Soil Fertility of Annual Legumes

Prepared for 2007 Crop Pest Management School

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MONTANA STATE UNIVERSITY EXTENSION

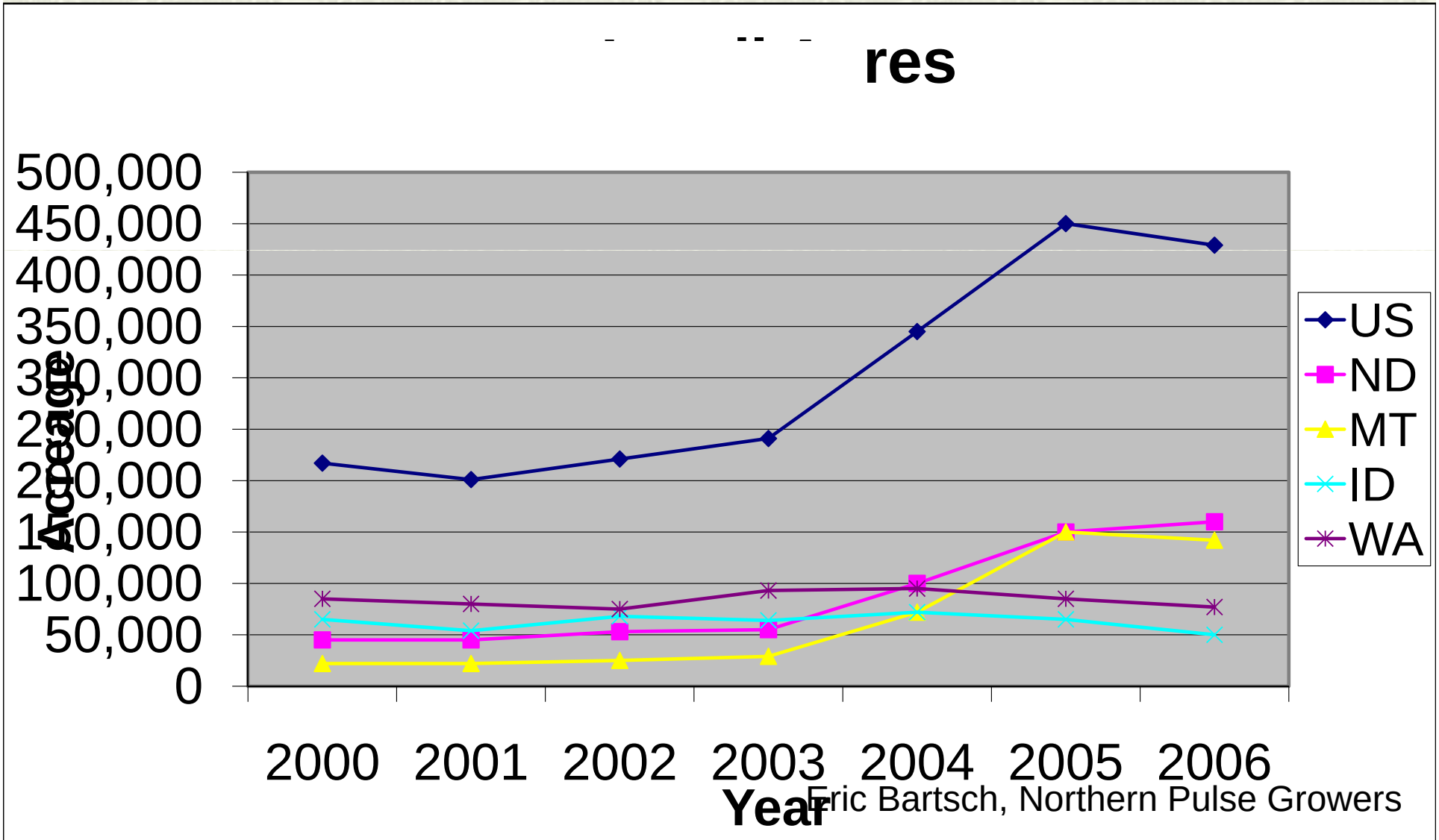
Questions for you

- How many of you have clients who grow annual legumes?
- How many of you grow annual legumes?
- Small grain replacement or fallow replacement?

Your experiences?
Both good and bad?

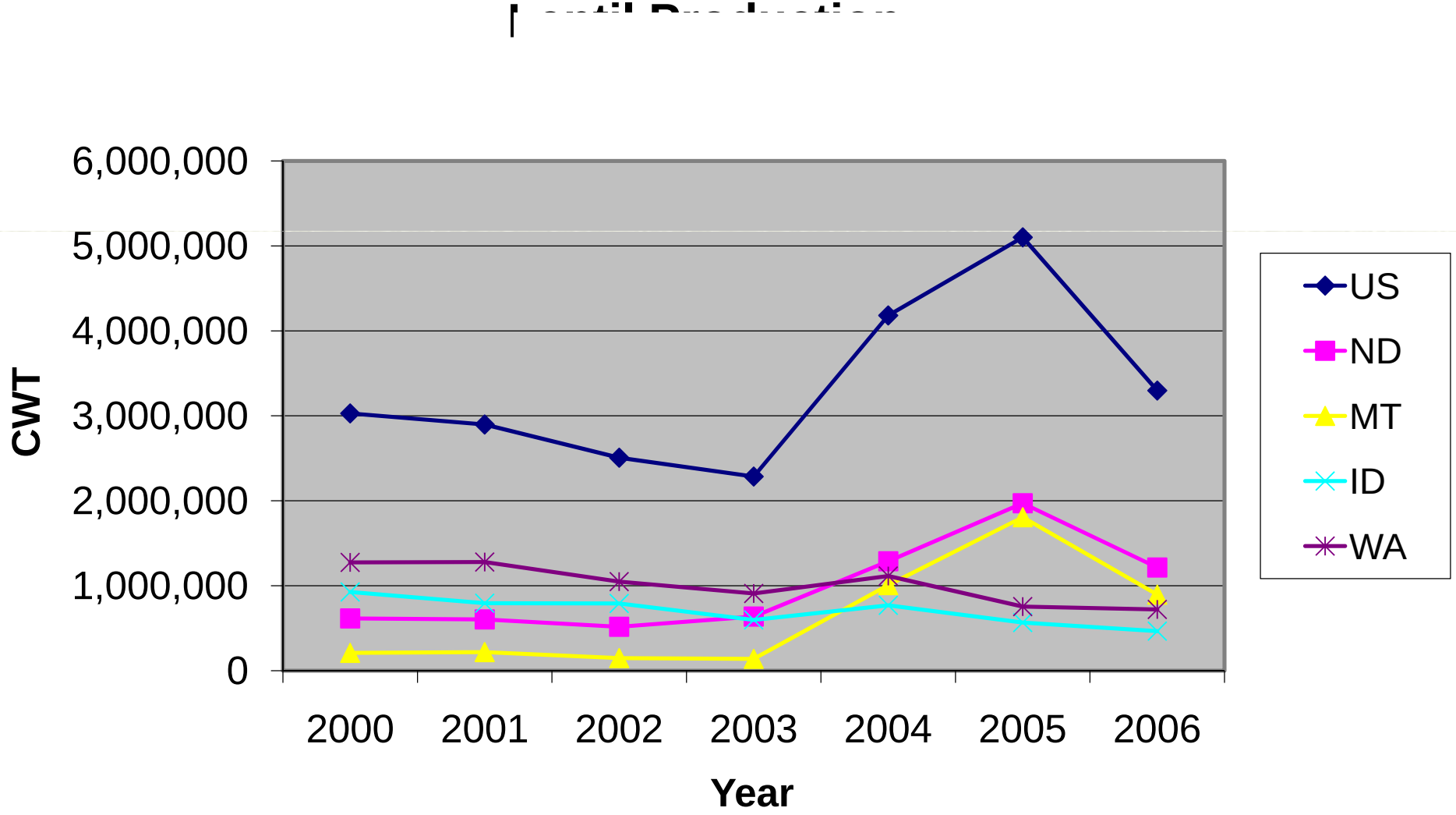
U.S. Lentil Acres

(USDA – NASS)

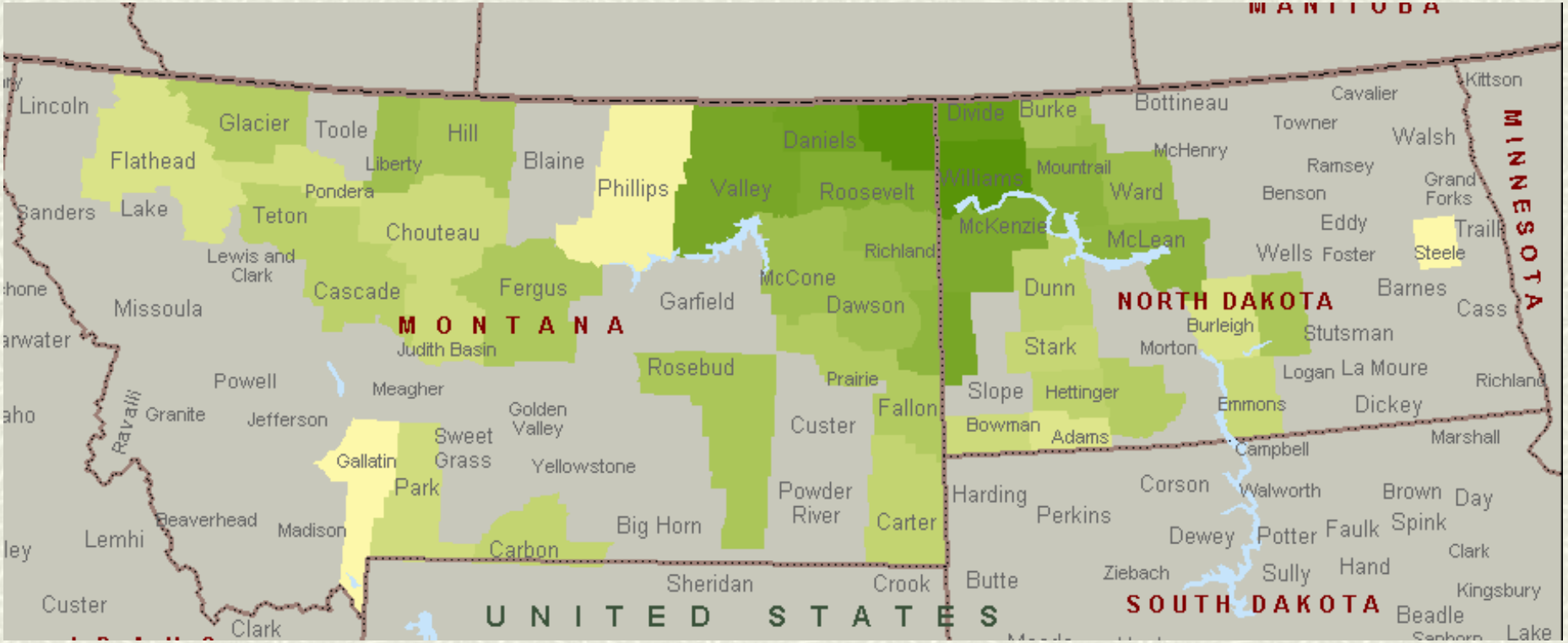


Eric Bartsch, Northern Pulse Growers

U.S. Lentil Production

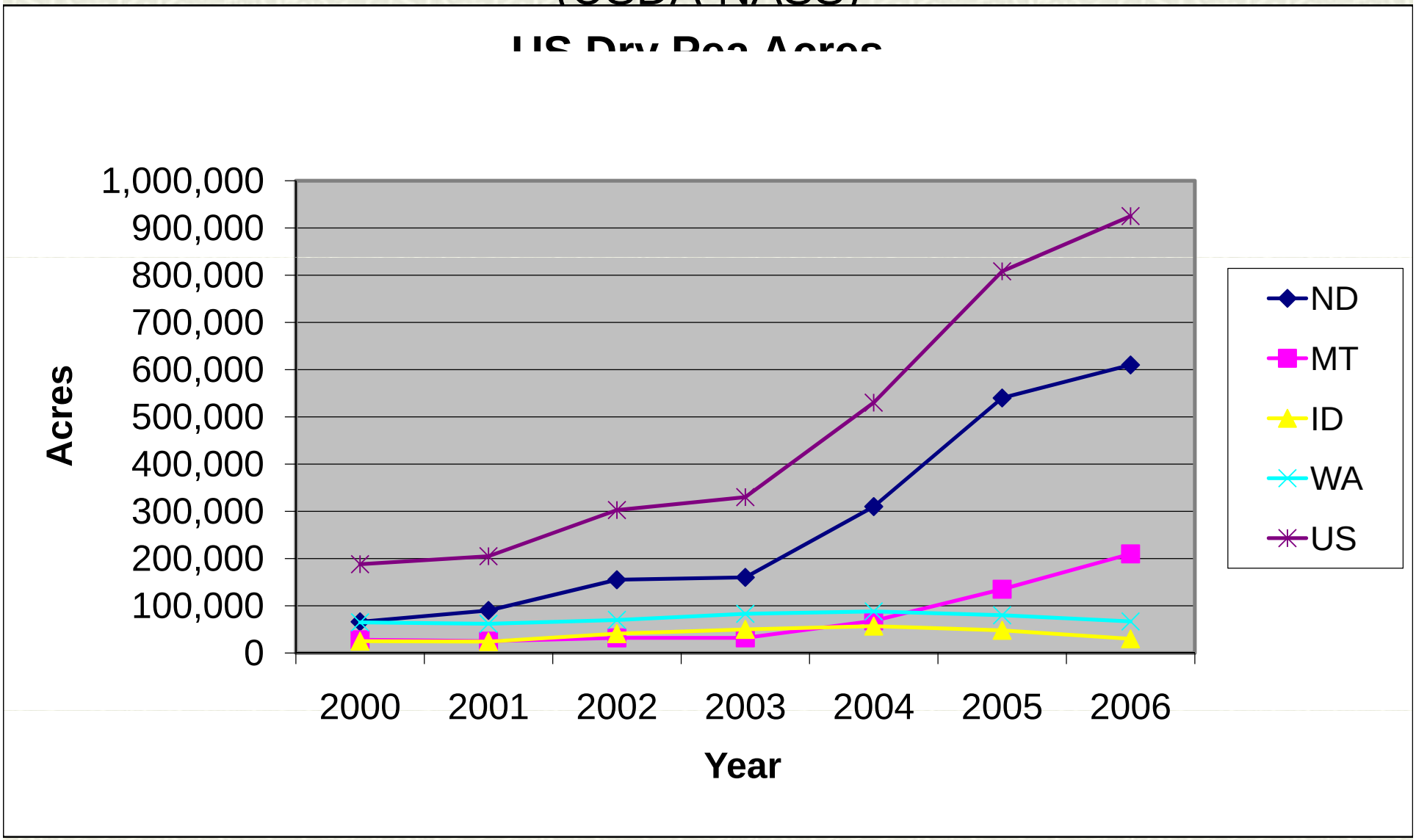


Lentil Production Area

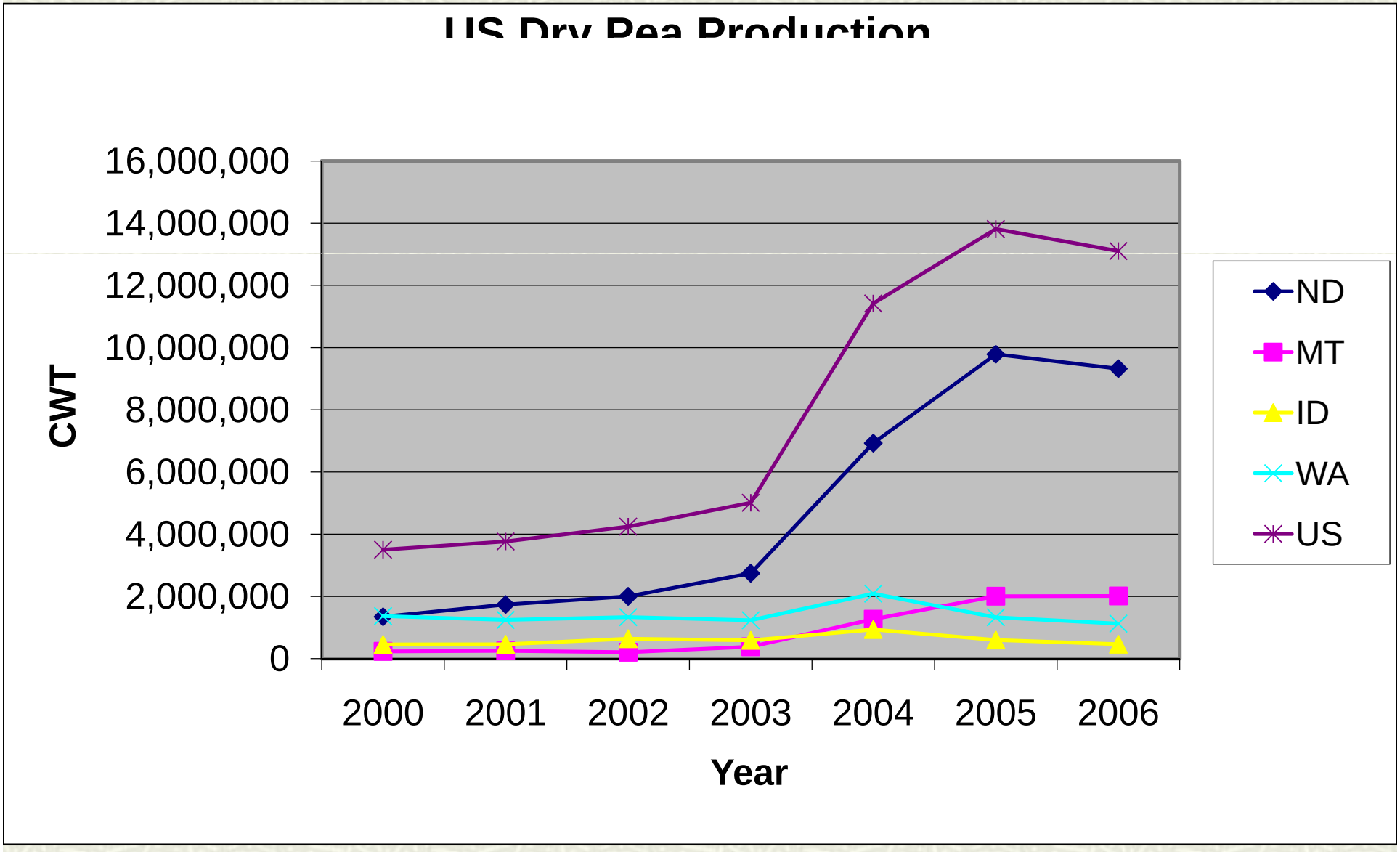


US Dry Pea Acres

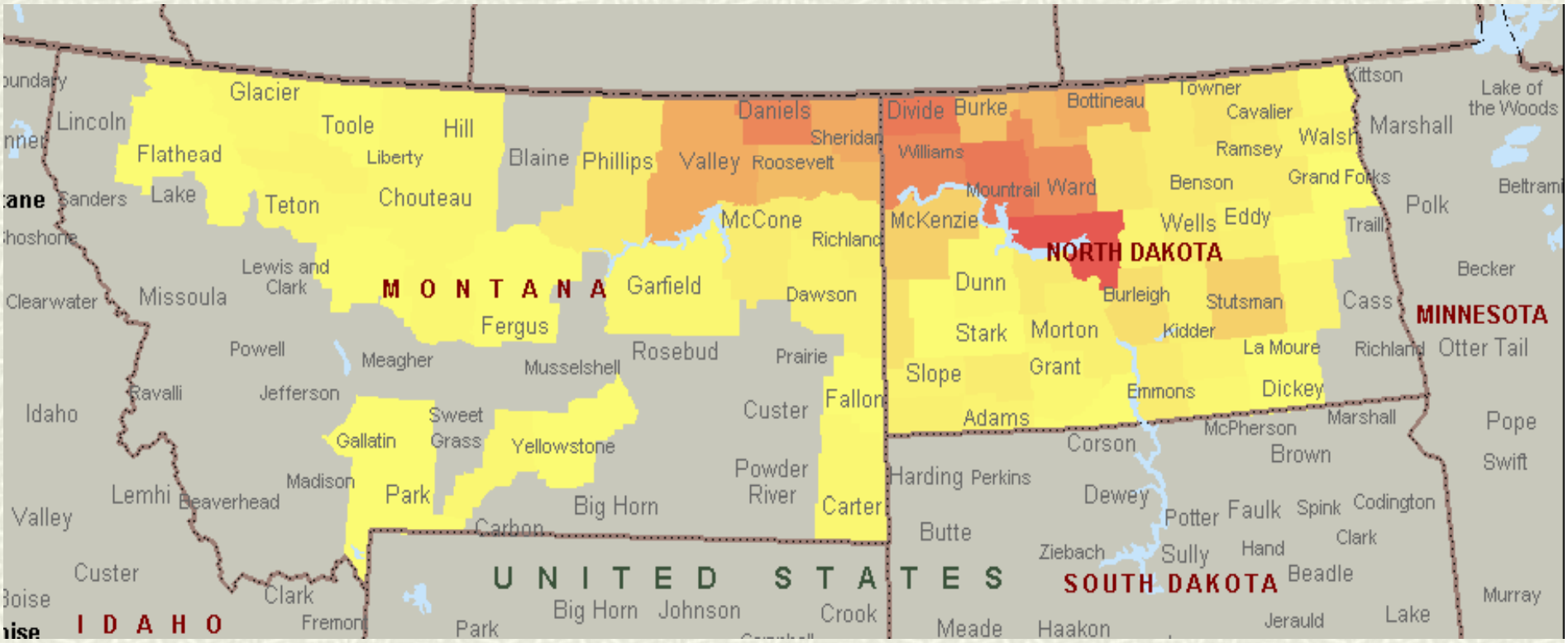
(USDA-NASS)



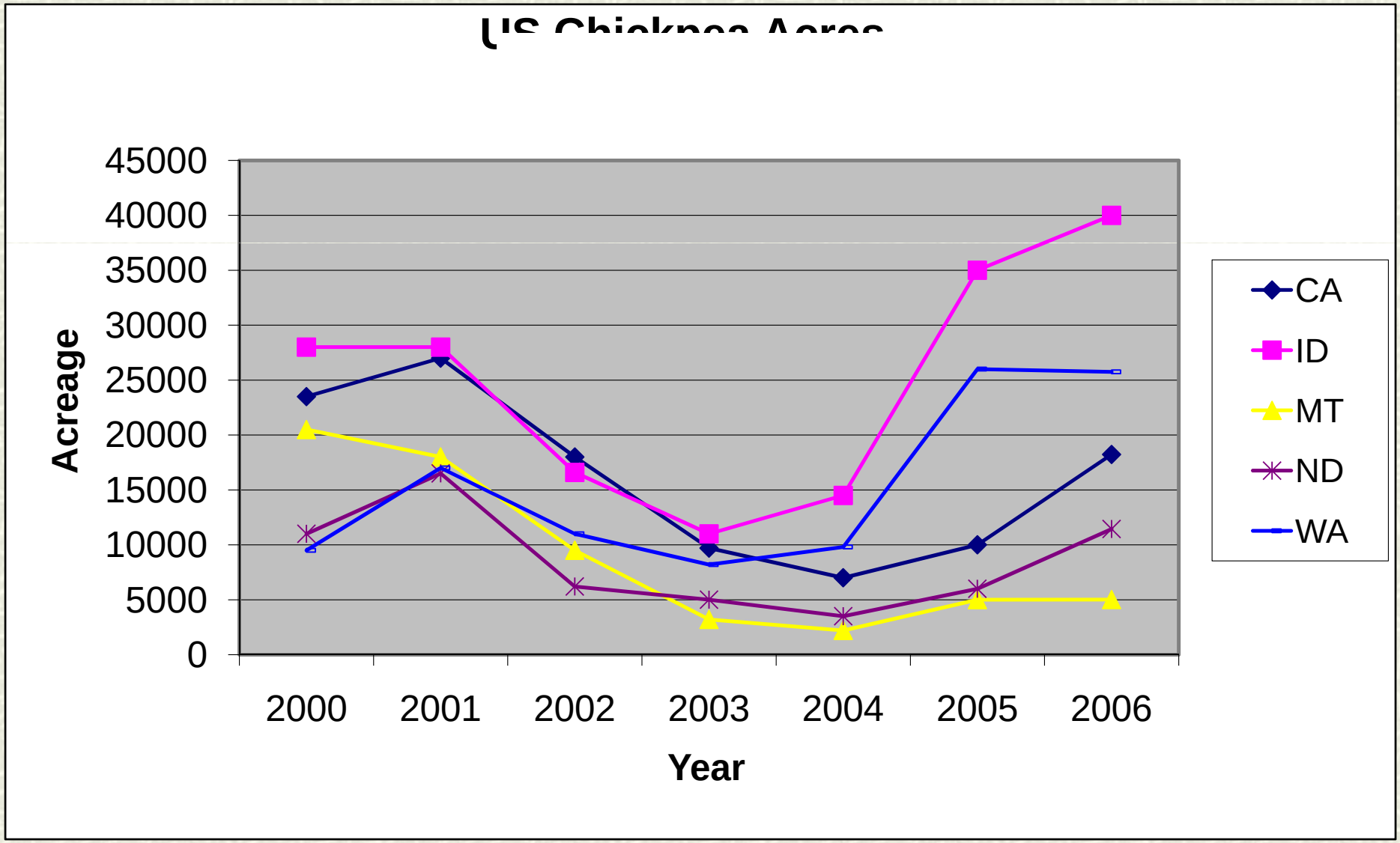
U.S Dry Pea Production



Dry Pea Production Area



US Chickpea Acres



New Organization:
Northern Pulse Growers

- Formed last year:

  Combined ND Pea and Lentil Association with Montana annual legume growers
- Checkoff: For marketing and research
- Information:

  www.ndpealentil.org

Goals Today

- Show small grain yields following legumes compared to:
  - -Following Fallow
  - -Following Small grains
- Discuss N credit from legumes
- Point out phosphorus and potassium fertilizer needs of legumes vs small grains

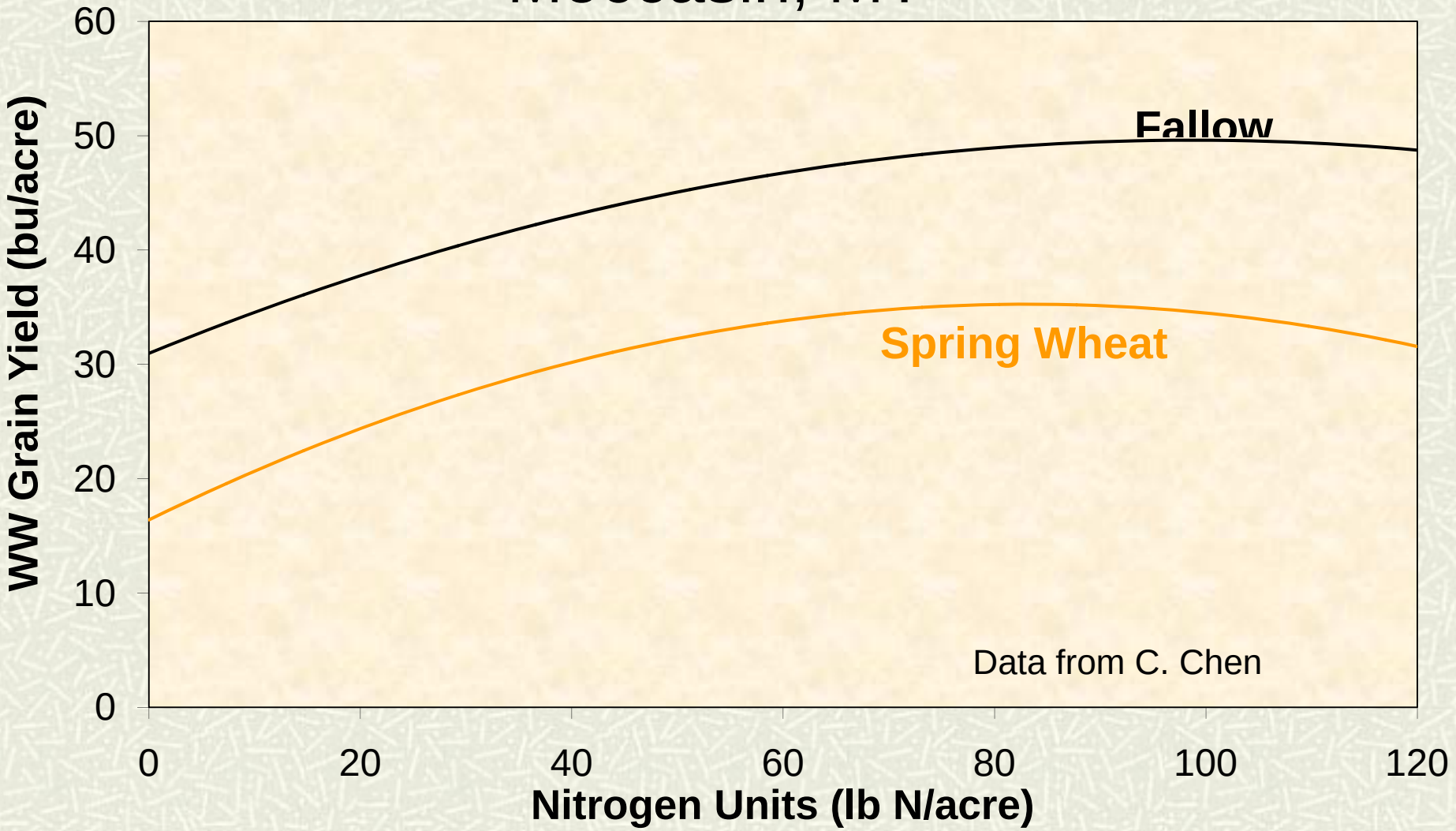
Pea field in north central MT
July 4, 2004

Photo: P. Miller

Moccasin Cropping System/Tillage Study

Effect of Previous Crop and N on 2006 Winter Wheat Grain Yield (NT)

Moccasin, MT



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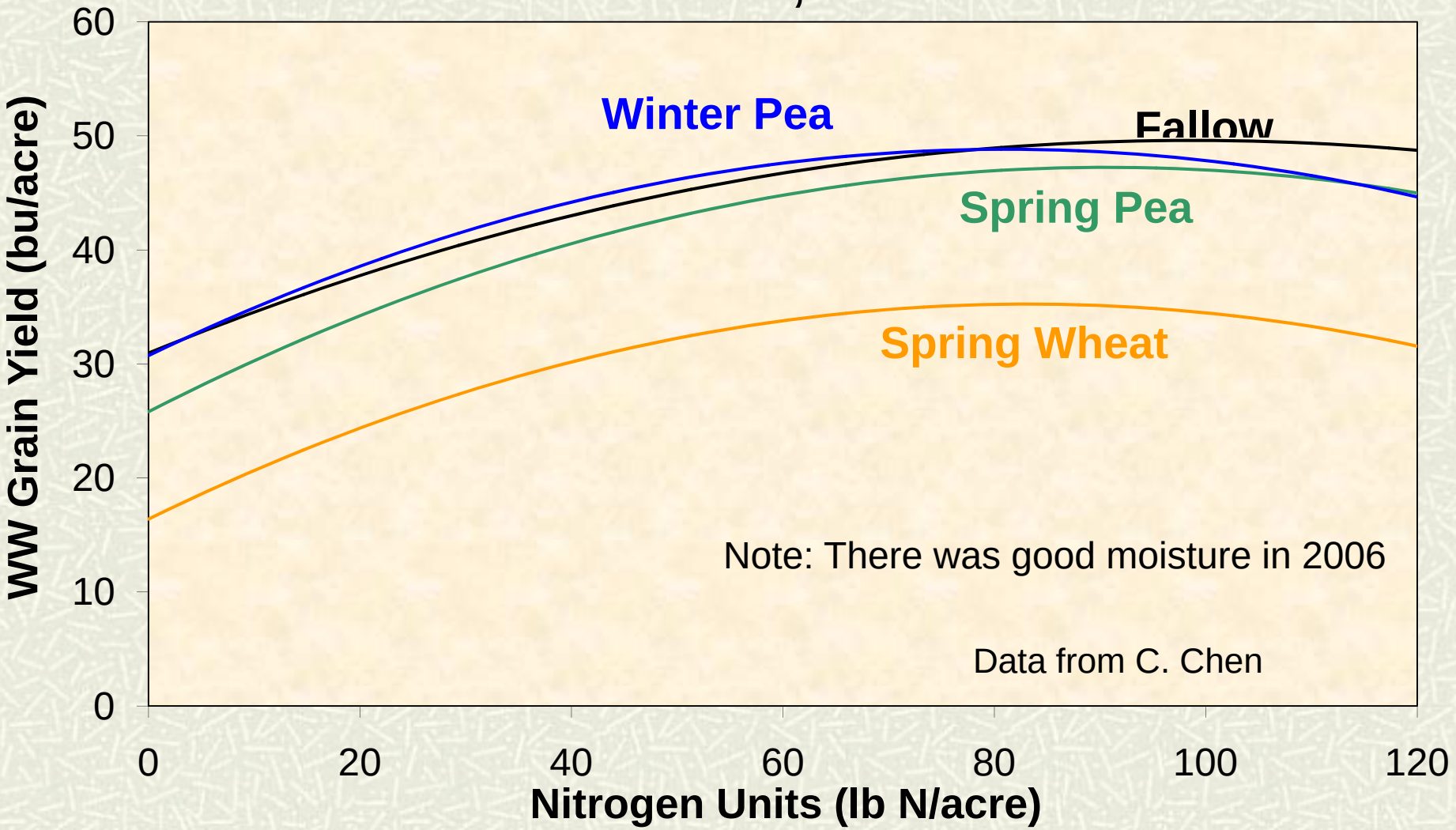
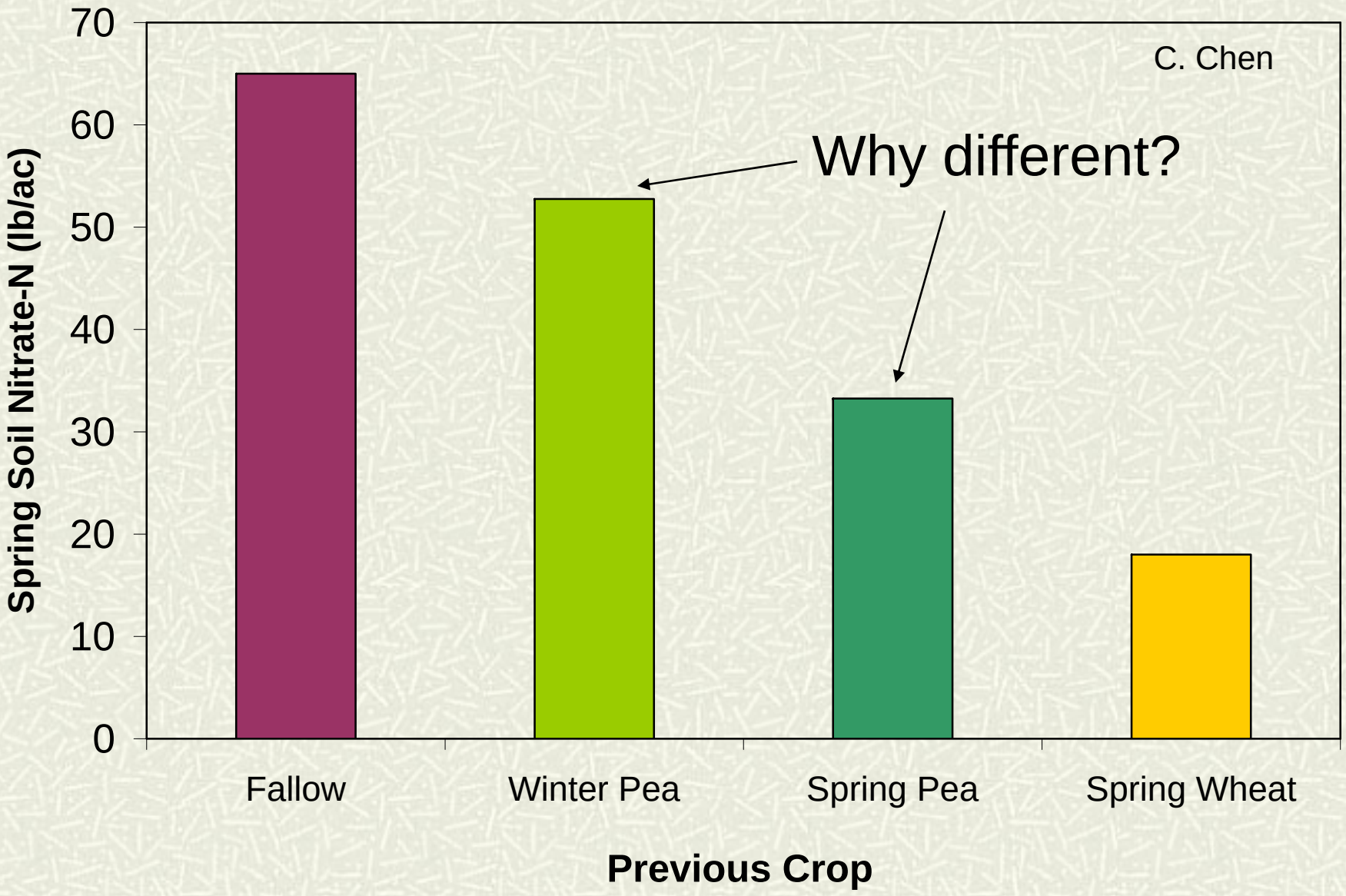
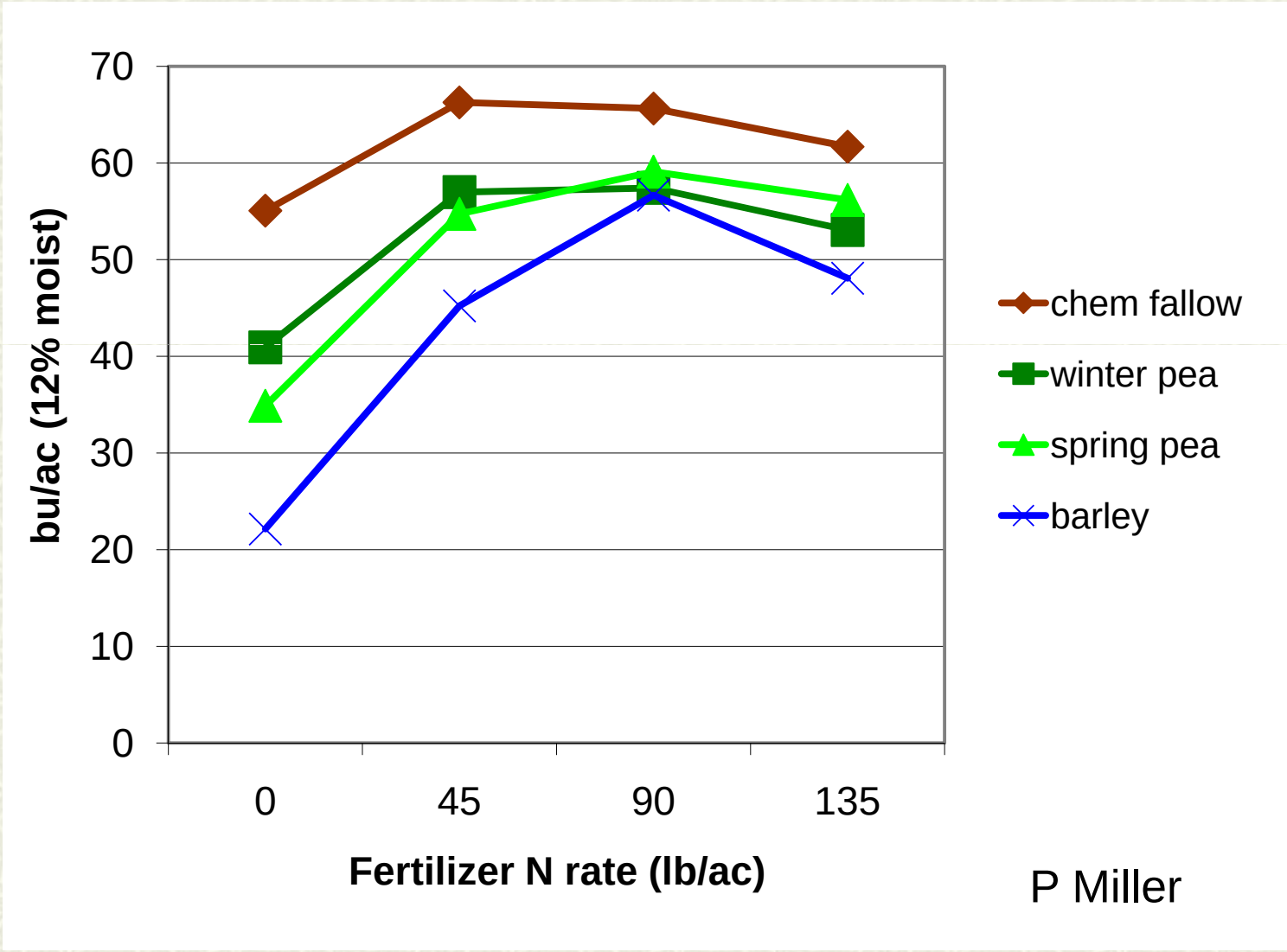


Effect of Previous Crop on Residual Nitrate-N

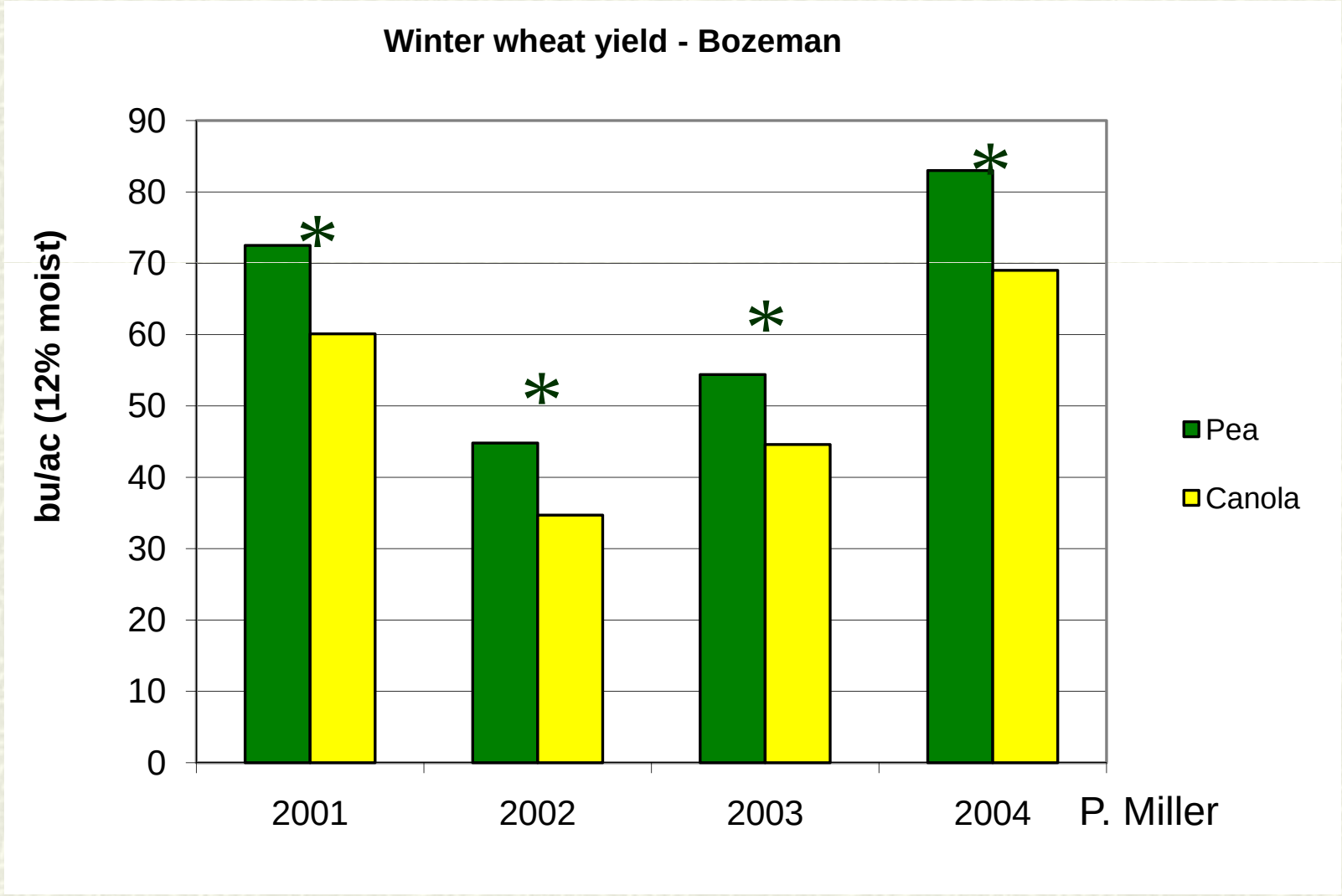


Effect of Previous Crop and N on Winter Wheat Yield

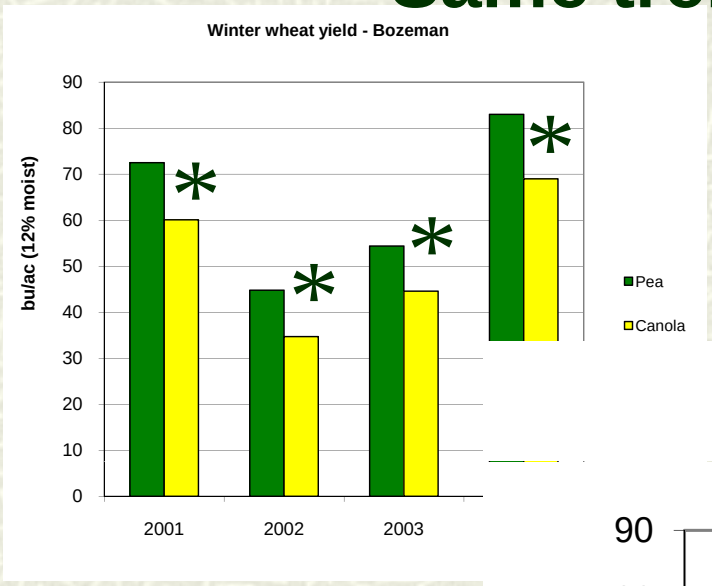


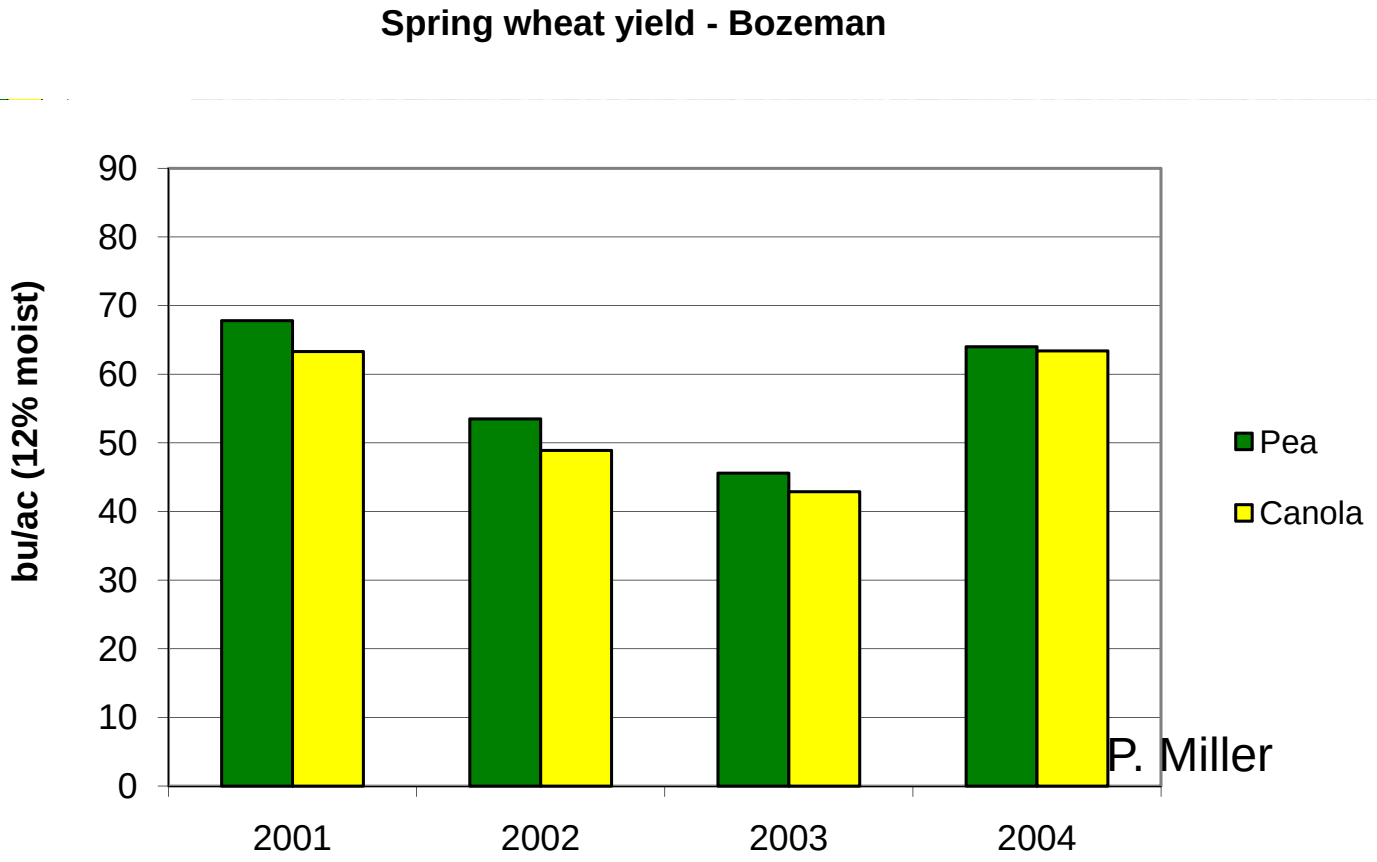
Wheat needs up to 45 lb/ac less N when grown on fallow or winter pea than on barley, but the same amount of N when grown on spring pea..

Effect of Previous Crop on WW Yield
Bozeman Rotation Study



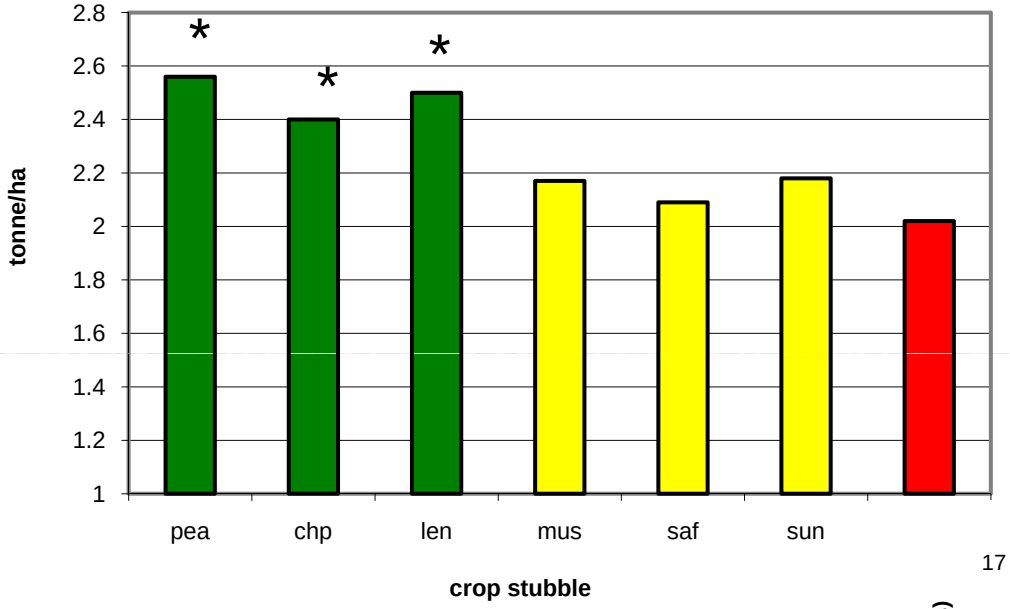
Same trend with spring wheat?



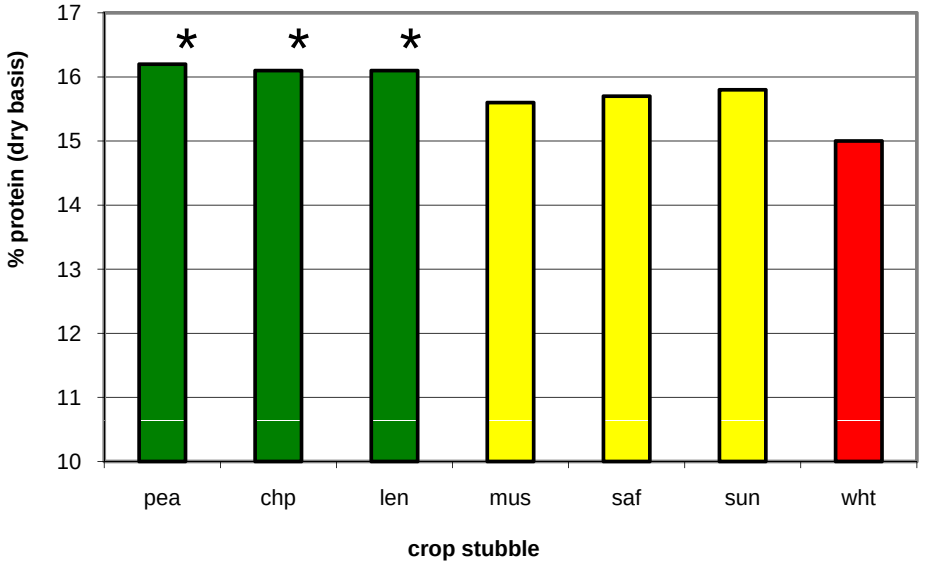


P. Miller

What about wheat yield following other annual legumes?



Spring Wheat
Saskatchewan



P Miller

Take home messages on yield

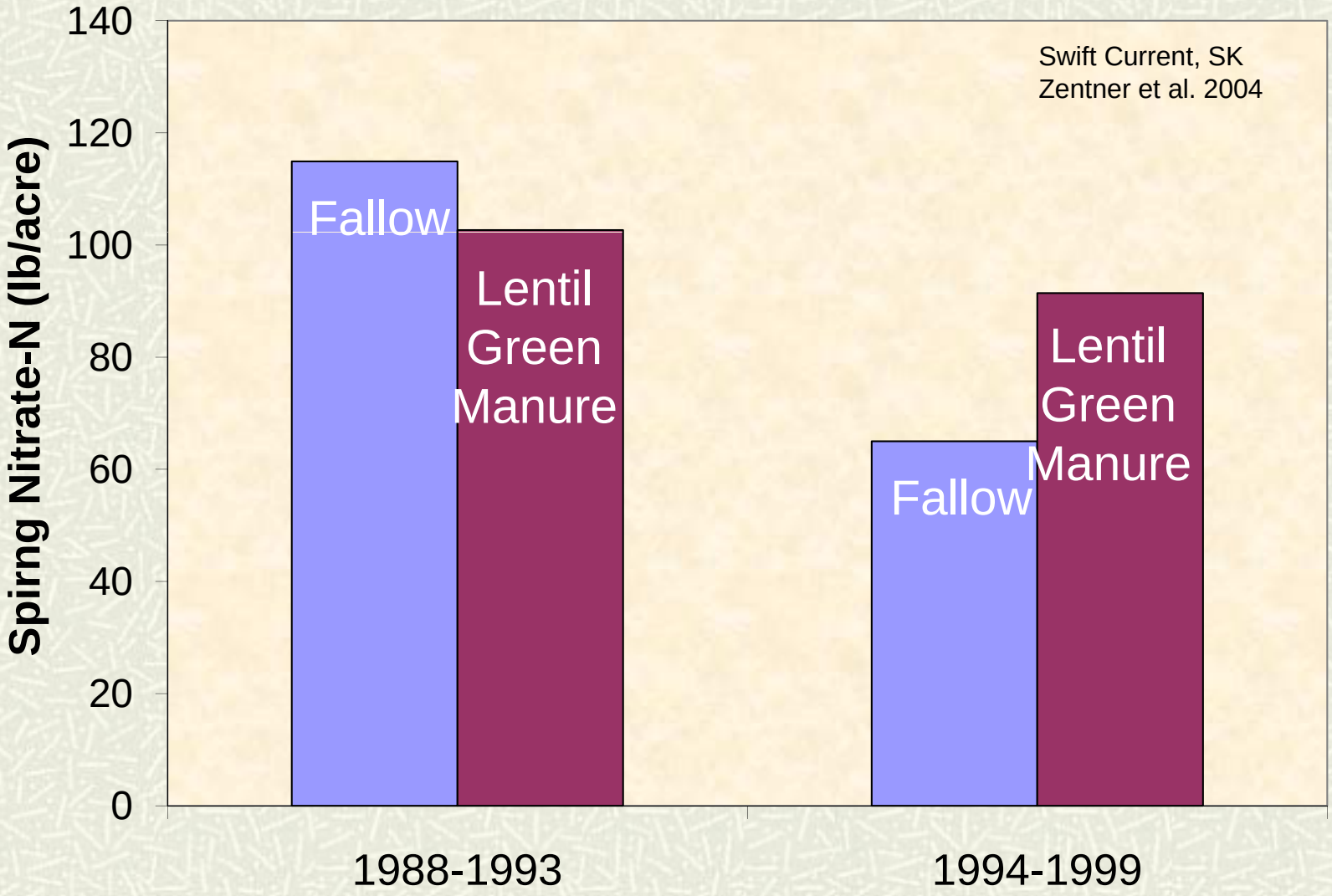
- Small grain yield after pea is generally greater than after small grains and oil seed crops.
- Small grain yield after pea can be competitive with after fallow.
- Caution needed in dry areas and dry years.

QUESTIONS SO FAR?

Nitrogen Benefits

- Peas and lentils CAN ‘fix’ about 2-4 lb N/bu. Ex: 50-100 lb N/acre for 25 bu crop.
- Over 1/2 of this is removed at harvest.
- Credit TO NEXT CROP is between 0 and 20 lb N/acre. Where did rest go?
- If replacing a small grain or oilseed with a legume, bigger N savings will be in legume year.
- If replacing fallow with legume, bigger N savings will be in long-term.

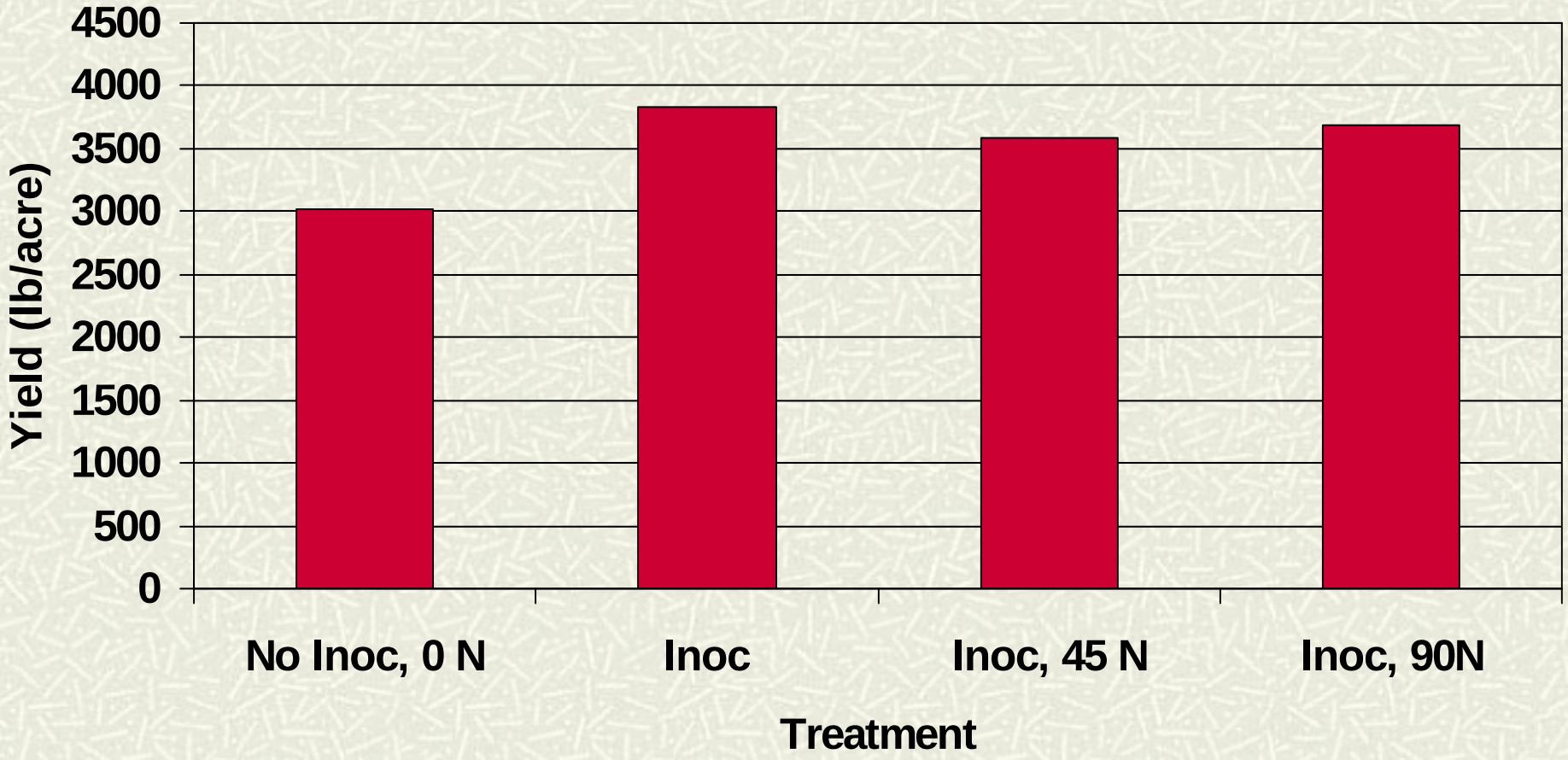
Effect of Lentil on Spring Soil Nitrate-N Levels



How do I maximize N benefit?

- Seed legume into soil with low available N
- Inoculate, especially if field never had legumes
- Provide sufficient phosphorus (P) and potassium (K)

Effect of Inoculation on Dry Pea Yield Carrington, ND



QUESTIONS SO FAR?

Phosphorus and Potassium Uptake

Nutrient	Peas, Lentils, Chickpeas	Wheat
Phosphorus (lb/bu)	0.67	0.62
Potassium (lb/bu)	0.87	0.38

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!

Effect of P Fertilizer on Amount of N Fixed: Soybeans

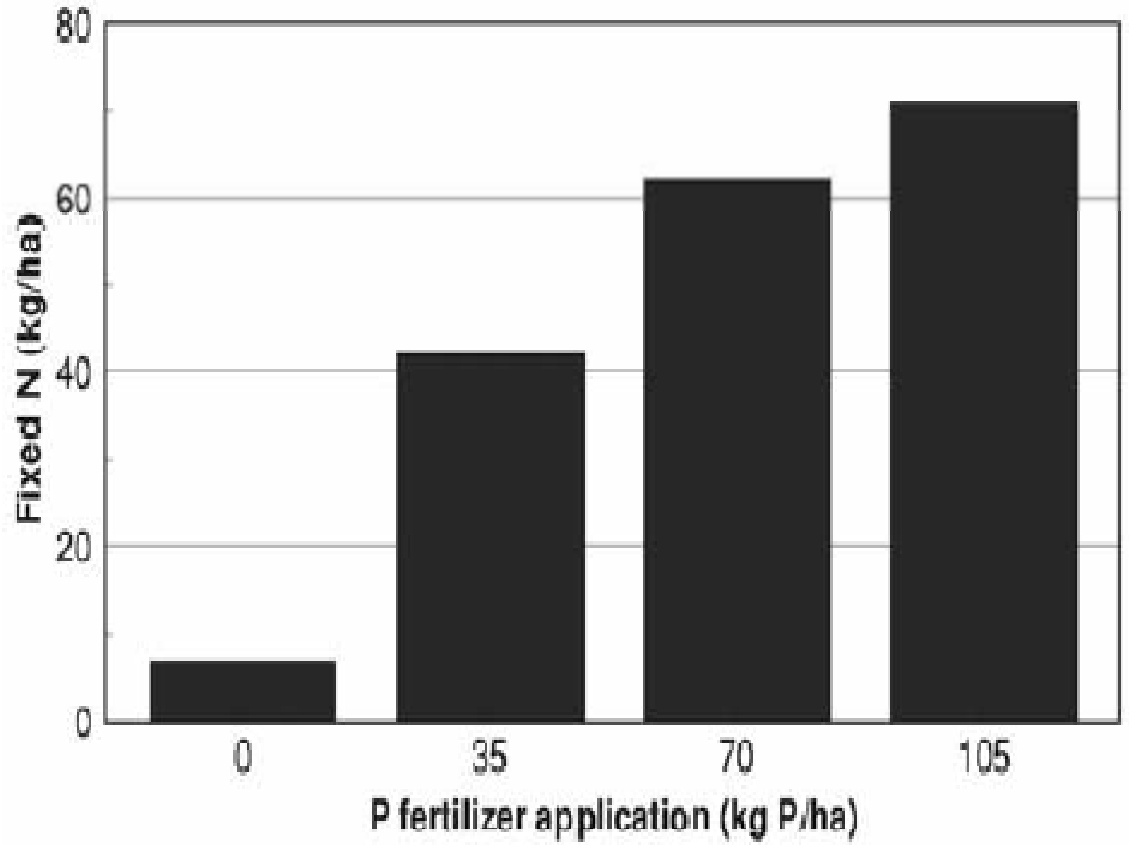
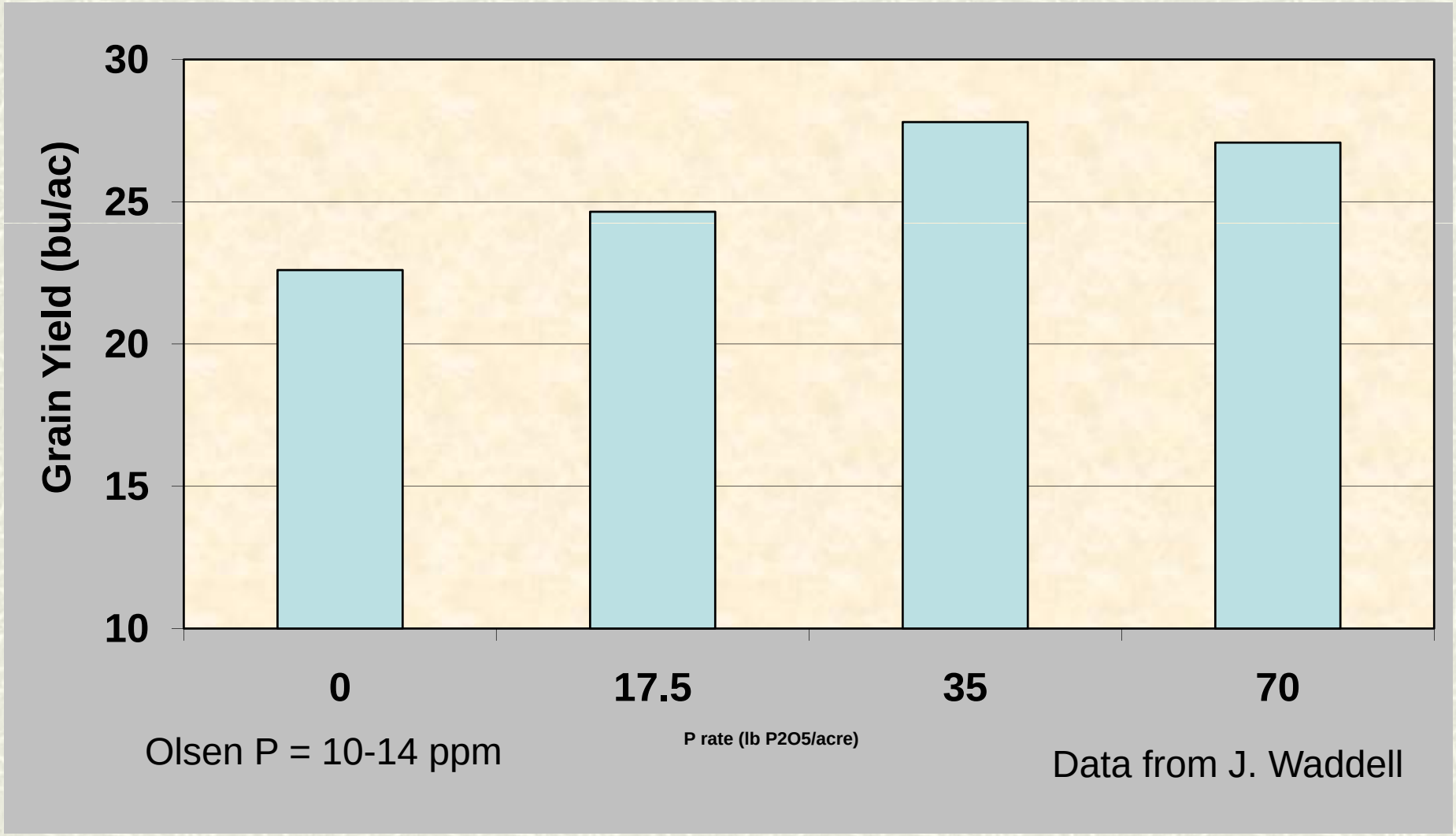


Figure 5. Phosphorus application may enhance N_2 fixation in soybean growing in low P soils. Biological N_2 fixation can only be effective if all necessary nutrients are available in the soil. If phosphorus is limiting, N_2 fixation can be enhanced by P fertiliser application, as illustrated in the above example (data of J. Dombovari presented by Zapata and Baert, 1989)

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

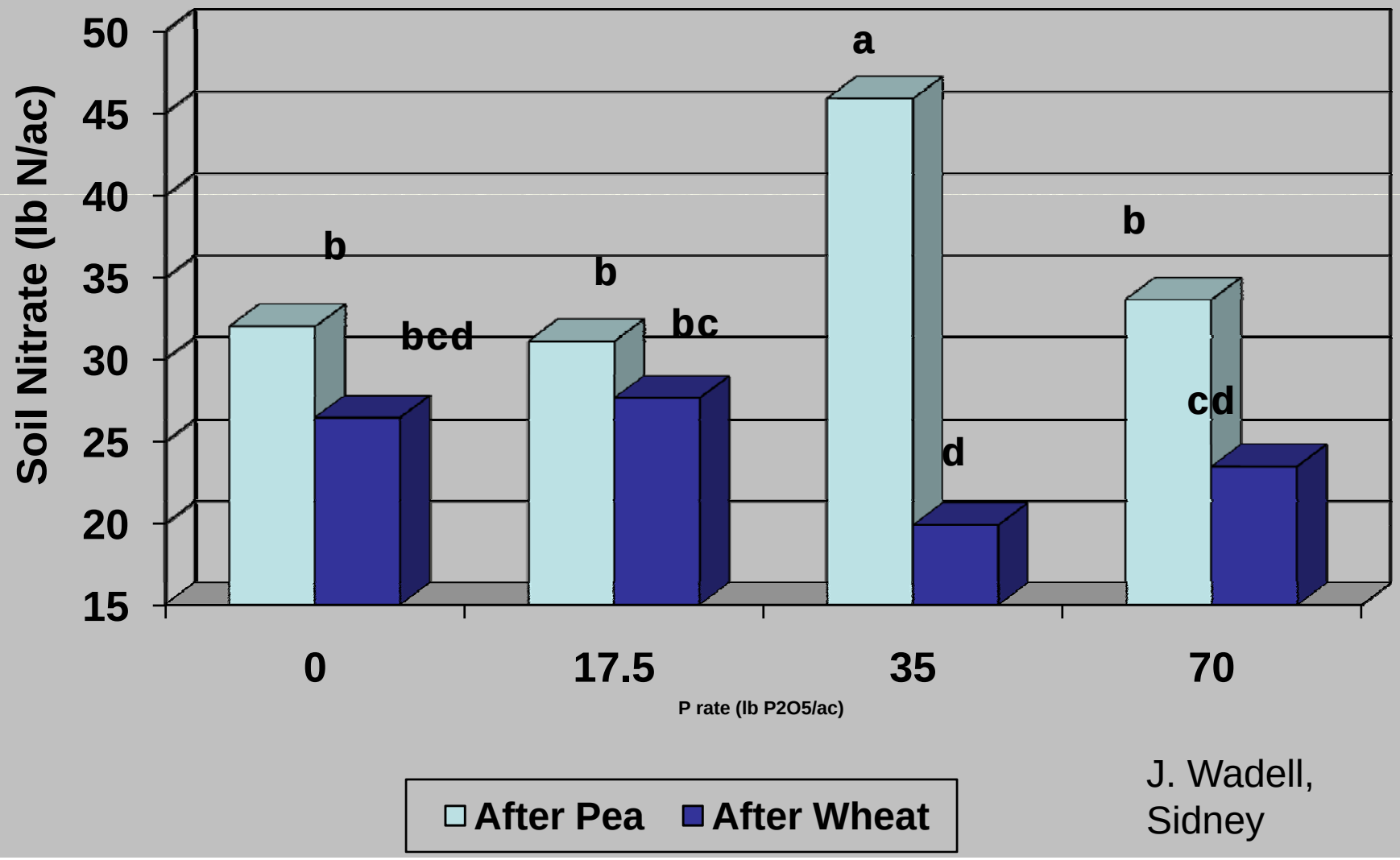


Olsen P = 10-14 ppm

Data from J. Waddell

Effects of P and Previous Crop on Soil Nitrate (to 3 ft.)

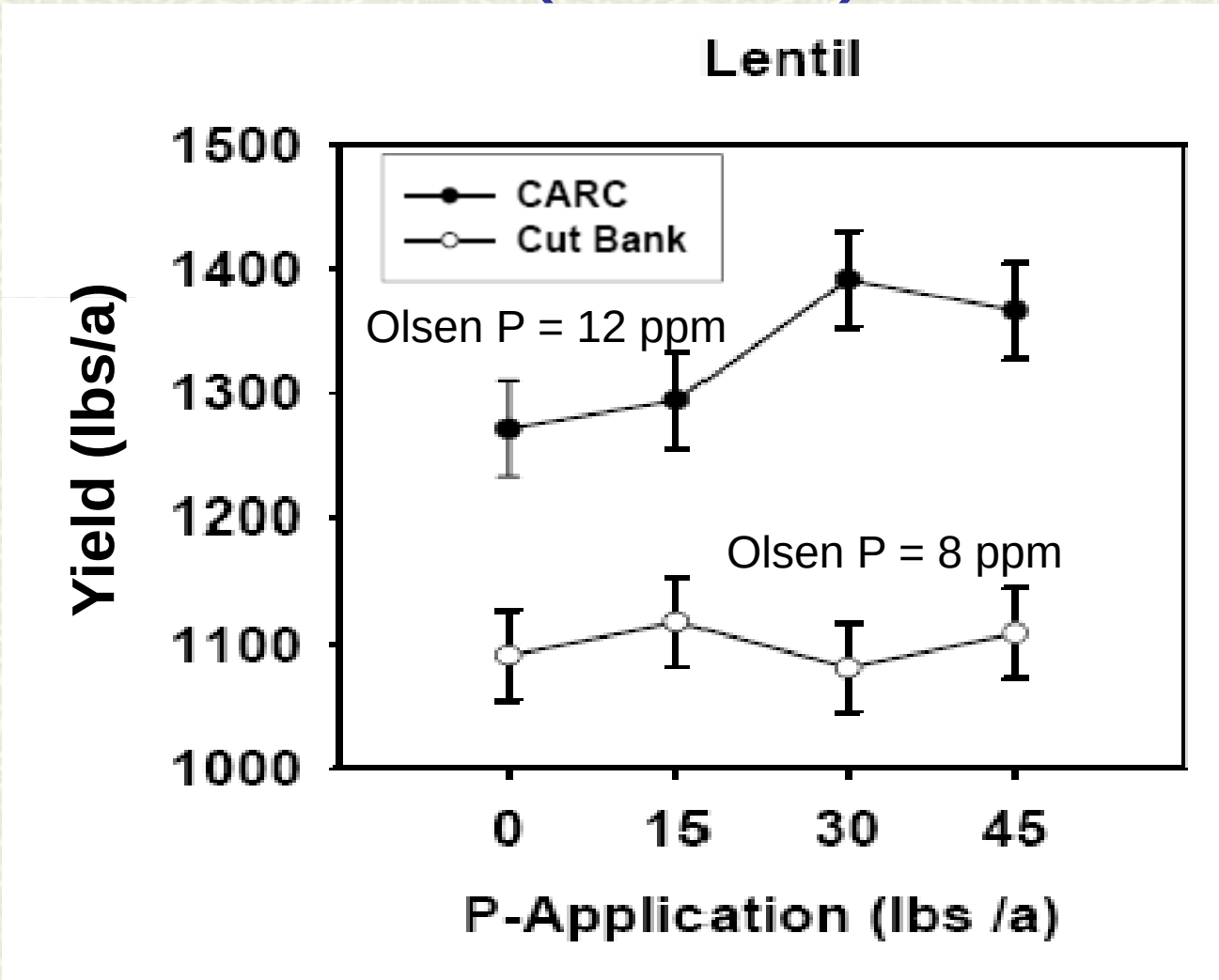
Spring 2005



J. Wadell, Sidney

Effect of Pea on Spring Lentil Yield

Moccasin (CARC) and Cutbank



Data from C. Chen and G. Jackson

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

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

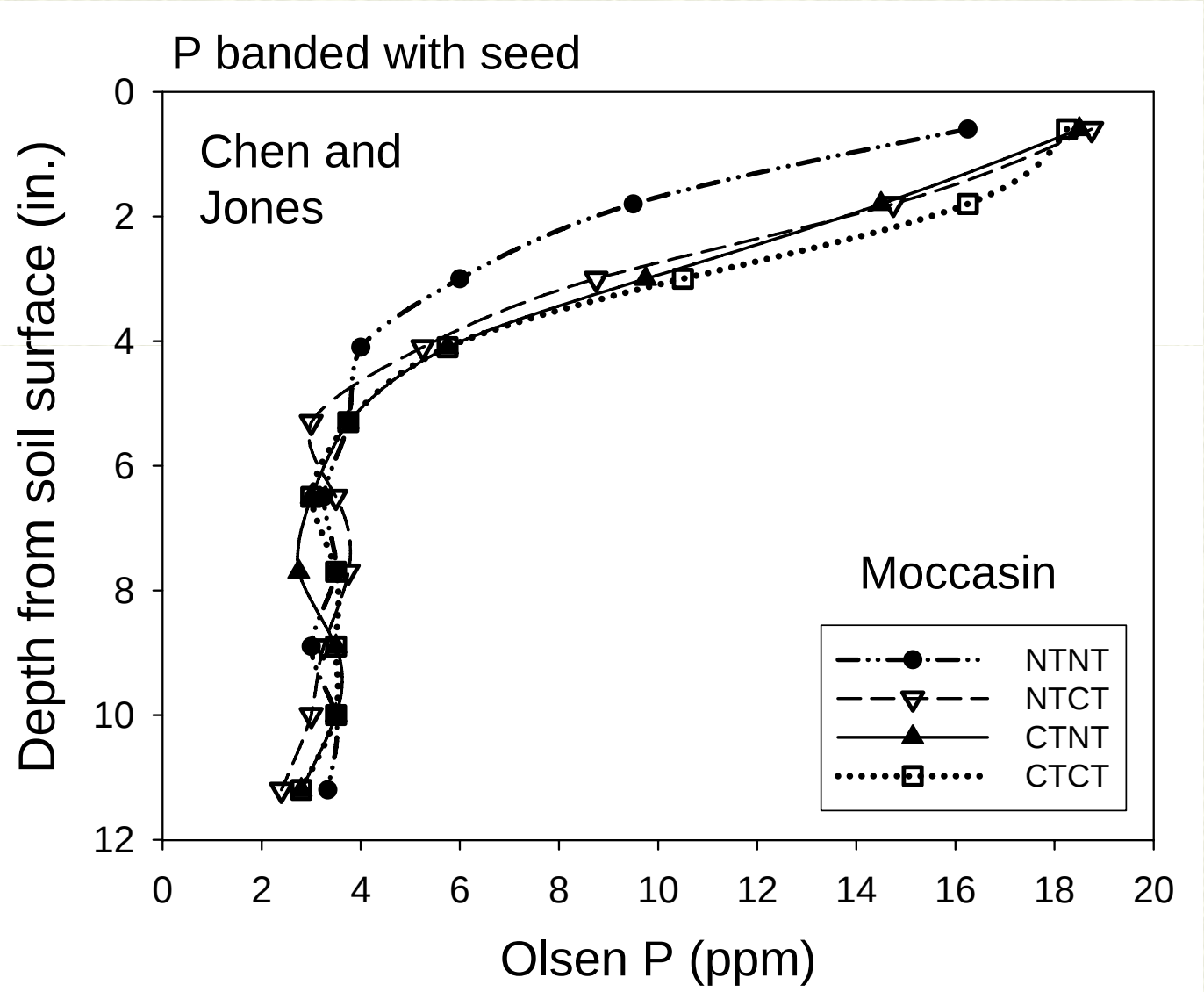
Why are P needs of annual legumes somewhat less than for small grains and oilseeds?

- 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

Why does rooting depth matter?

P accumulates near surface



Why important?

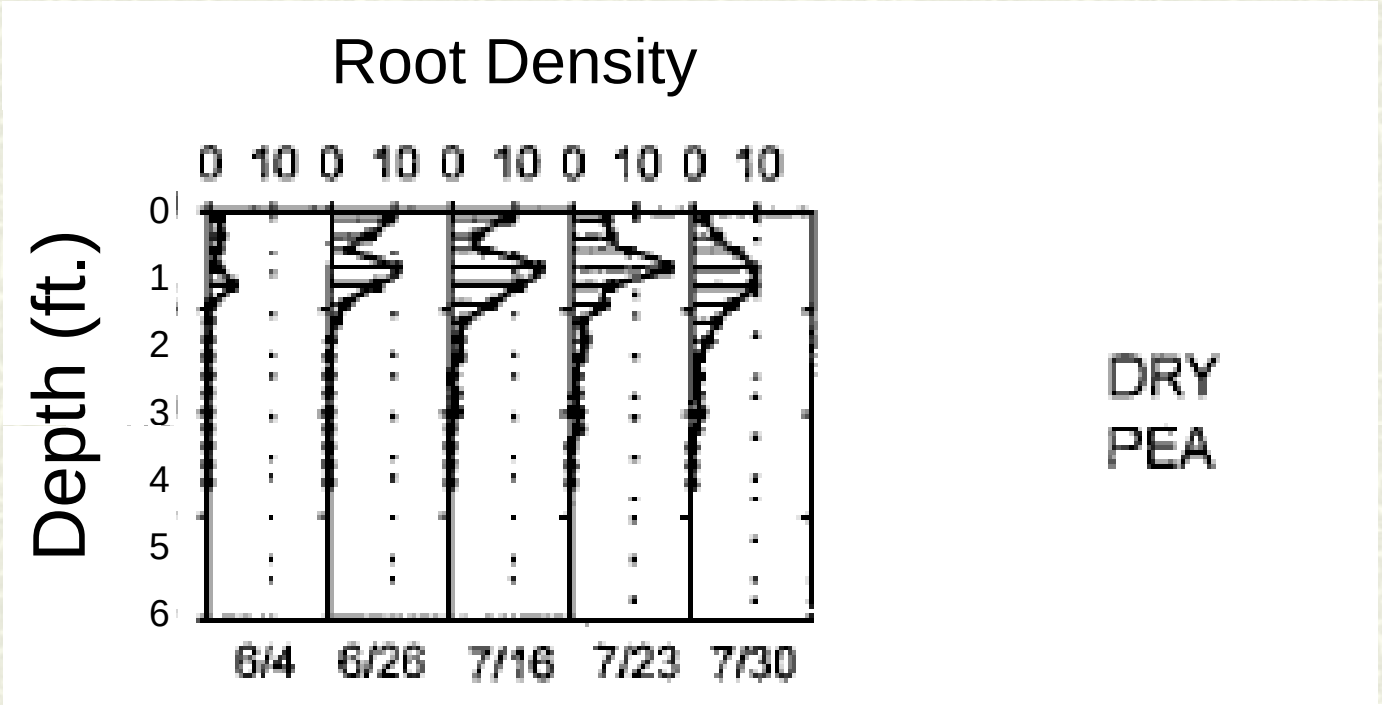
Shallow rooted crops can better utilize P from near surface

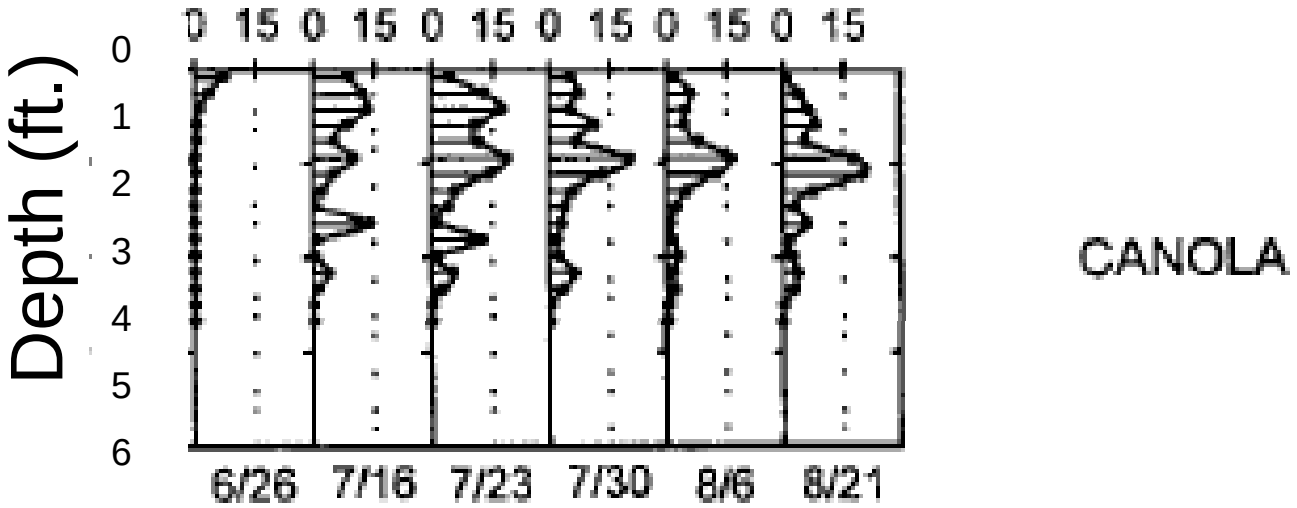
Maximum Rooting Depths (Mandan, North Dakota)

Crop	Maximum rooting depth (ft.)
Dry Pea	3.0
Canola	3.5
Spring Wheat	4.0
Sunflower	4.5

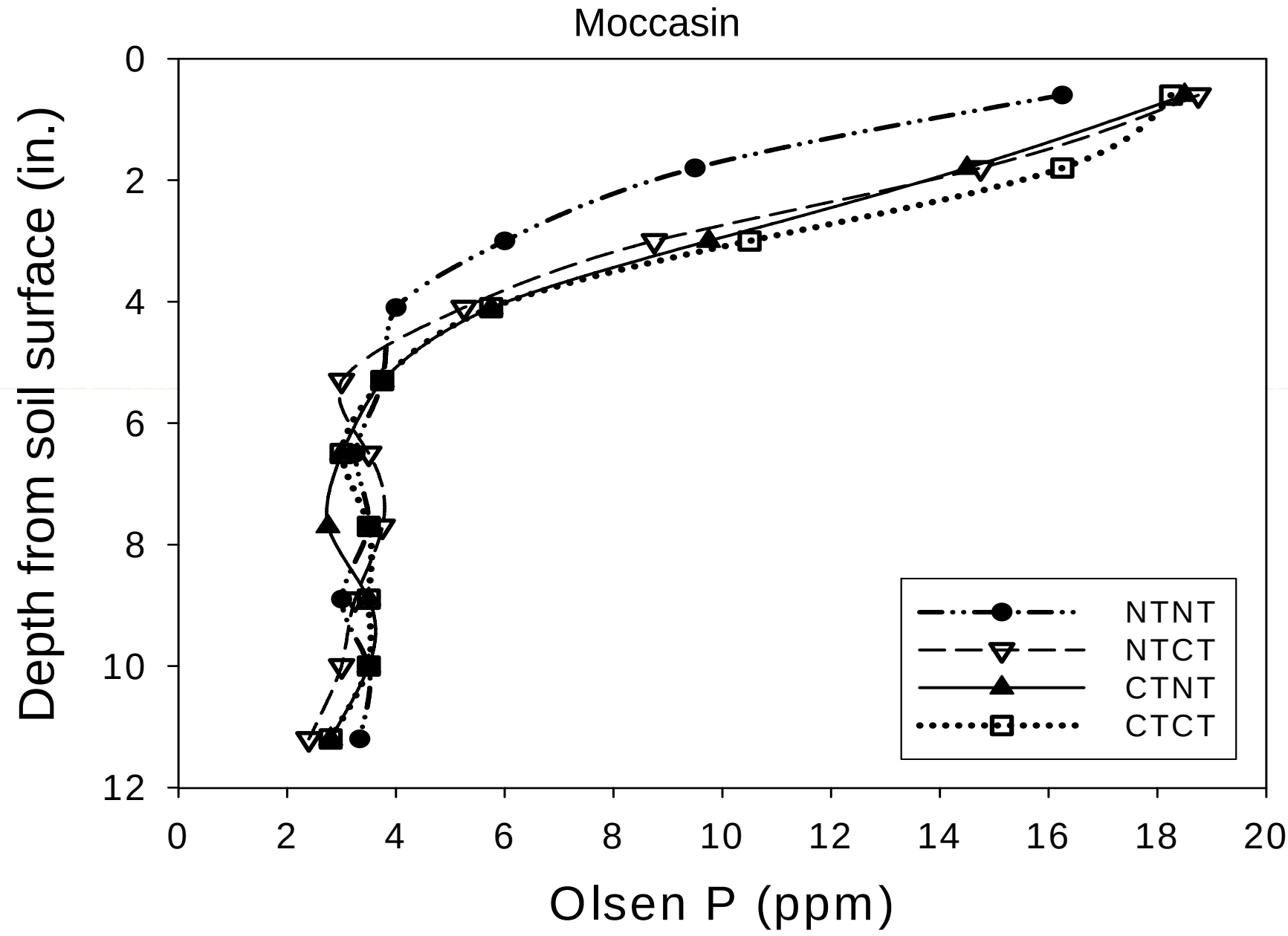
Merrill et al. 2002

What is More Important than Max. Root Length for Nutrient Uptake?

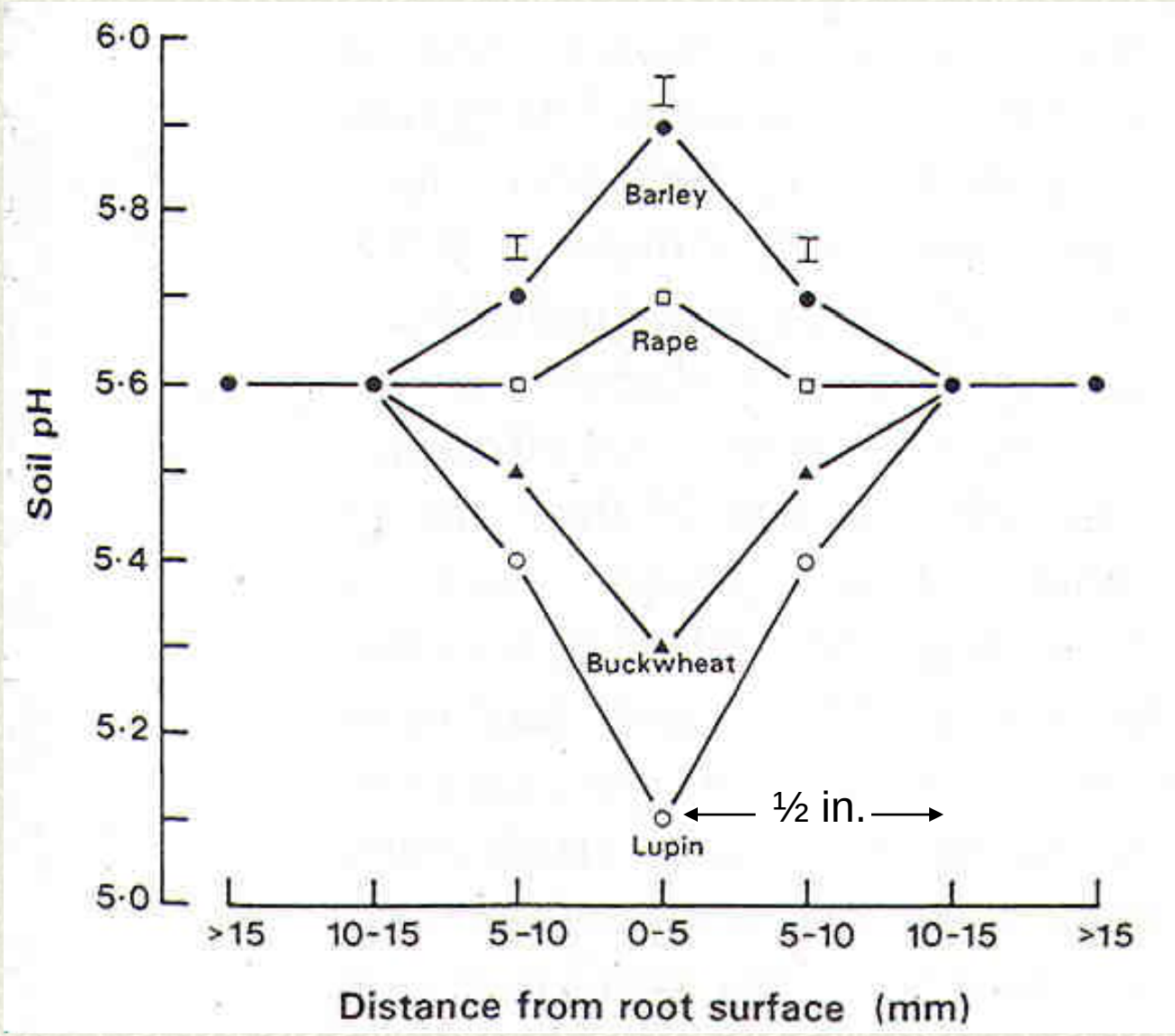




Dry pea will use more nutrients from surface; canola will use more from depth


Moccasin
Depth from soil surface (in.)
0
2
4
6
8
10
12
0
2
4
6
8
10
12
14
16
18
20
Olsen P (ppm)
NTNT
NTCT
CTNT
CTCT

Legumes can also acidify root zone



Take home messages on P

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

QUESTIONS SO FAR?

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 per bushel of grain

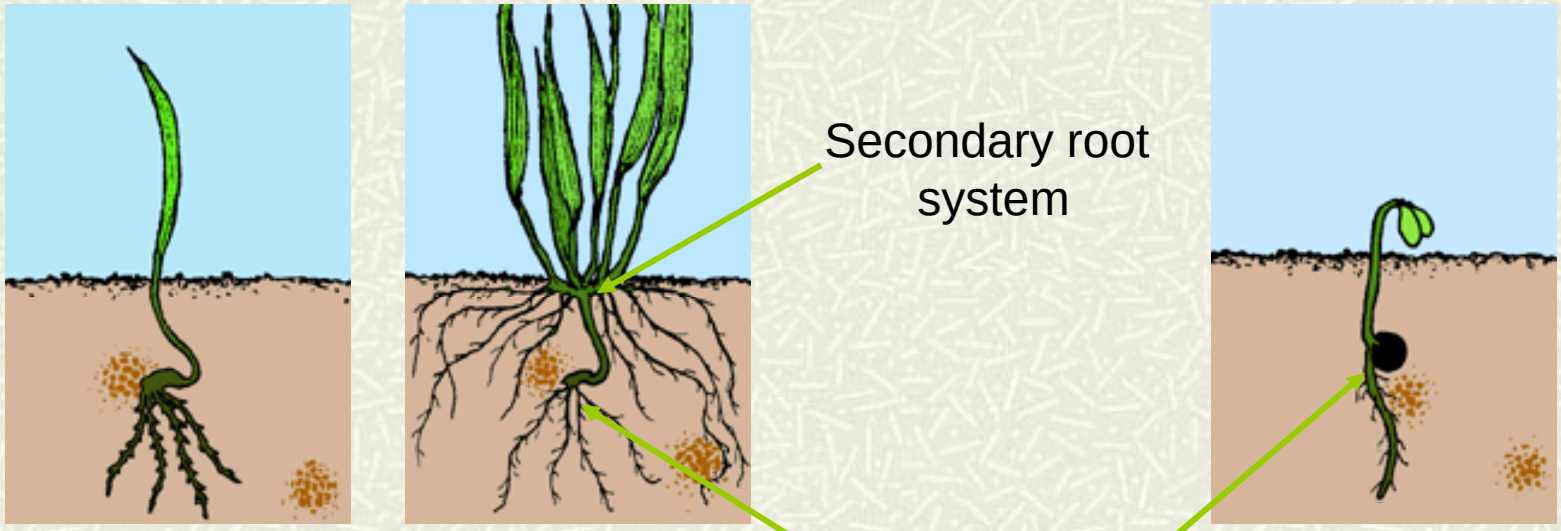
Fertilizer placement for legumes

- No nitrogen or potassium fertilizer with the seed
- Small amounts of phosphorus (<10 lb P_2O_5/ac) with the seed
- Ideal placement is below the seed

Rooting patterns and starter and deep band fertilizer placements

Wheat

Legumes



Conclusions

- Small grain yields are generally higher following legumes than following small grains or oilseeds.
- Small grain yields can be similar following legumes than following fallow, esp. in moist year.
- N benefits from legumes will be higher when soil N is low, seed is inoculated, and P and K 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.
- Potassium needs are high for legumes, partly b/c needed for N fixation, but little research has been conducted on pea or lentil responses.

For more information

- Soil Fertility Website: http://landresources.montana.edu/soilfertility
- Cropping Systems Website: http://scarab.msu.montana.edu/CropSystems