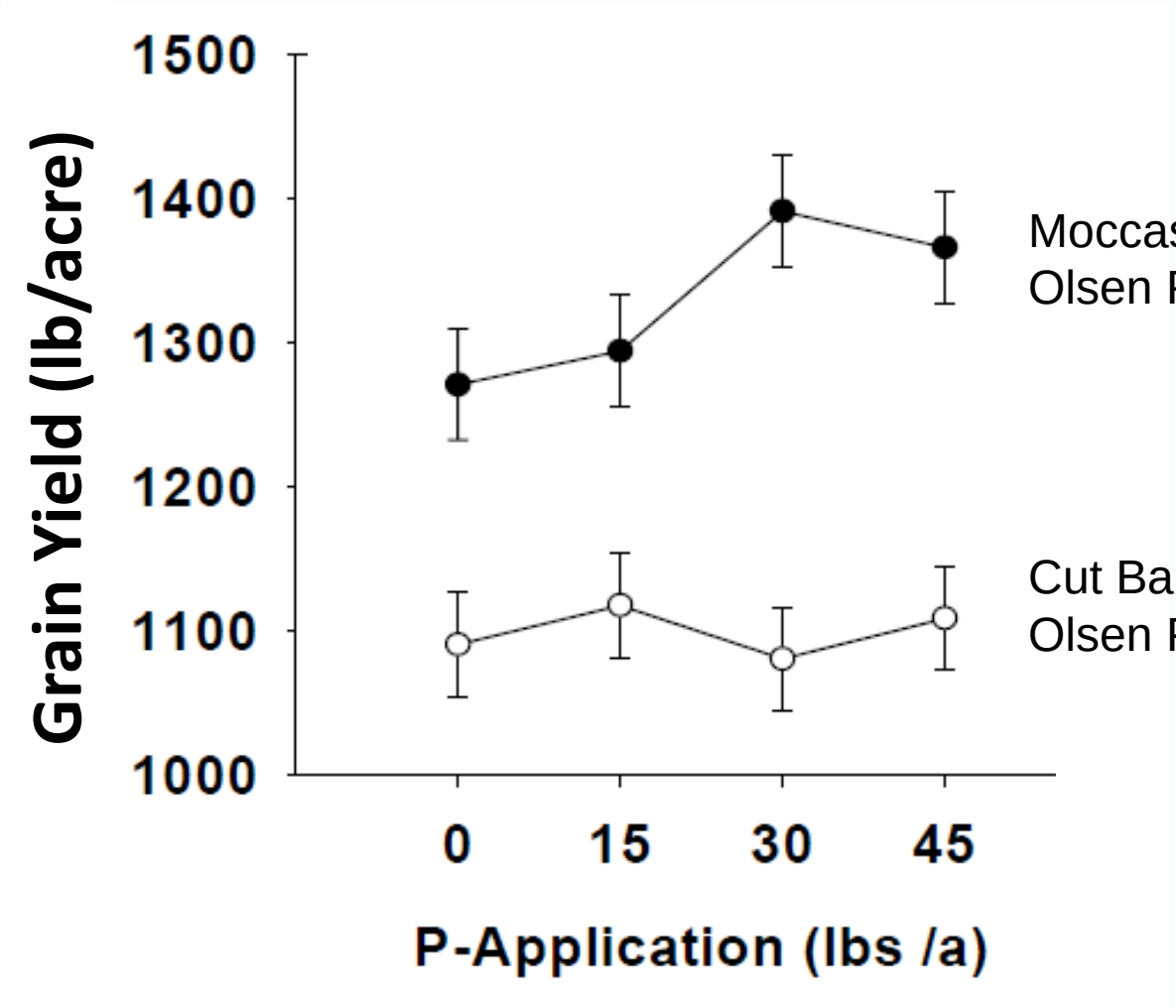
Olsen P = 10-14 ppm

Data from J. Waddell

Increasing pea yield increases soil nitrate

Adding 35 lb P_2O_5/ac at Sidney increased soil nitrate-N the following spring by 50% over peas with no added P, possibly due to N fixation differences.

Effect of P on Spring Lentil Yield Moccasin (CARC) and Cutbank



Data from C. Chen and G. Jackson

http://landresources.montana.edu/fertilizerfacts (# 38)

Take home messages on P

- Annual legumes need similar amounts of P PER bu than wheat.
- P is necessary for N fixation.
- Legumes are better able to access soil and fertilizer P than small grains.

Questions?

Potassium

- Use soil test or crop removal rate
- Best broadcast and incorporated pre-plant or banded at planting.
- Seed placed $N+K_2O < 15$ lb/ac when seed placed.

  E.g. 50 lb 11-52-0 as starter = 5.5 lb N/ac

  15-5.5 = 9.5 lb/ac limit on K_2O if applied with seed

Montana Potassium Fertilizer Guidelines for Annual Legumes

Soil Test K (ppm) 0 to 6 inches	Application rate (lb K_2O/acre)
100	35
150	30
200	25
250	20
Above 250	0 up to crop removal*

* Assume 0.87 lb K_2O/bu of grain

Sulfur

- Soil tests are not reliable for S
- Base S on prior crop performance, S removal rate (0.15 lb S/bu seed) or tissue concentration (varies by crop)
- Elemental S can be used to bank S. About 70 lb S/ac before canola in canola, barley, pea system provided enough for the pea rotation 3 years later (sulfate fertilizer did not)
- Sulfate S for in-season
  - 15-20 lb/ac at planting
  - 3-5 lb S/ac as granular or liquid as rescue treatment

Plant tissue S concentrations

Leaf S concentration at which 90% of maximum yields were obtained.	
Crop	**Plant tissue S concentration (%)**
Chickpea	0.18
Lentil	0.29
Faba bean	0.038
Sampling 2nd to 4th mature leaf at 7th leaf stage, 4 weeks after seeding. Huang et al. 1992.	

Conclusions on nutrient management of pulses

- Inoculation and adequate nutrients maximize N fixation. N benefits from legumes will be higher when soil N is low, seed is inoculated, and P, K, and S are adequate.
- Phosphorus has been shown to have both positive and neutral results on pea and lentil yields, but response should be higher on low P soils.

Conclusions on nutrient management of pulses (cont.)

- Potassium needs are high for legumes, partly b/c needed for N fixation, but little research has been conducted on pea or lentil responses to K.
- Elemental S can be applied to last for several years or in-season
- With high pulse prices, maximizing yield with fertilization can easily pay for itself.

Questions so far?

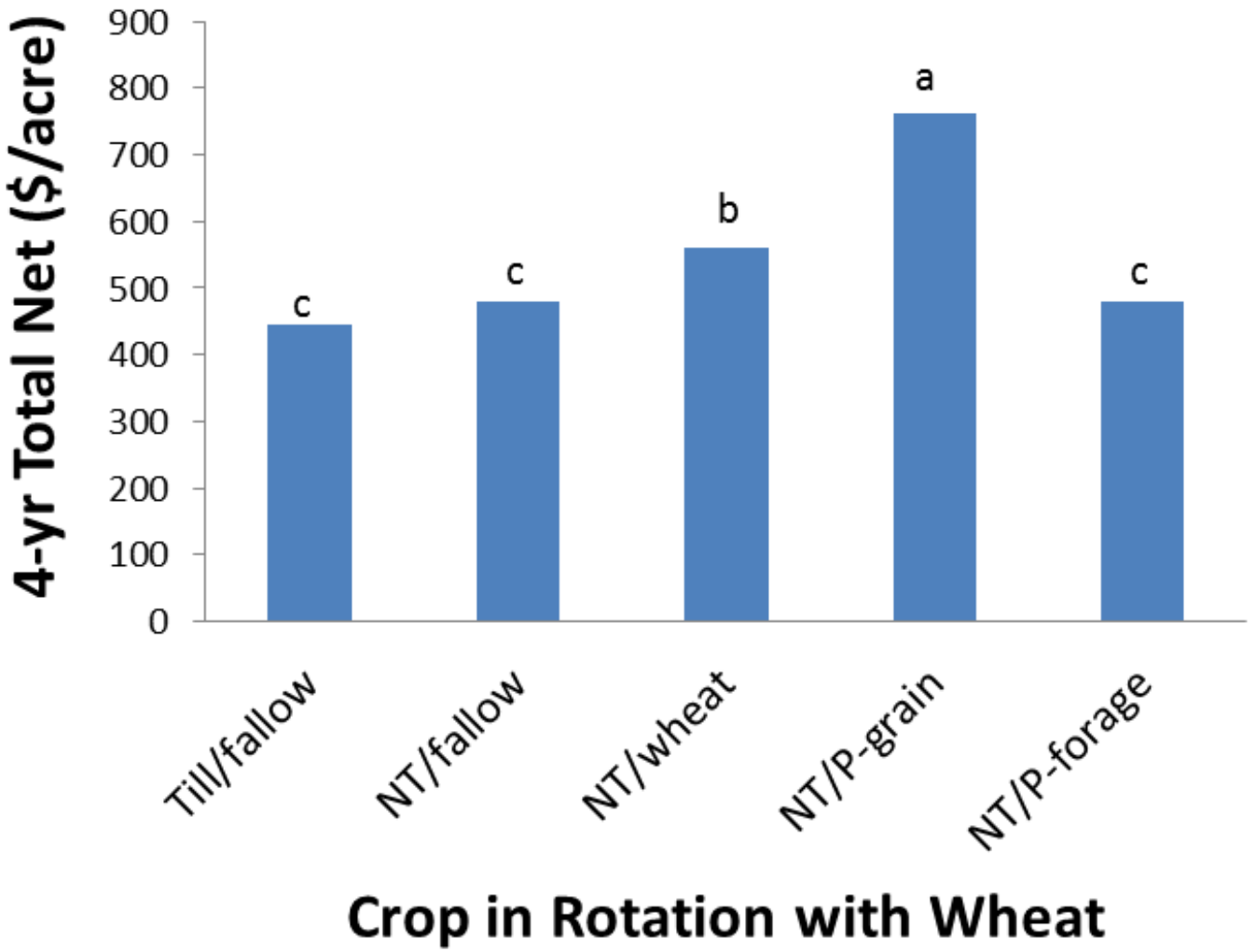
Potential benefits of pulse crops and legume green manures in rotations

Pulse crops replacing fallow could:

- Reduced the need for N fertilizer
- Increased subsequent wheat protein
- Improve soil health
- Provided higher economic return

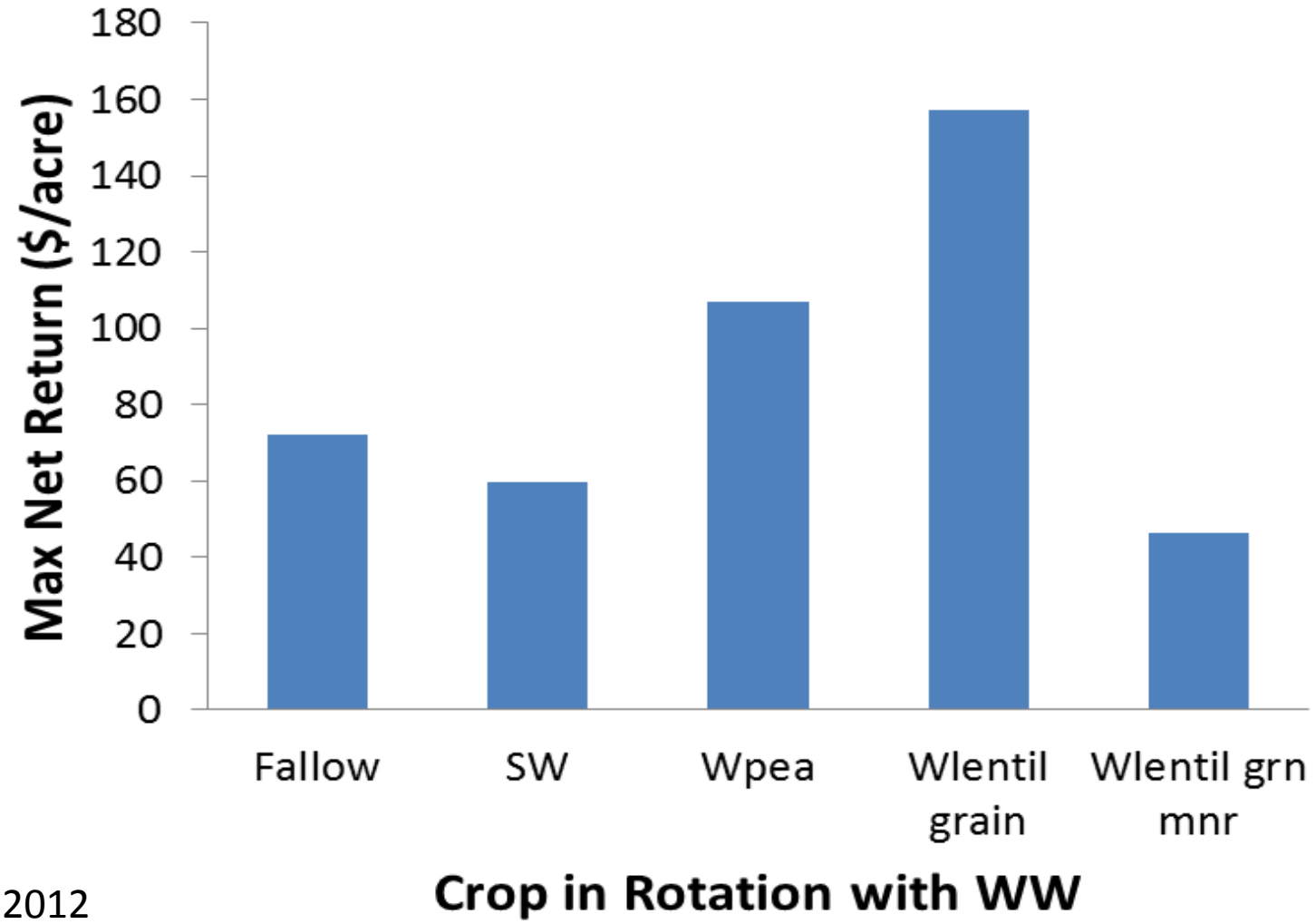
However, water use by legume crop may reduce yield of following crop in some years.

Economics of integrating pulse crops into wheat systems



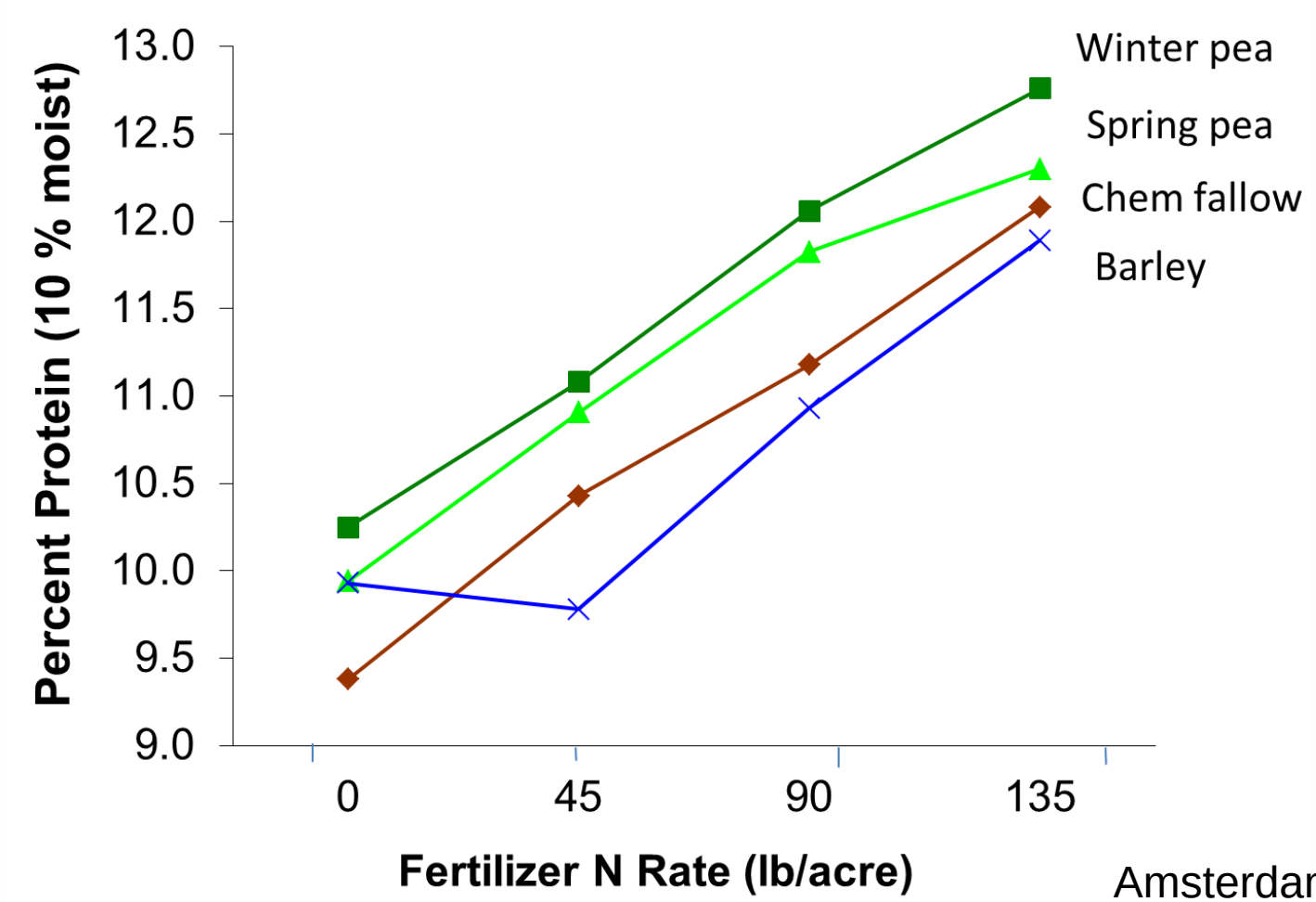
Bozeman
Miller et al. 2012 unpub data

Economics of integrating pulse crops into wheat systems



Chen et al. 2012
Moccasin

Legumes in rotation w/ winter wheat to increase protein?



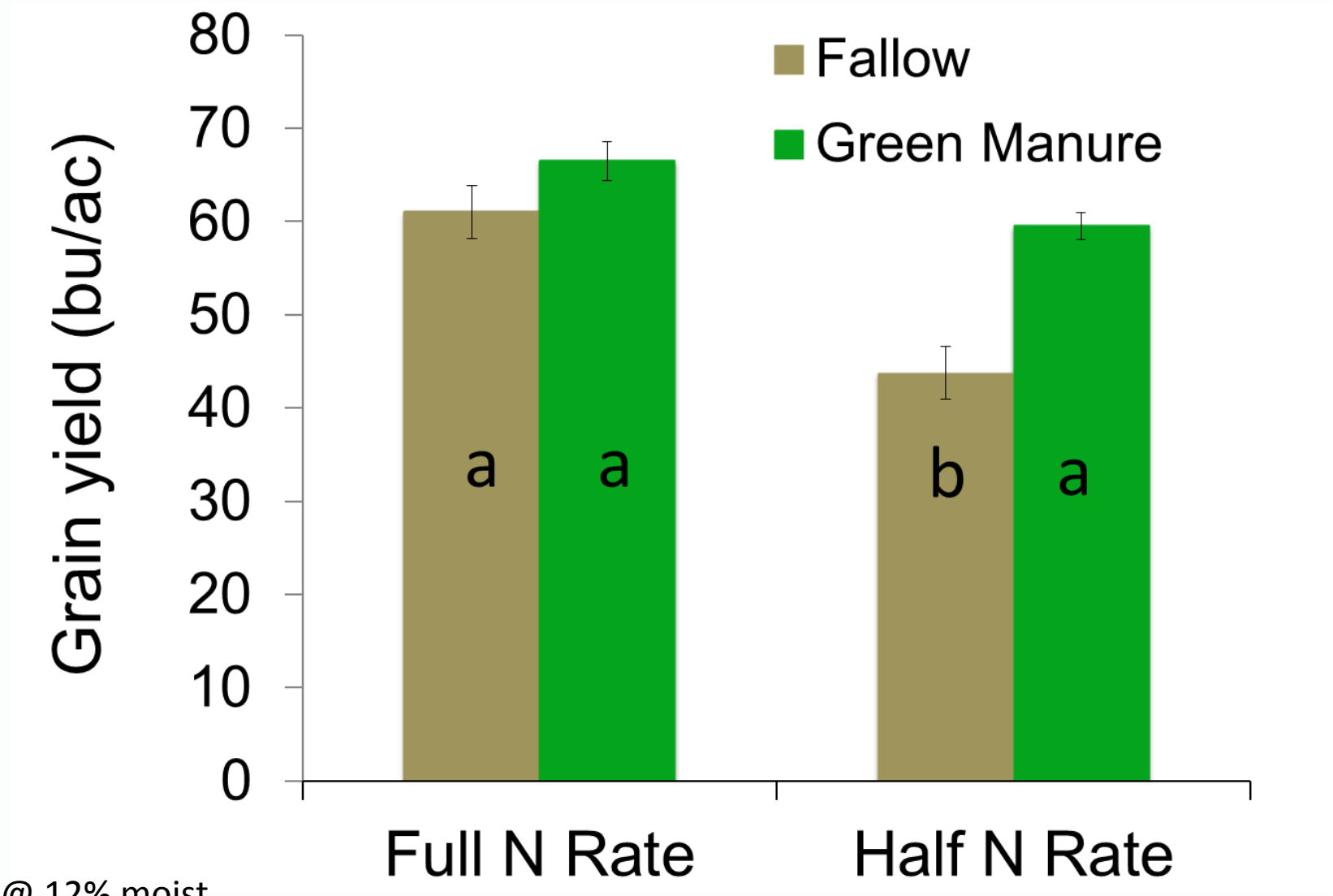
Amsterdam
Miller unpub data

Legumes grown instead of a small grain or fallow can result in a protein increase similar to about 25 lb N/ac of fertilizer.

Legume green manure (LGM) study near Bozeman

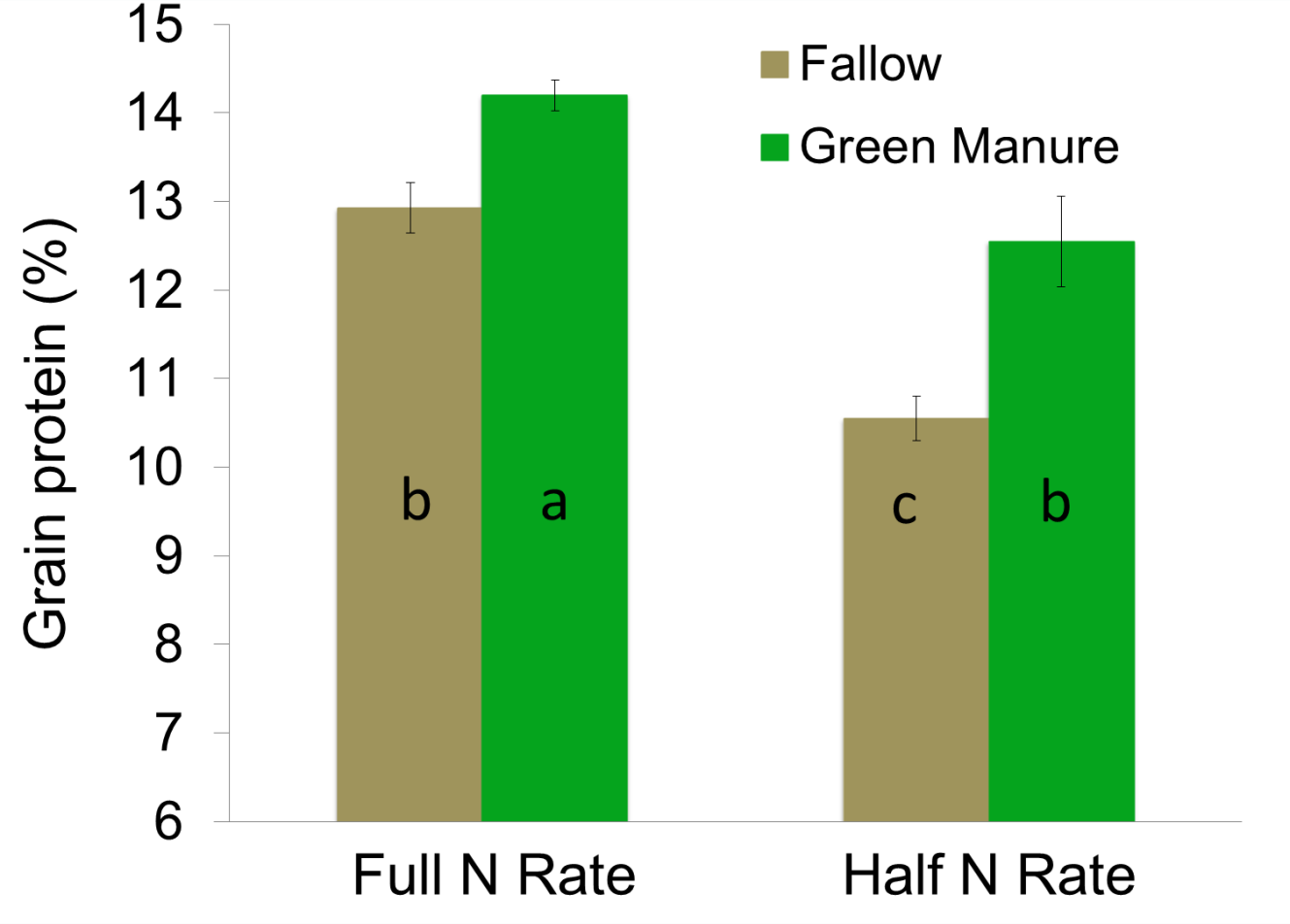
- No-till pea forage/legume green manure-wheat vs. fallow-wheat
- Pea forage grown in 2003, 2005, 2007 and pea green manure grown in 2009, terminated at full pod
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years.
- 2 N rates: Full (3 lb available N/bu) and ½
- No wheat yield or protein differences between after fallow and pea forage/pea manure in first 6 years of study (3 pea cycles)

Spring wheat grain yield in 8th year



@ 12% moist

Spring wheat grain protein in 8th year



* N fertilizer rates	*Fallow-Wheat*	*LGM-Wheat*
Full N rate (lbs/ac)	124.00	83.00
Half N rate (lbs/ac)	39.00	0.00

Pea green manure after 4 LGM-wheat rotations saved **124 lb N/ac** compared to fallow.

Take home messages

- After 4 two-year cycles, wheat grain yield and protein were higher after LGM than after fallow.
- Over 100 lb N/ac was saved in the fourth cycle of LGM-wheat compared to fallow-wheat.

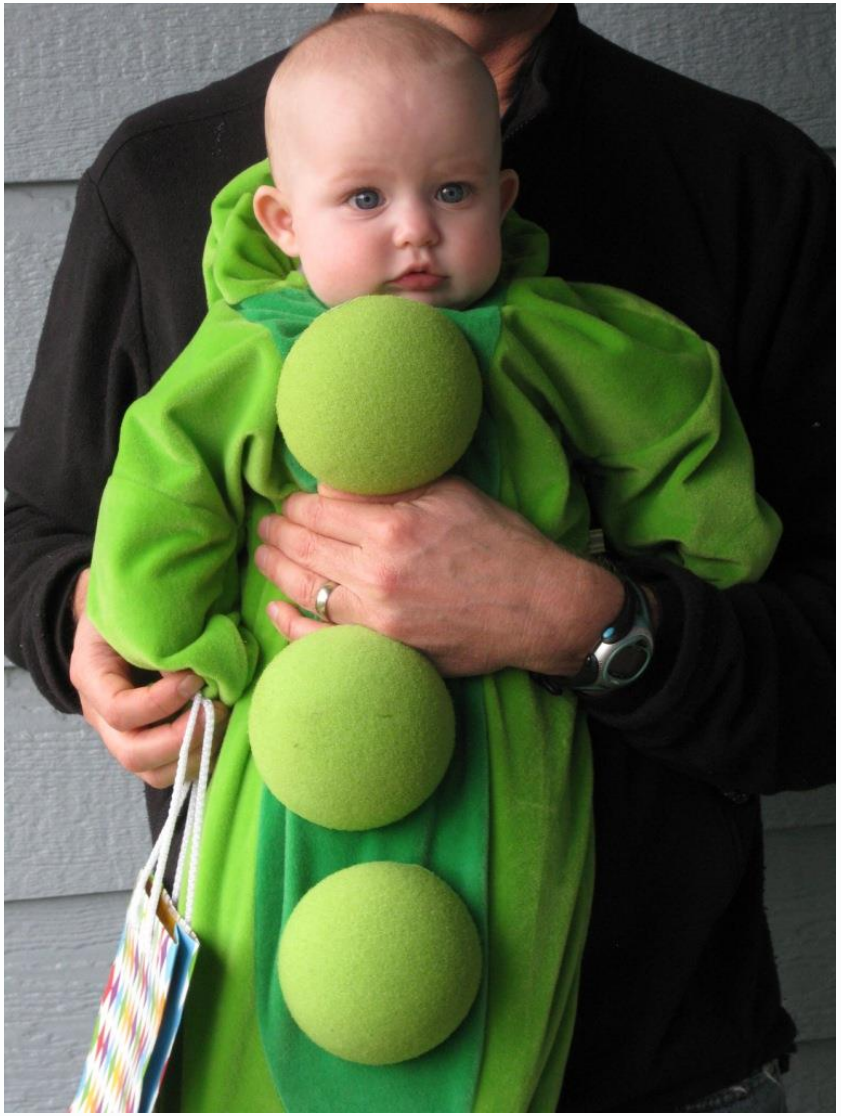
For additional information

Soil Fertility Website:

http://landresources.montana.edu/soilfertility

Contains links to my presentations including this one, the bulletin *Montana Cool Season Pulse Production Guide*, and more.

With good soil fertility you can grow big pods



Questions?