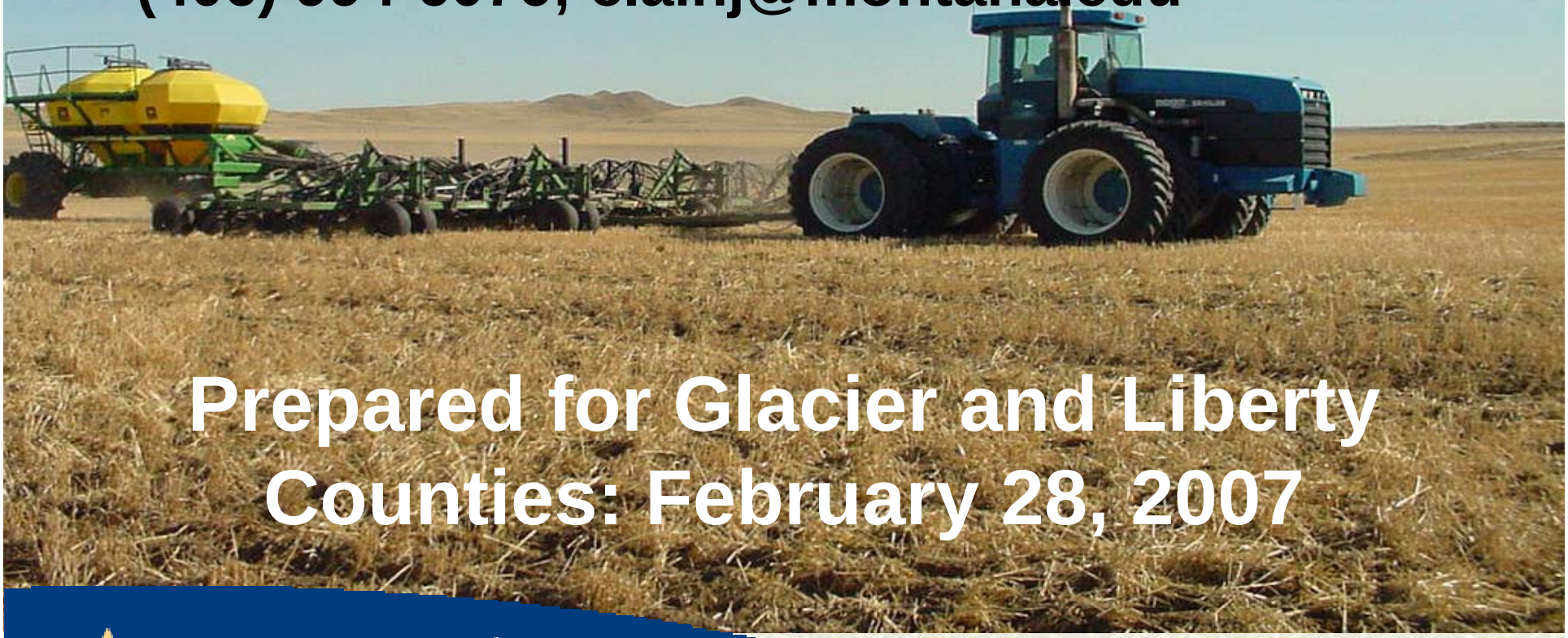
Nitrogen Mineralization and Uptake, and Effects of Cropping Systems on Nitrogen and Phosphorus Availability

Clain Jones, Soil Fertility Extension Specialist
(406) 994-6076; clainj@montana.edu



Prepared for Glacier and Liberty Counties: February 28, 2007

MONTANA STATE UNIVERSITY | EXTENSION

Questions for you

- What crops do you grow?
- What crops have you considered growing?
- Are your nitrate-N levels on fallow any different this year than last few?

Factors increasing ‘Nitrogen mineralization’ (Conversion of organic N to plant available N)

- Warm Temperature
- High Moisture

How did last late spring/summer compare to ‘normal’?

- Legumes as previous crop (vs small grain stubble)
- High Organic Matter
- Tillage - Why?

Take home message: soil N will vary year to year making soil testing essential for determining N needs

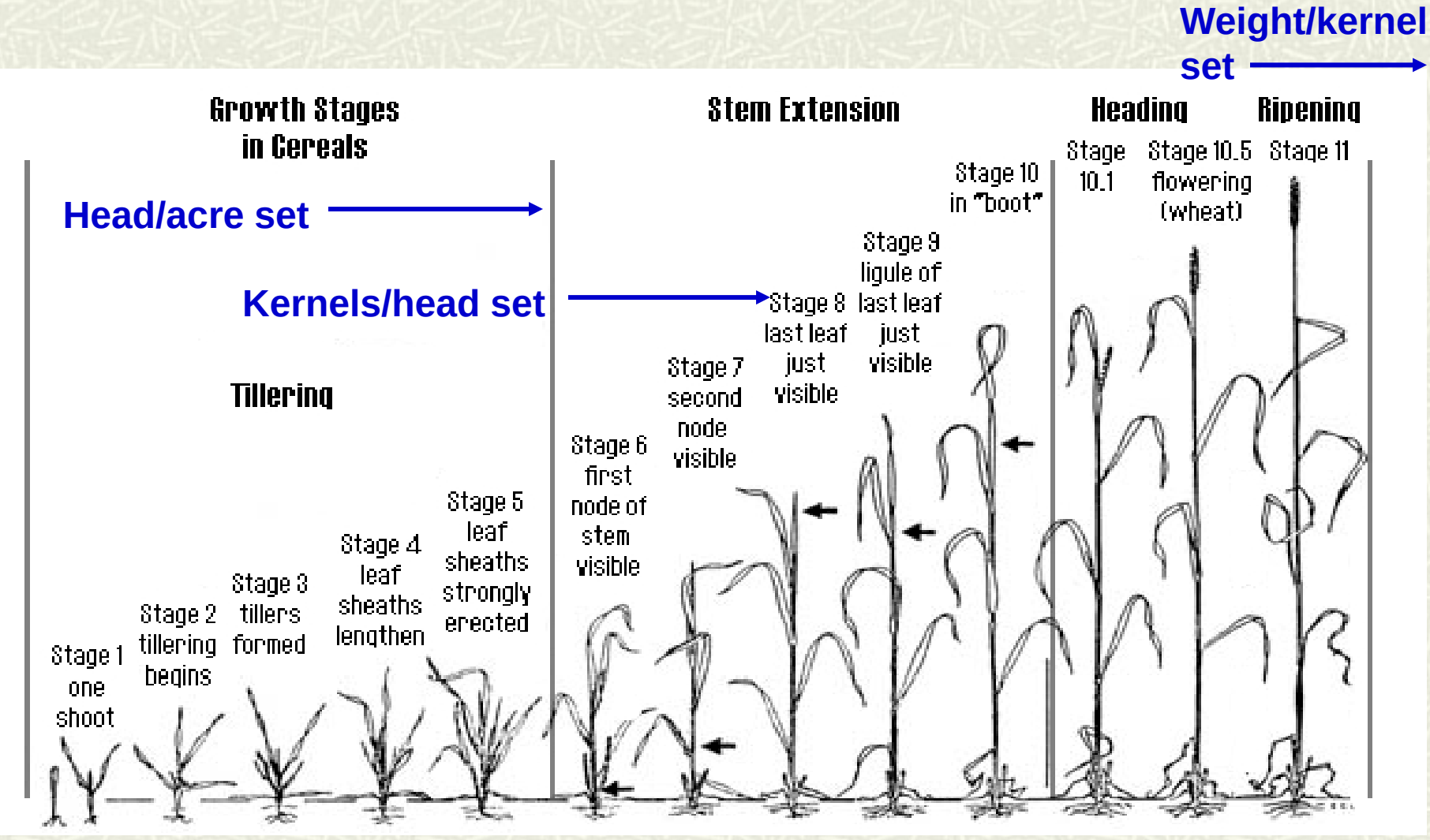
Timing of N Uptake

- Relevance: Affects Yield and Protein

What makes yield?

Heads/area x Kernels/heads x Weight/kernel

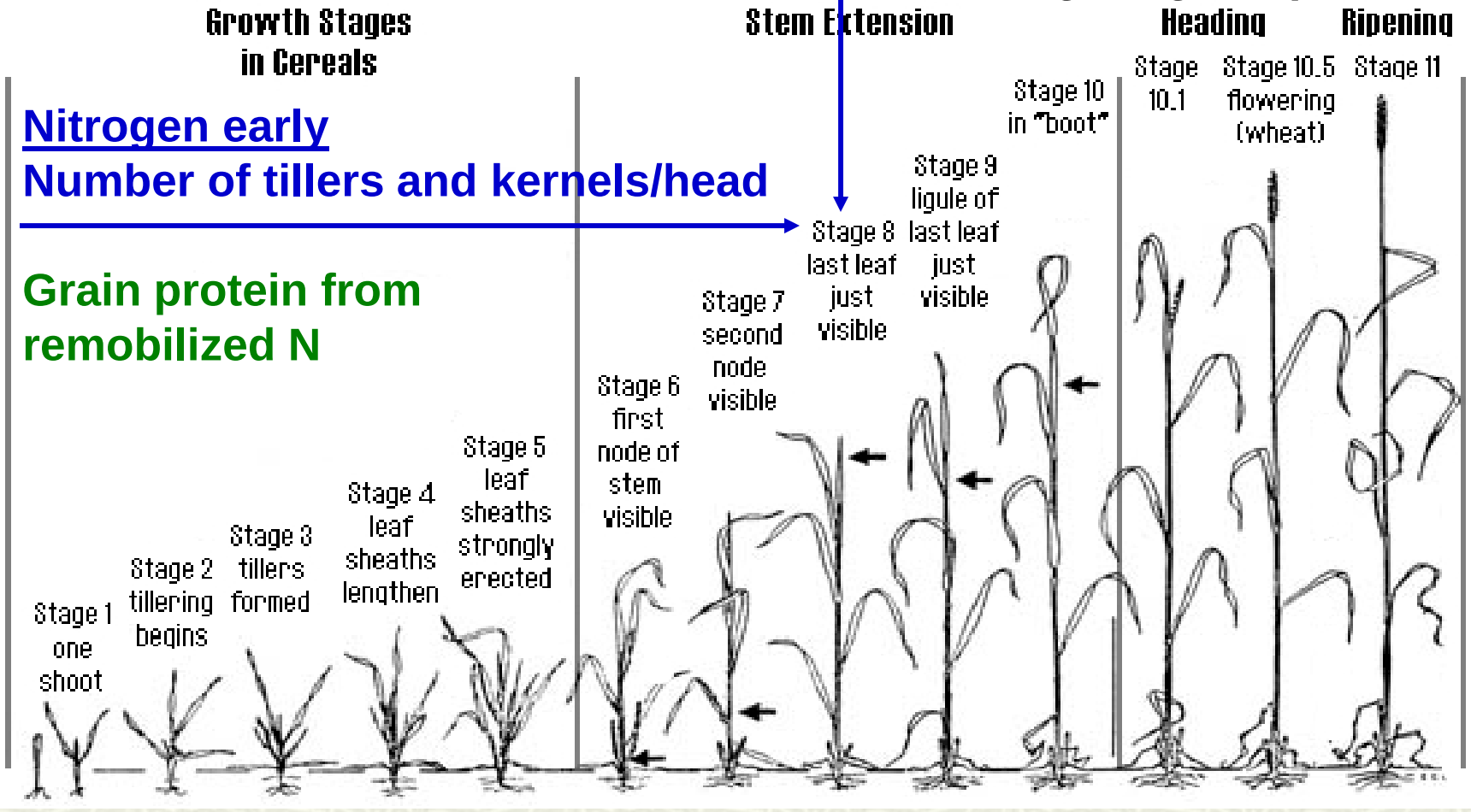
When are yield components “set”?



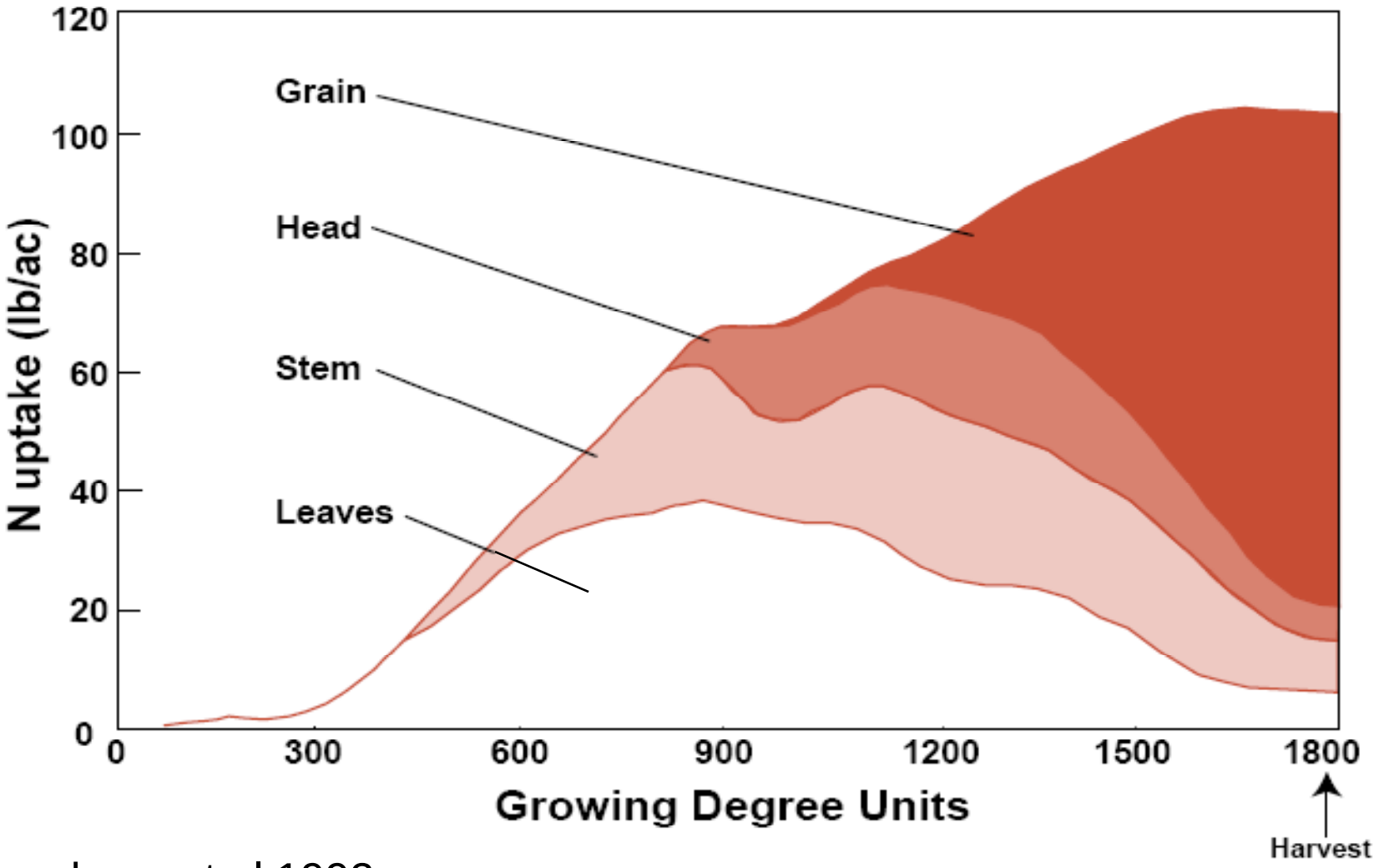
Impacts of nitrogen

Nitrogen late
Weight/kernel

Higher grain protein



Spring Wheat N Uptake



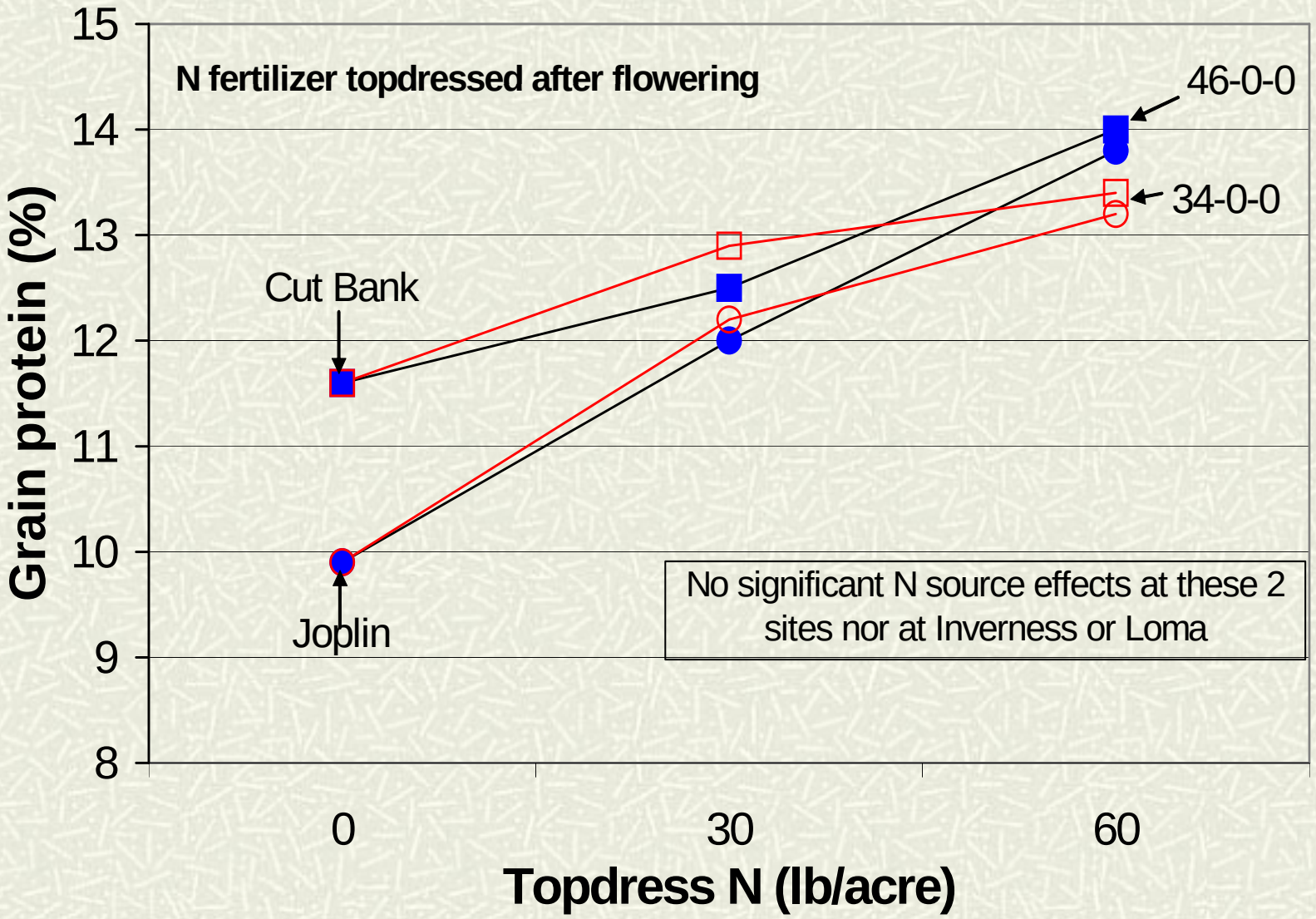
Jacobsen et al.1992

Effect of Slow Release N Fertilizer

- CAN increase establishment if N seed-placed (due to less seed germination problems, esp. in dry sandier soils)
- CAN increase protein
- CAN decrease yield (if soil N is low)
- CAN decrease N losses (volatilization, leaching), possibly increasing yield

Effect of N Rate and Source on Spring Wheat Protein

G. Jackson, 1993, WTARC Annual Report



QUESTIONS?

As diversity of cropping system increases:

Efficiency of fertilizer use increases. Why?

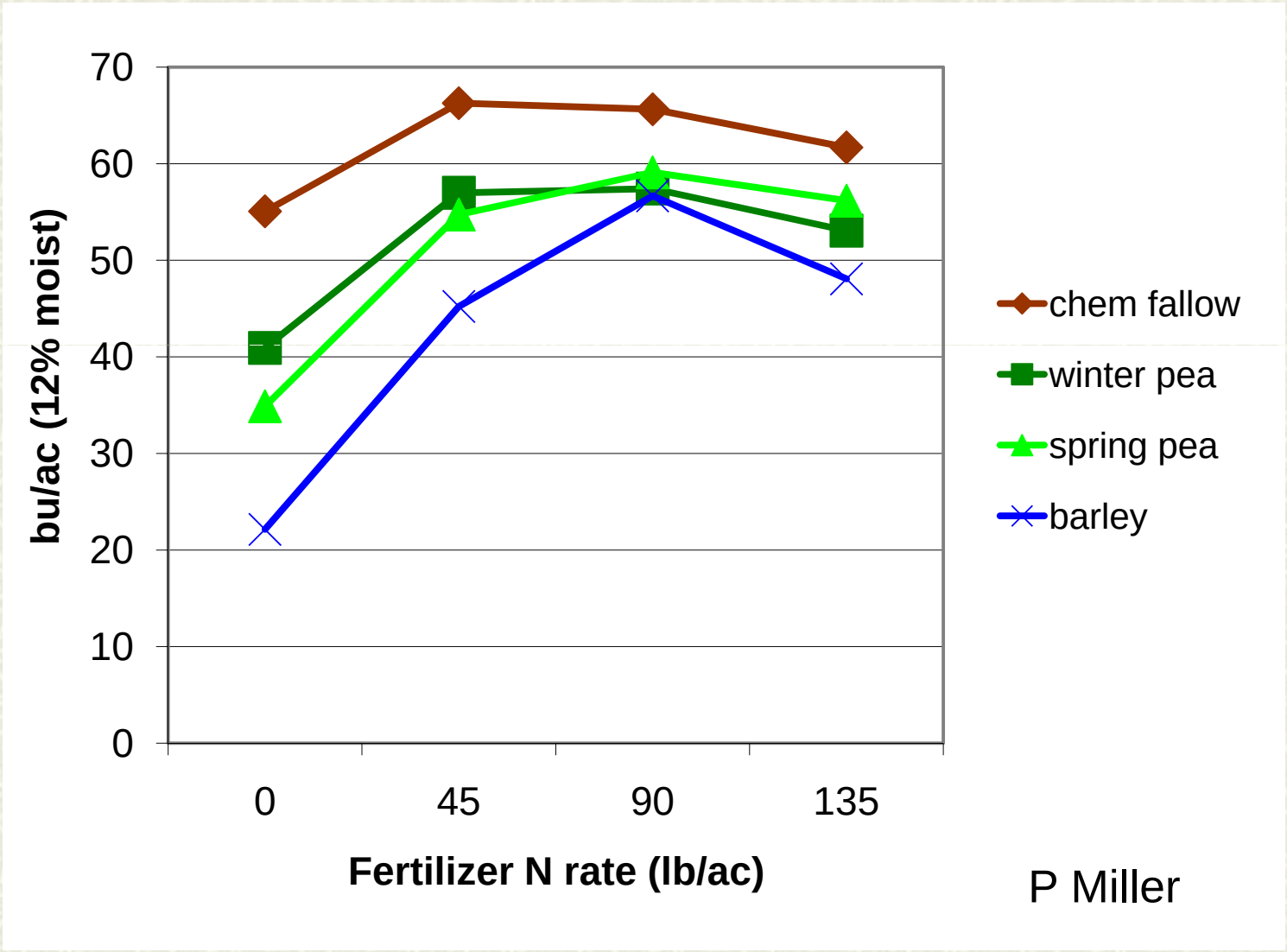
- Different rooting depths scavenge nitrogen and phosphorus at different depths
- Deep rooted crops can bring nutrients from subsurface to surface for use by shallow rooted crops (winter wheat → pea)

Some basics on effects of cropping systems on soil nitrogen (N)

Previous crop affects:

- Amount of N
  - Small grain and oilseed stubble ties up N
  - Legumes release N
- Vertical distribution of N
  - Depends on rooting depth and fallow frequency
- Timing of N release
  - Spring vs winter crop
  - Legumes decompose quickly. Affected by harvest timing
  - Small grain and oilseed stubble slowly

Effect of Previous Crop on N Needed to Optimize Wheat Yield

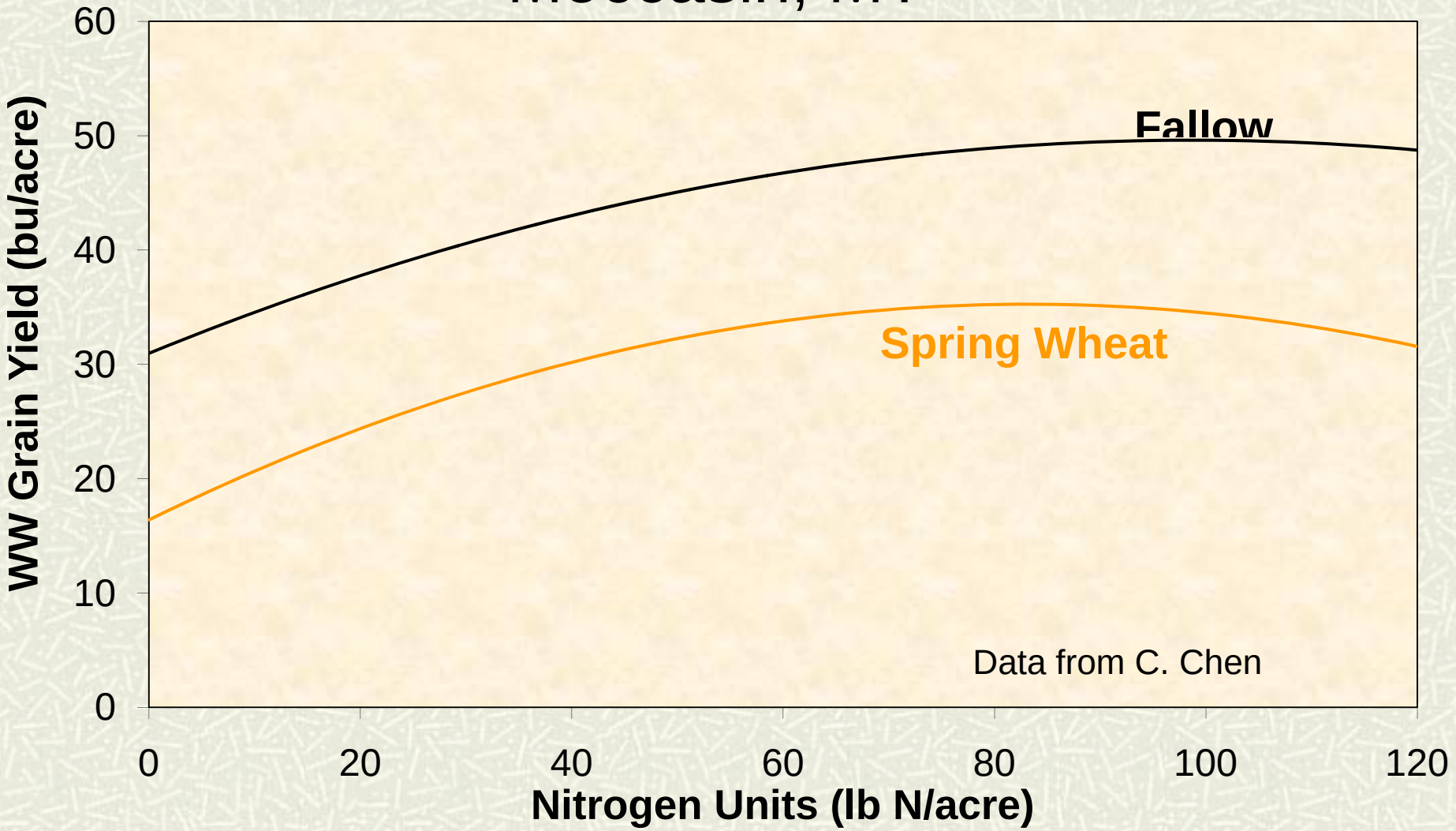


Wheat needs less N when grown on fallow or winter pea than on barley.

Moccasin Cropping System/Tillage Study

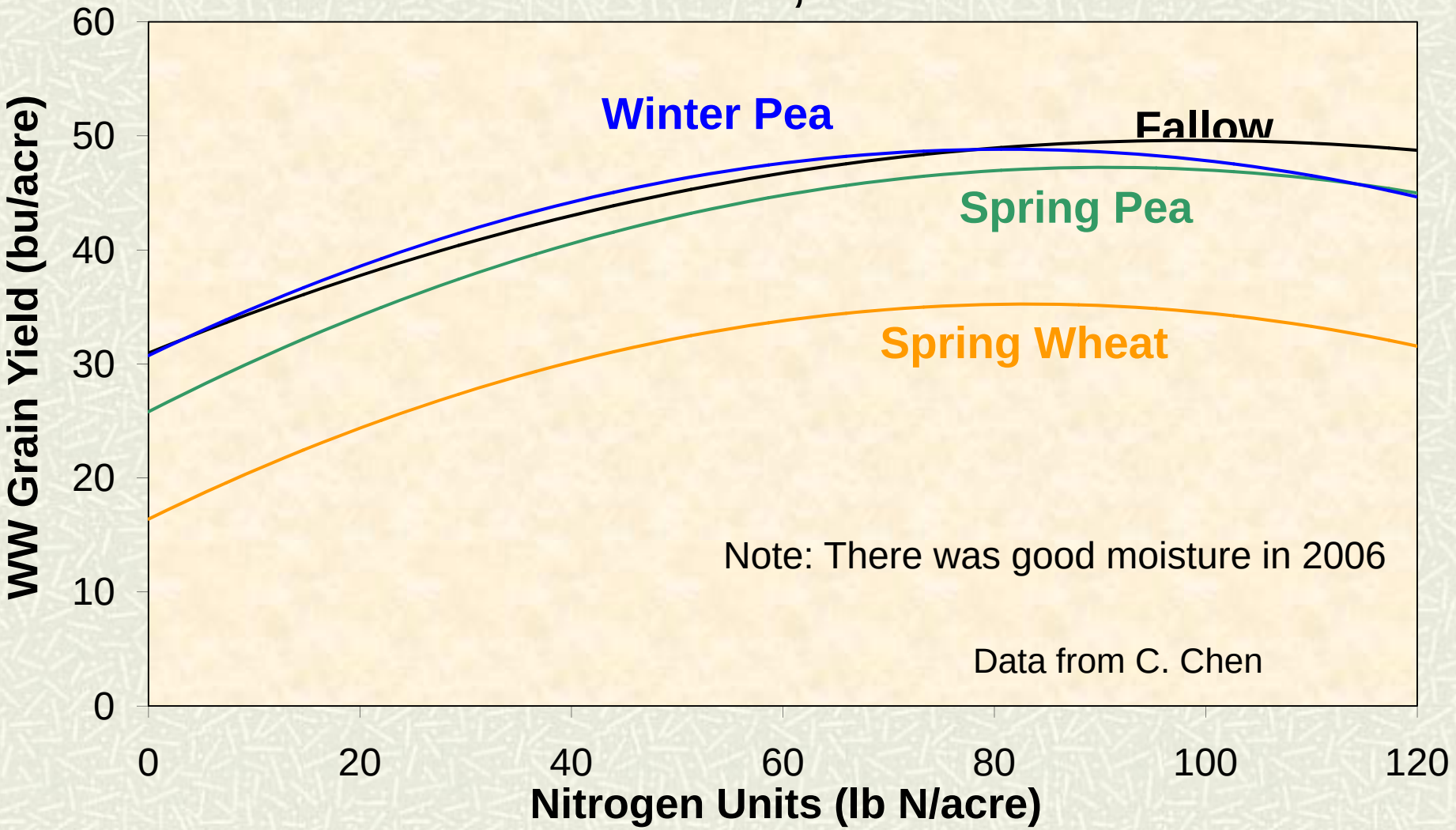
Effect of Previous Crop and N on 2006 Winter Wheat Grain Yield (NT)

Moccasin, MT

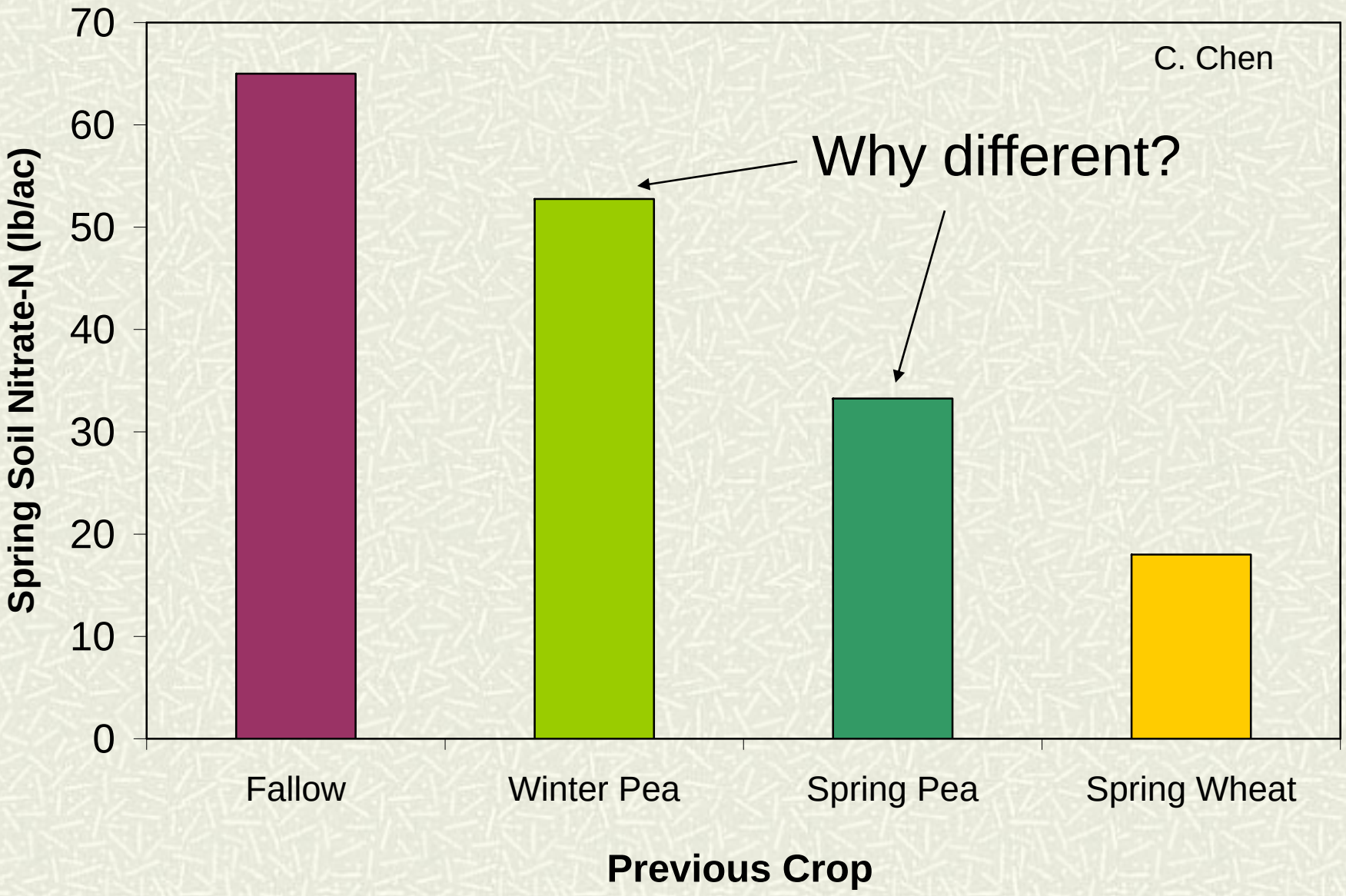


Effect of Previous Crop and N on 2006 Winter Wheat Grain Yield (NT)

Moccasin, MT



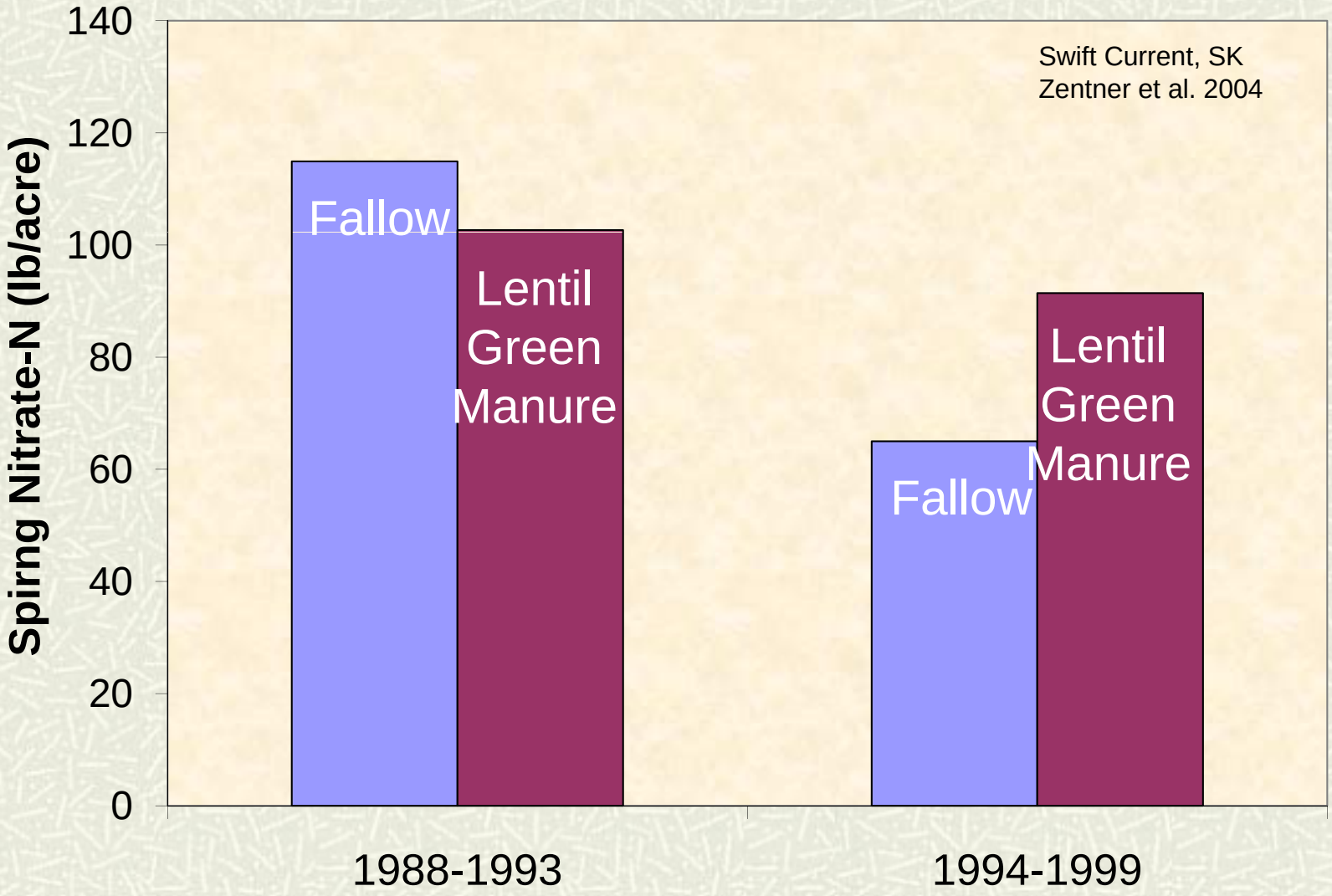
Effect of Previous Crop on Residual Nitrate-N



Nitrogen Benefits from Legumes

- 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.
- N credit for 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



QUESTIONS?

Some basics on effects of cropping systems on soil phosphorus (P)

- Previous crop affects:

  -Soil moisture. Dry soil decreases available P.

  Sunflowers, safflower, corn, wheat, barley can use substantial amounts of water

  Legumes use similar amounts of water at shallow depth, but very little at deeper depth

  -Available P can be increased by:

  Legumes, buckwheat, and some mustards through root zone acidification

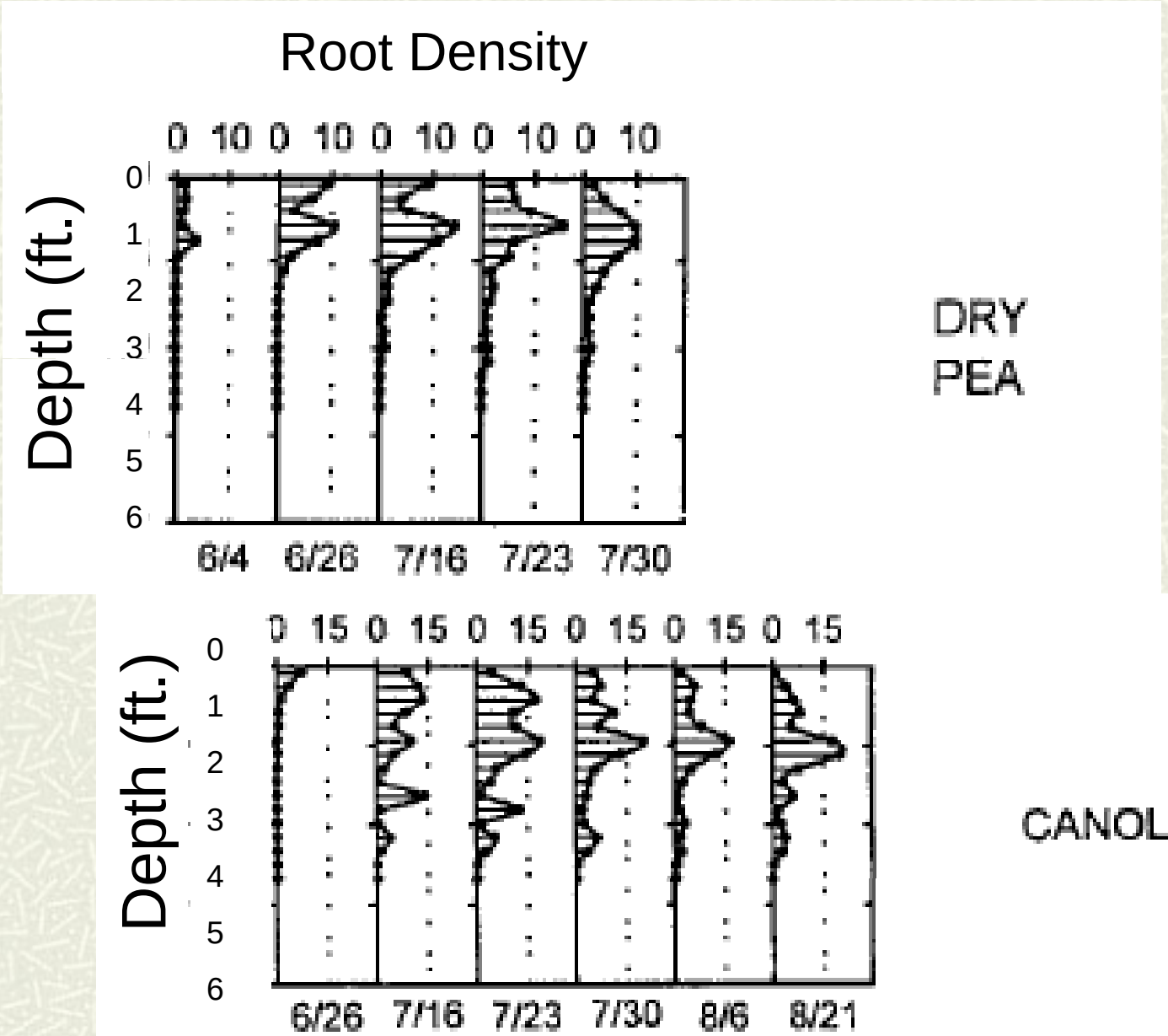
Maximum Rooting Depths (Mandan, North Dakota)

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

* 6 ft. in Montana (Miller, pers. comm.)

Merrill et al. 2002

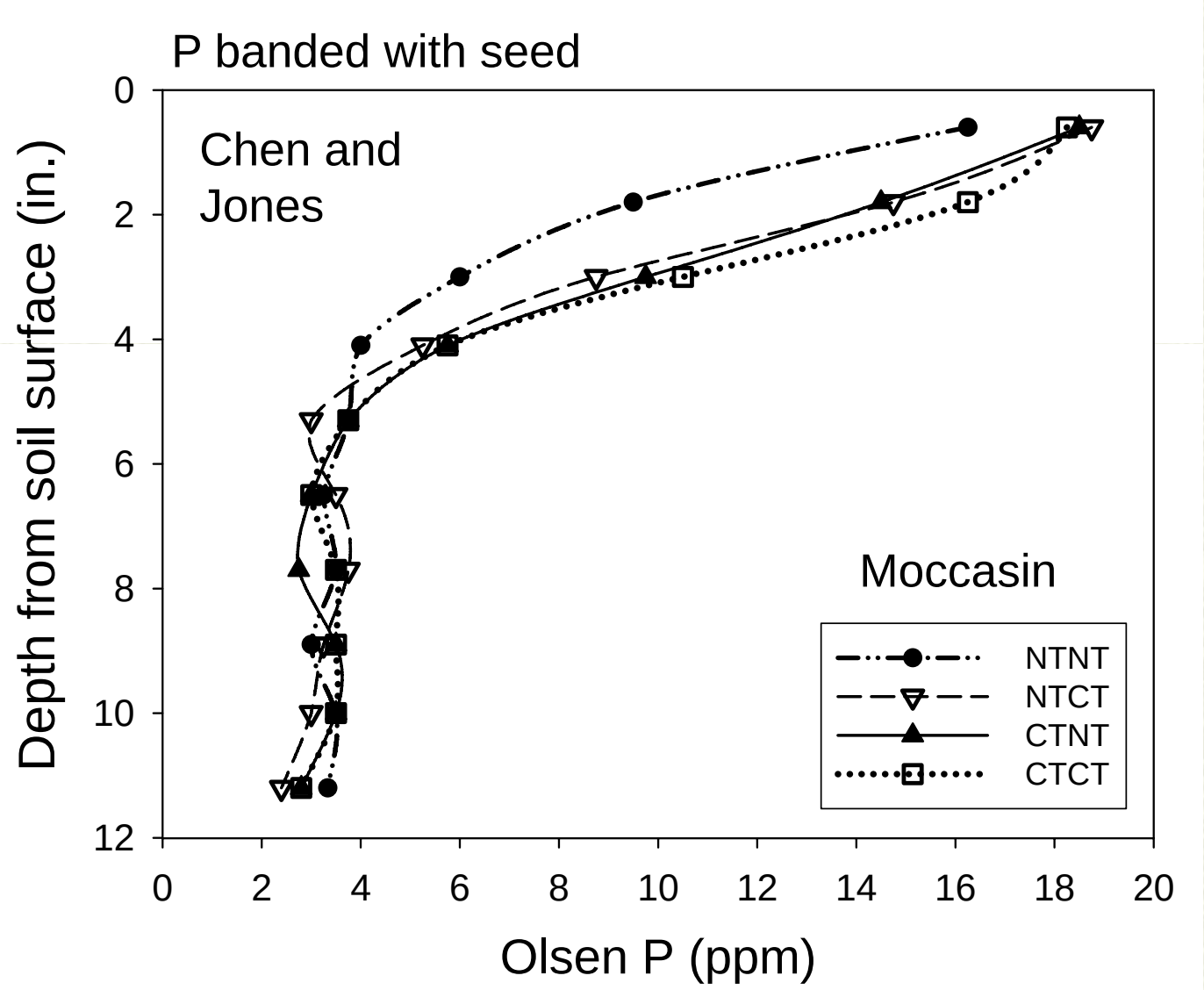
What is More Important than Max. Root Length for Nutrient Uptake?



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

Merrill et al. 2002

P can accumulate near surface in both no-till and tilled systems



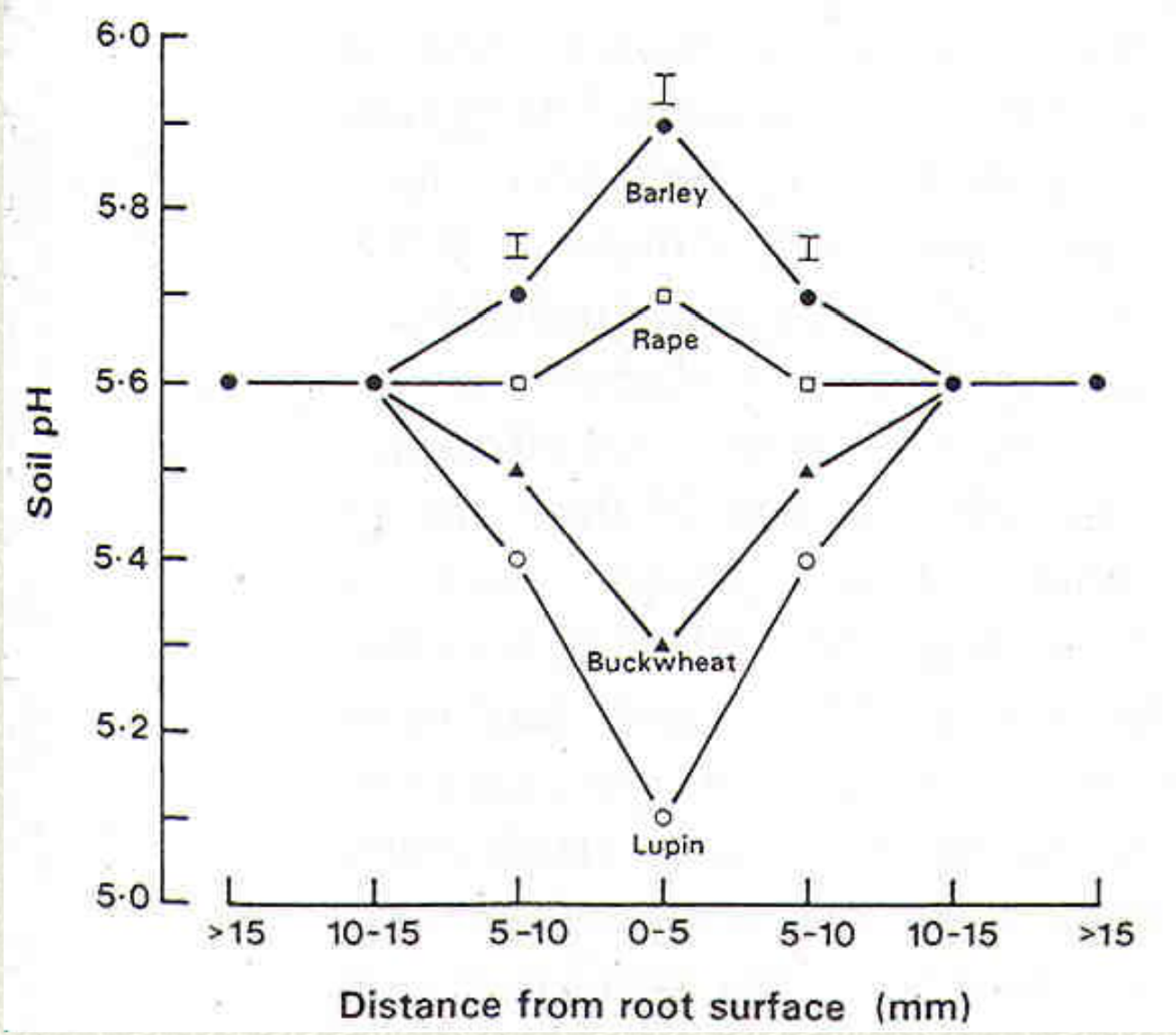
Why important?

Shallow rooted crops can scavenge P from near surface, increasing efficiency of P fertilizer.

Crop Species that Acidify Rootzone

Buckwheat Legumes Some Mustards

Root zone pH of four crops

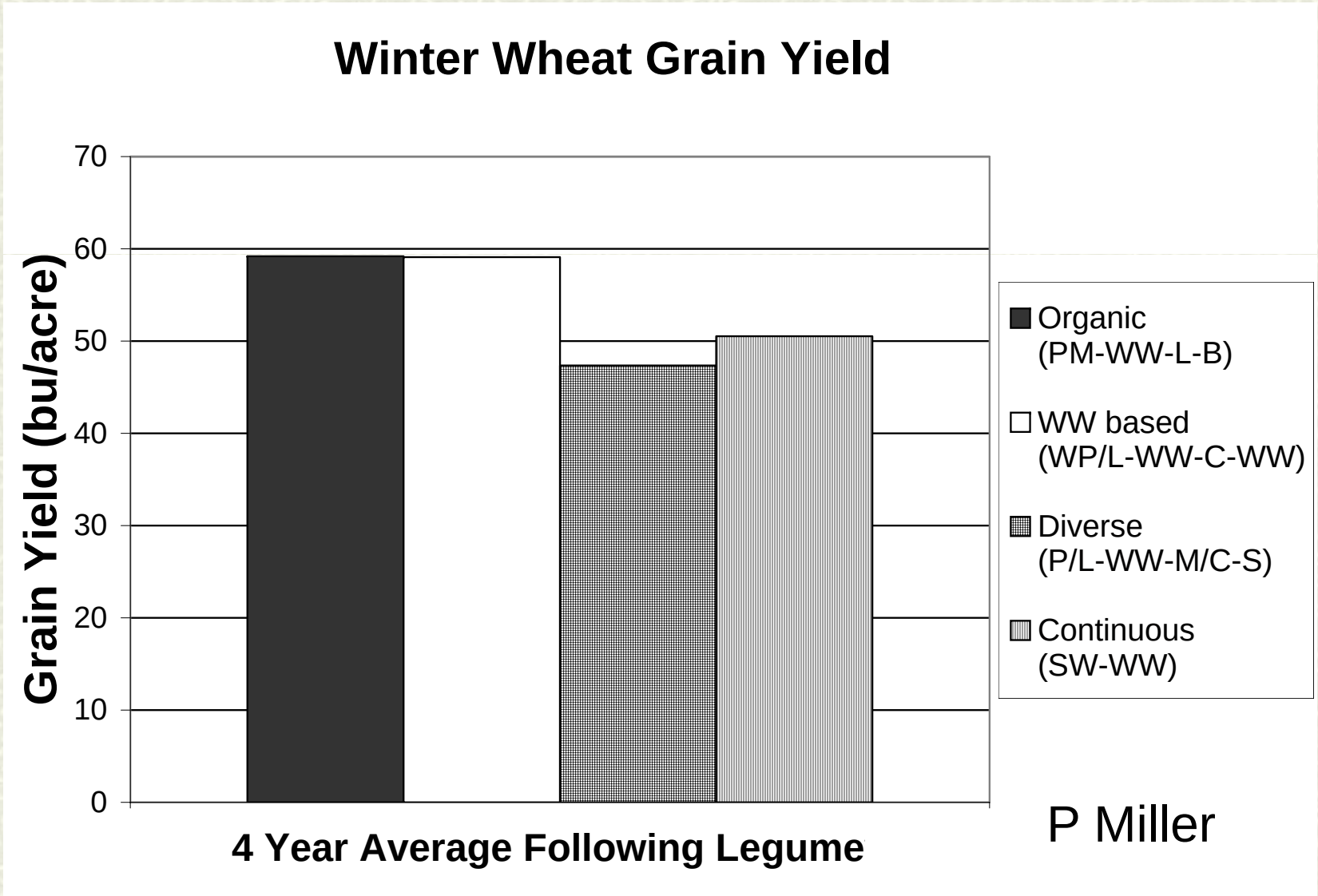


QUESTIONS?

Effects of Diversified No-till Cropping Systems on Soil Nutrient Status

by Clain Jones and Perry Miller

Bozeman Crop Rotation Study



P Miller

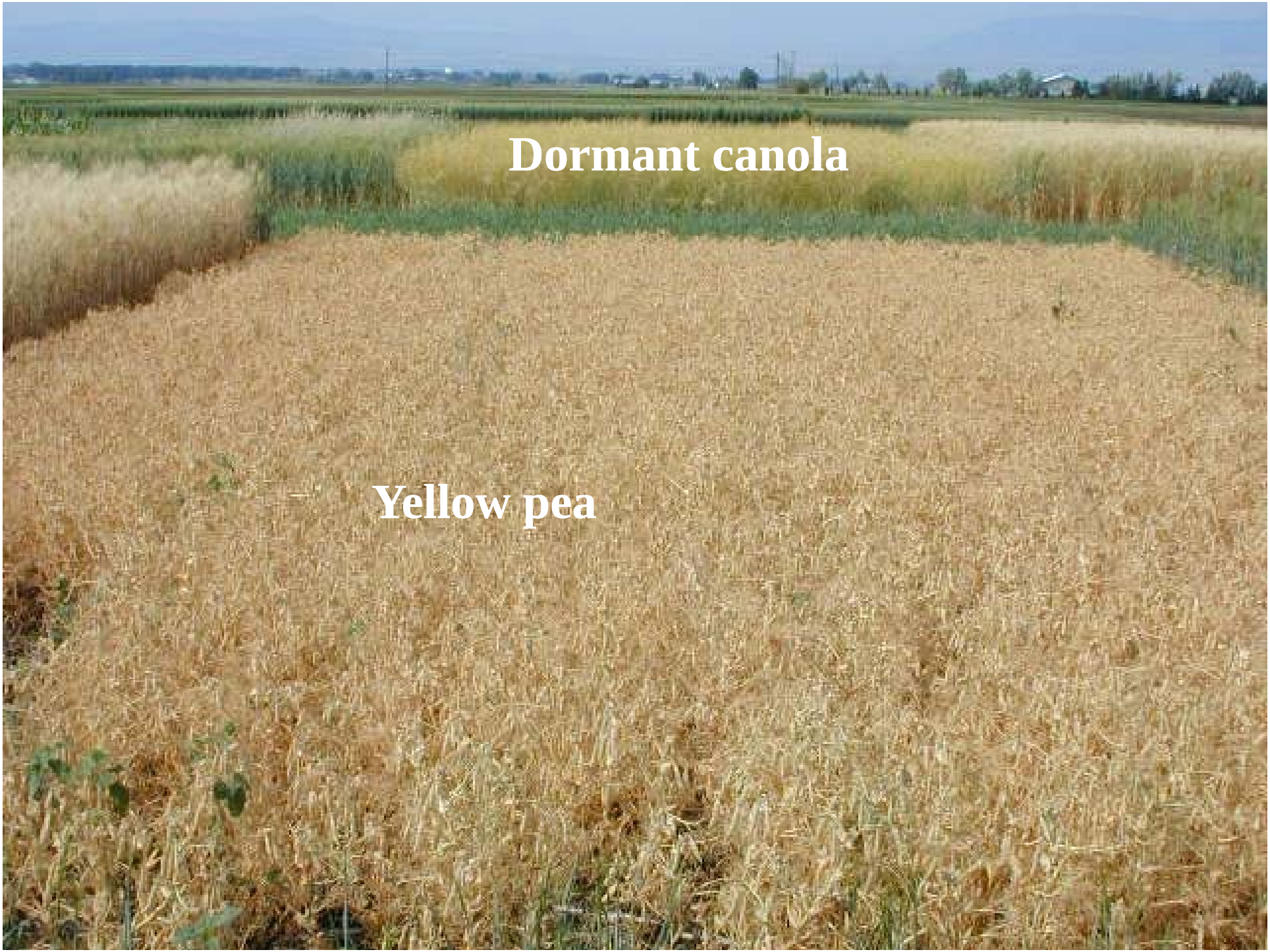
Question

Are yield differences partly due to the effects of rotation on nutrient levels?

Rotations

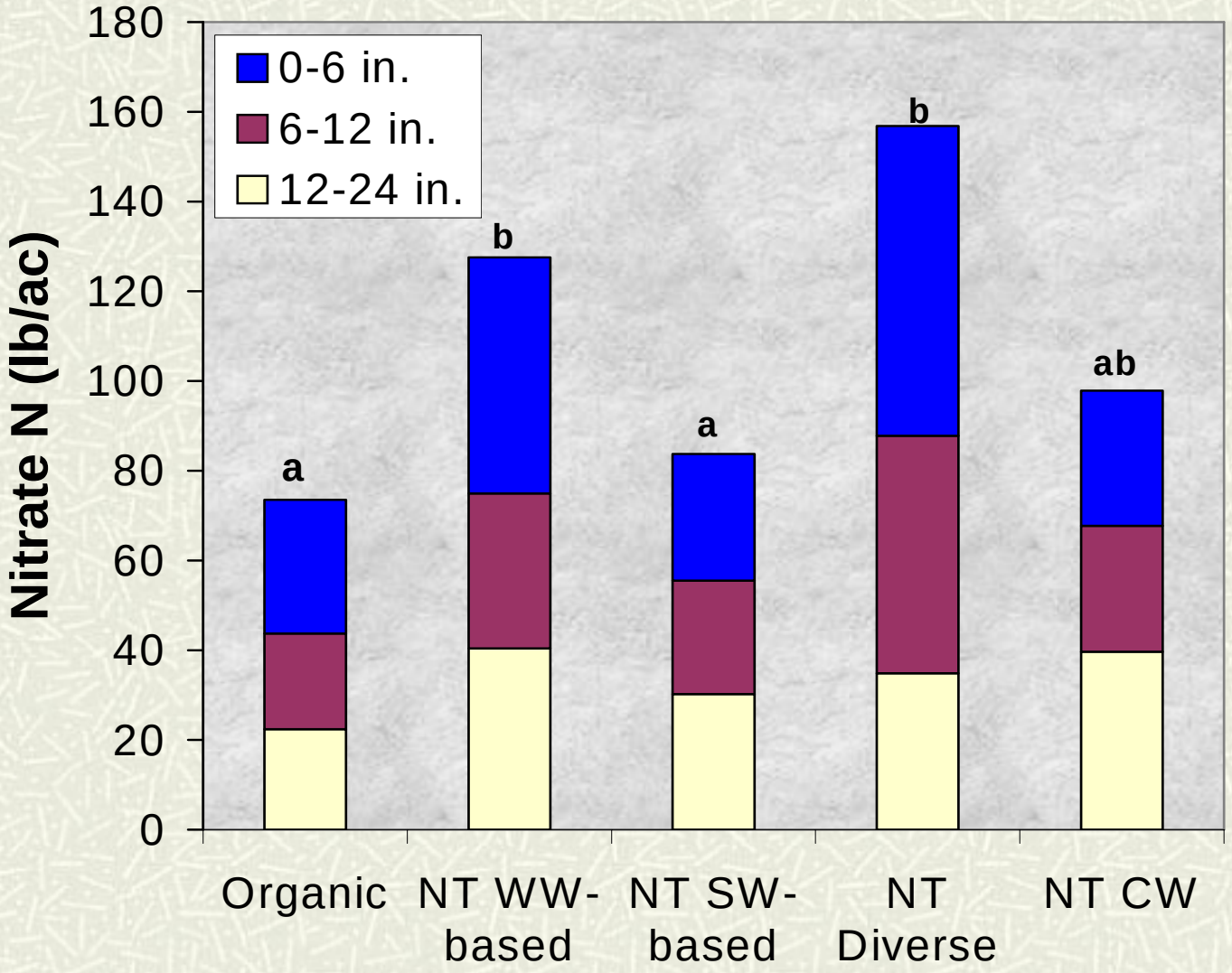
Crop Diversification Rotation Study (Miller) 2000-2003

System	Year 1	Year 2	Year 3	Year 4
Organic	AWP fallow	WWheat	Lentil	Barley
NT Winter	Winter Pea	WWheat	Dormant RR Canola	WWheat
NT Spring	Pea	SWheat	RR Canola	SWheat
NT Diverse	Pea	WWheat	Hybrid Corn	Sunflower
NT CW	SWheat	WWheat	SWheat	WWheat

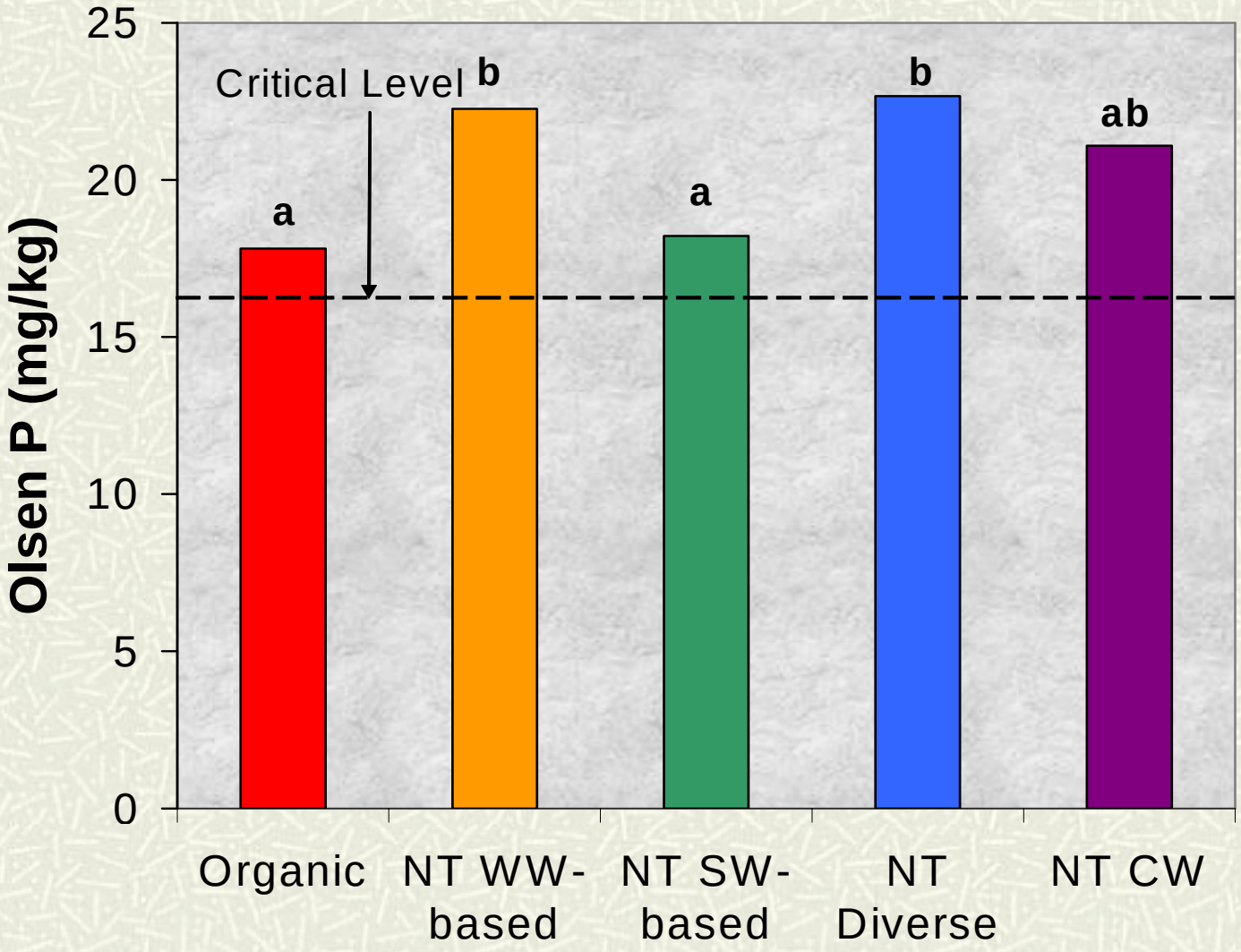

Dormant canola
Yellow pea

RESULTS

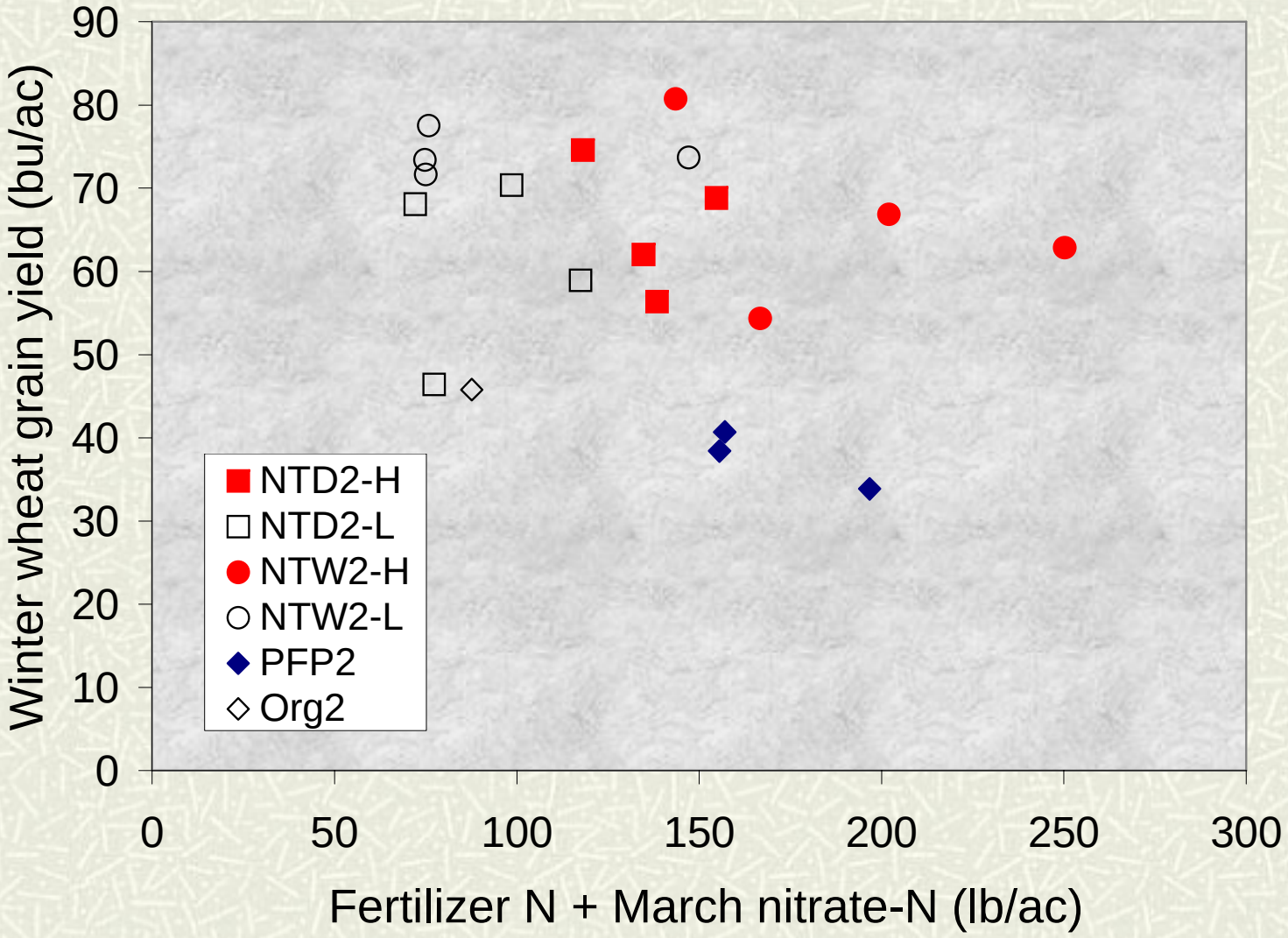
Nitrate


Nitrate N (lb/ac)
180
160
140
120
100
80
60
40
20
0
0-6 in.
6-12 in.
12-24 in.
a
b
a
b
ab
Organic
NT WW-based
NT SW-based
NT Diverse
NT CW

Olsen P


Olsen P (mg/kg)
25
20
15
10
5
0
Critical Level
a
b
a
b
ab
Organic
NT WW-based
NT SW-based
NT Diverse
NT CW

Effect of Available N on WW Yield

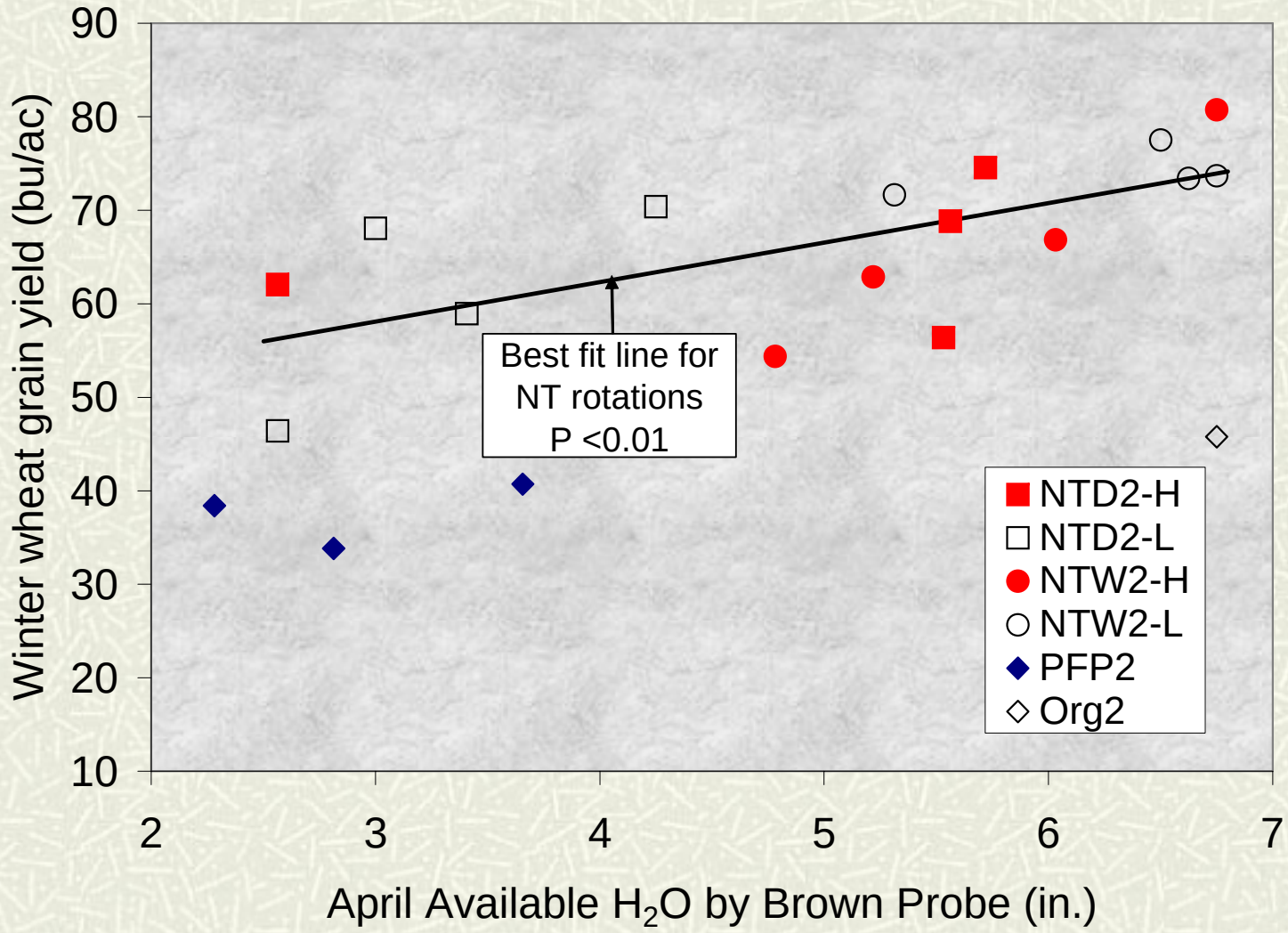


Effects of other Nutrients on Yield

Other nutrients also had no effect on winter wheat yield.

So what was causing large yield differences?

Effect of Plant-Available Water on WW Yield



Study Summary

1) Some small but measurable differences were observed in soil nutrient concentrations between no-till rotations after 4 yr.

2) Spring based rotations may require somewhat higher fertilizer levels.

3) Nutrient concentrations did not appear to substantially affect winter wheat grain yield in 2004.

4) Grain yield was highly influenced by water, and hence water use of previous crop.

Conclusions

- Legumes can increase soil N, though mainly a long-term effect.
- Legumes, oilseeds, and buckwheat can acidify root zone, increasing P availability
- Crop rotations have relatively small effects on nutrient availability in a 4 year period, but effects likely increase with time.
- Diverse cropping systems can help use fertilizer more efficiently, especially when crops with different rooting depths are grown.

For additional information:

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

QUESTIONS?