Effects of Tillage System on Nutrient Availability and Management

Prepared for 2007 MABA Convention

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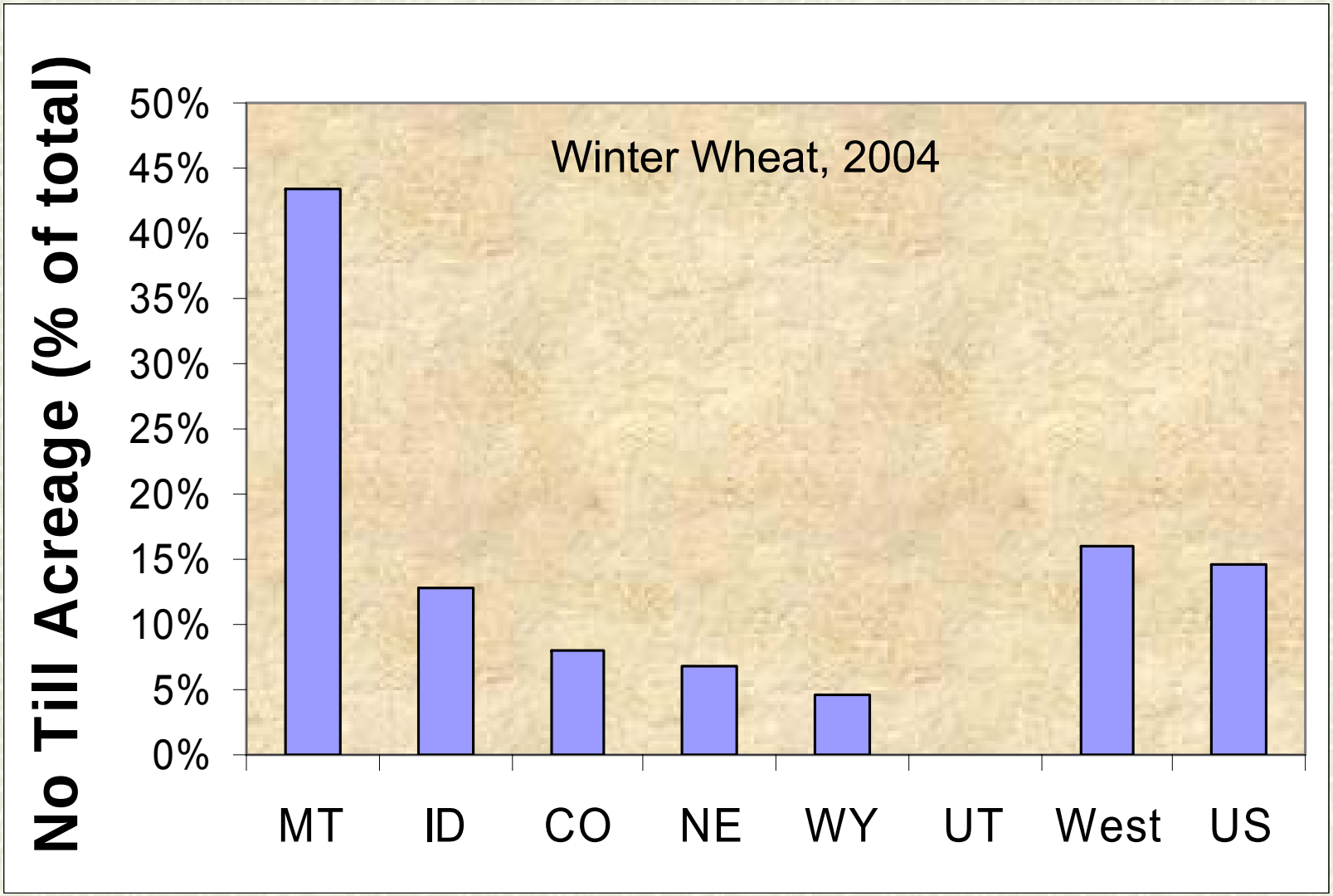
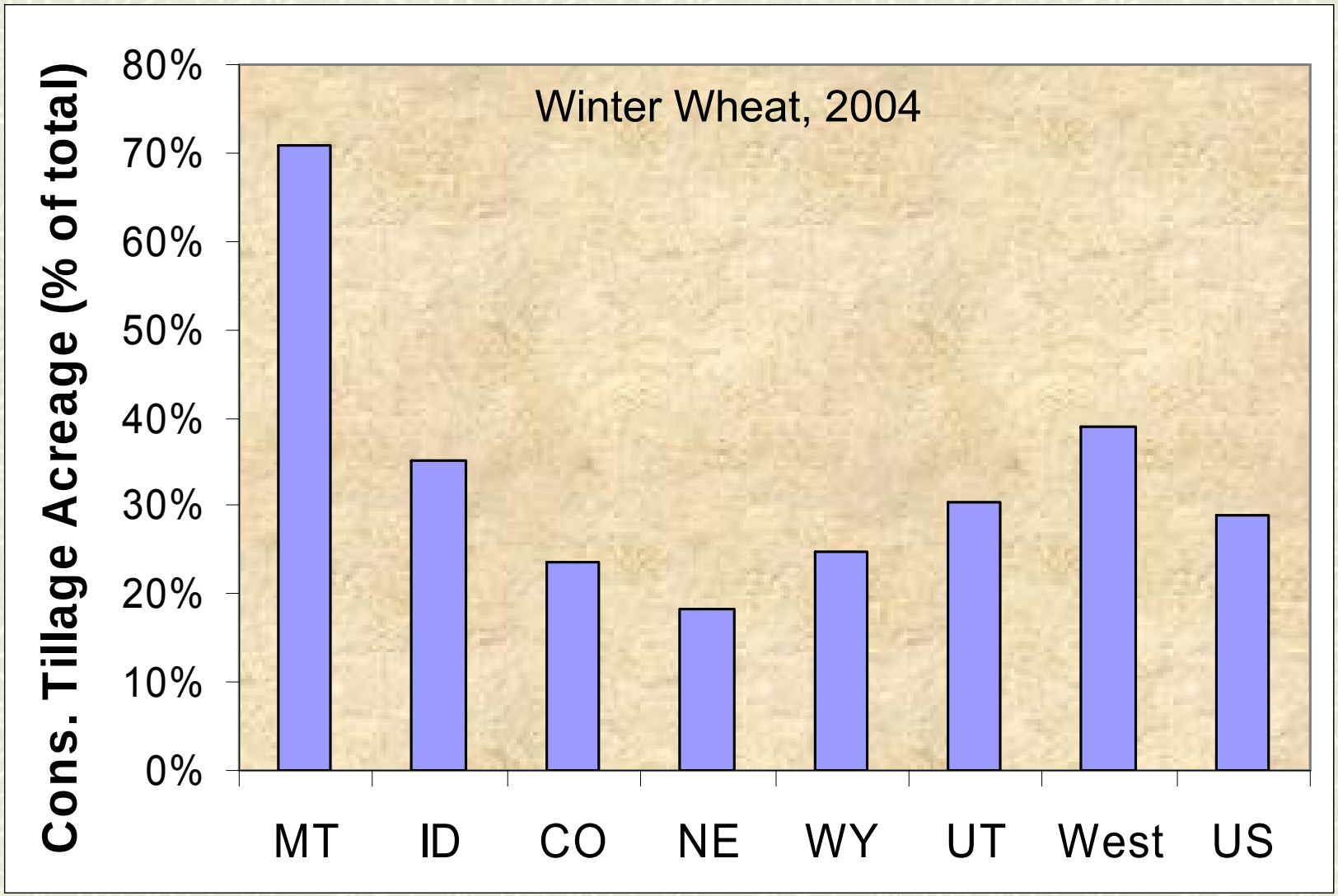
MONTANA STATE UNIVERSITY EXTENSION

No-till Relevance



Data from Conservation Technology Information Center

Conservation Tillage



Questions for you

- Is the majority of all of your clients' acreage in no-till? Yes, No?
- Who recommends different N fertilizer rates for no-till than for till?

Objectives today

- Discuss how tillage, reduced tillage, or no till can affect nutrient availability
- Show the effects of tillage system on yield and protein responses to nitrogen (N)
- Show the effects of tillage system on vertical ‘stratification’ of phosphorus (P) and P availability

Basics

Tillage ‘mineralizes’ more N than no-till, especially in short term.

Why?

1. Soil Aeration: bacteria and fungi work faster with oxygen.
2. Breaks up organic particles and colloids: More surface area → faster decomposition
3. Temperature slightly higher in spring under tillage, due to less shading/darker surface: Higher temp → faster breakdown

Basics, continued

When N fertilizer is surface broadcast, 'immobilization' will be higher on no-till than tilled fields.

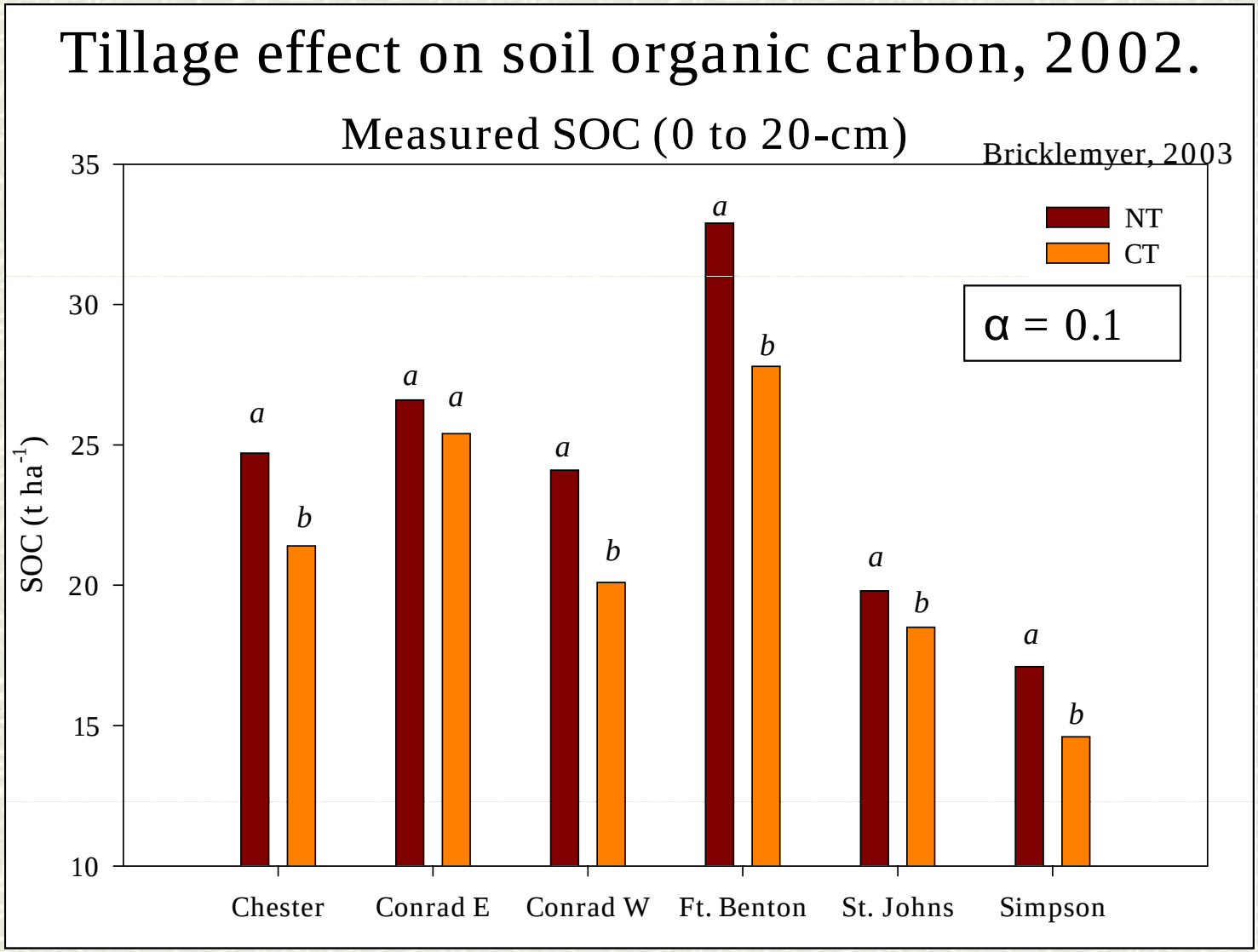
Why?

Bacteria and fungi use fertilizer N in breaking down stubble at surface.

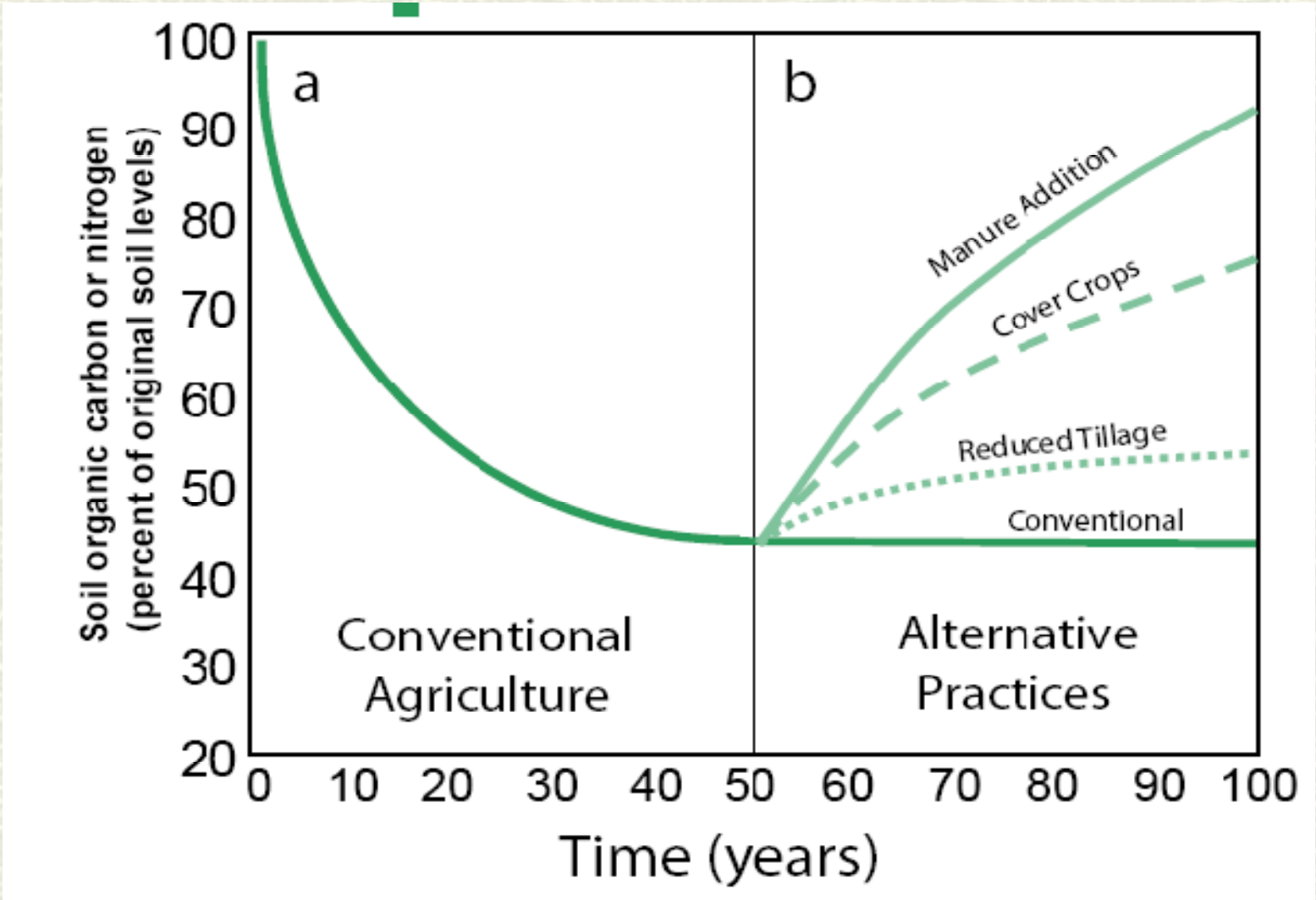
Solution?

Add 10 lb N/ac more for each ½ ton stubble that remains on surface IF broadcast N (stubble weight = ~1.5 x grain weight).

How does tillage affect O.M. in Montana?



Organic matter and organic N changes with management



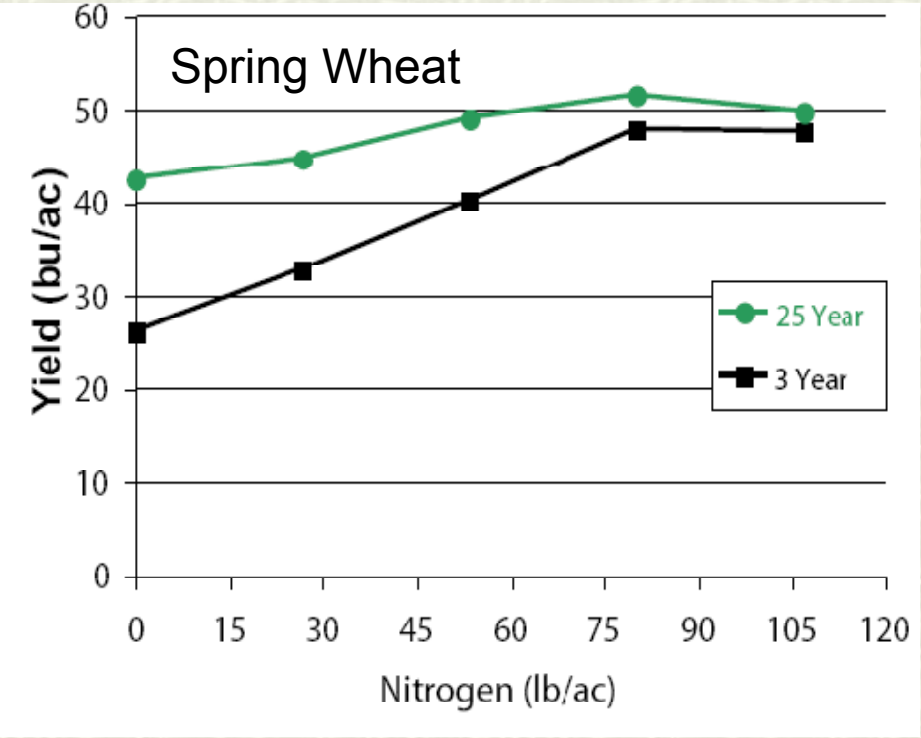
Is building O.M. free?

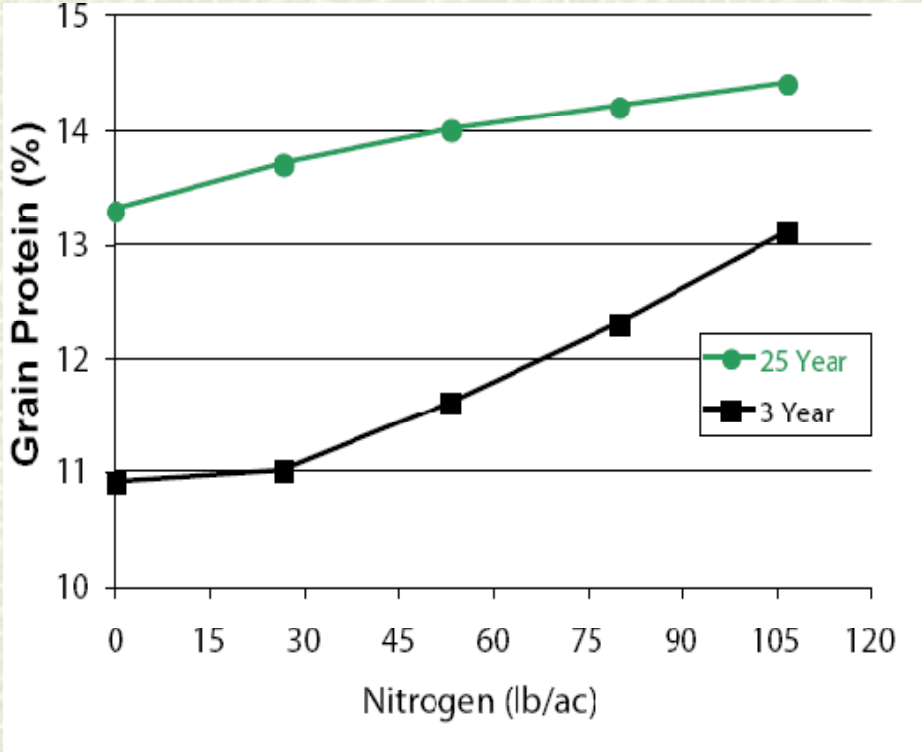
- NO!
- It takes N to 'grow' O.M.:

  To gain 1% O.M. in upper 6 inches takes about 1,000 lb N/acre extra N.

  (assumes 20:1 O.M.:N ratio)
- Need more N in first few years after converting to NT to attain same response as CT. Less N in long-term.

N response curves differ between short- and long-term NT





From Miller et al. 2004

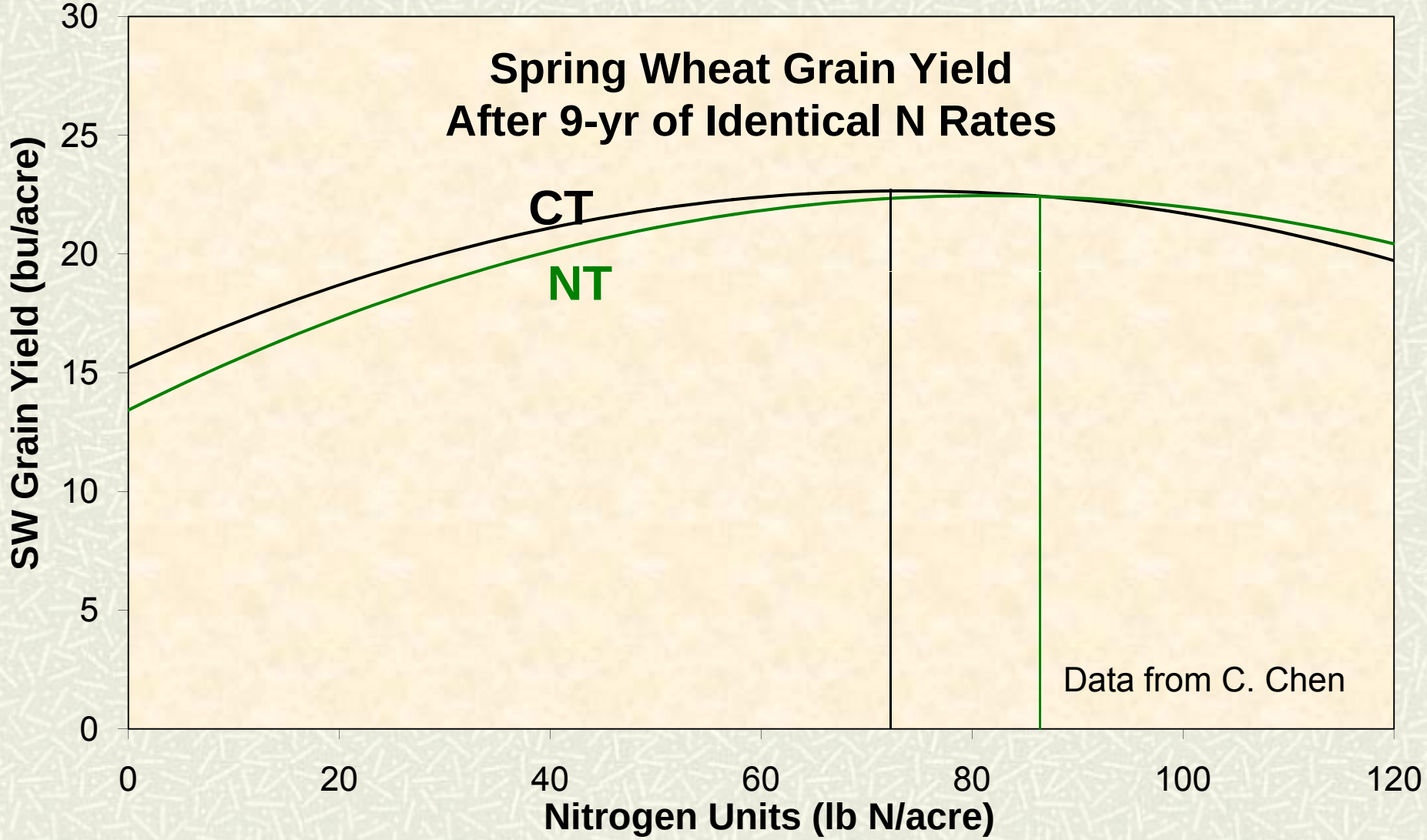
Why is there a larger difference with protein than with yield at high N?

QUESTIONS SO FAR?

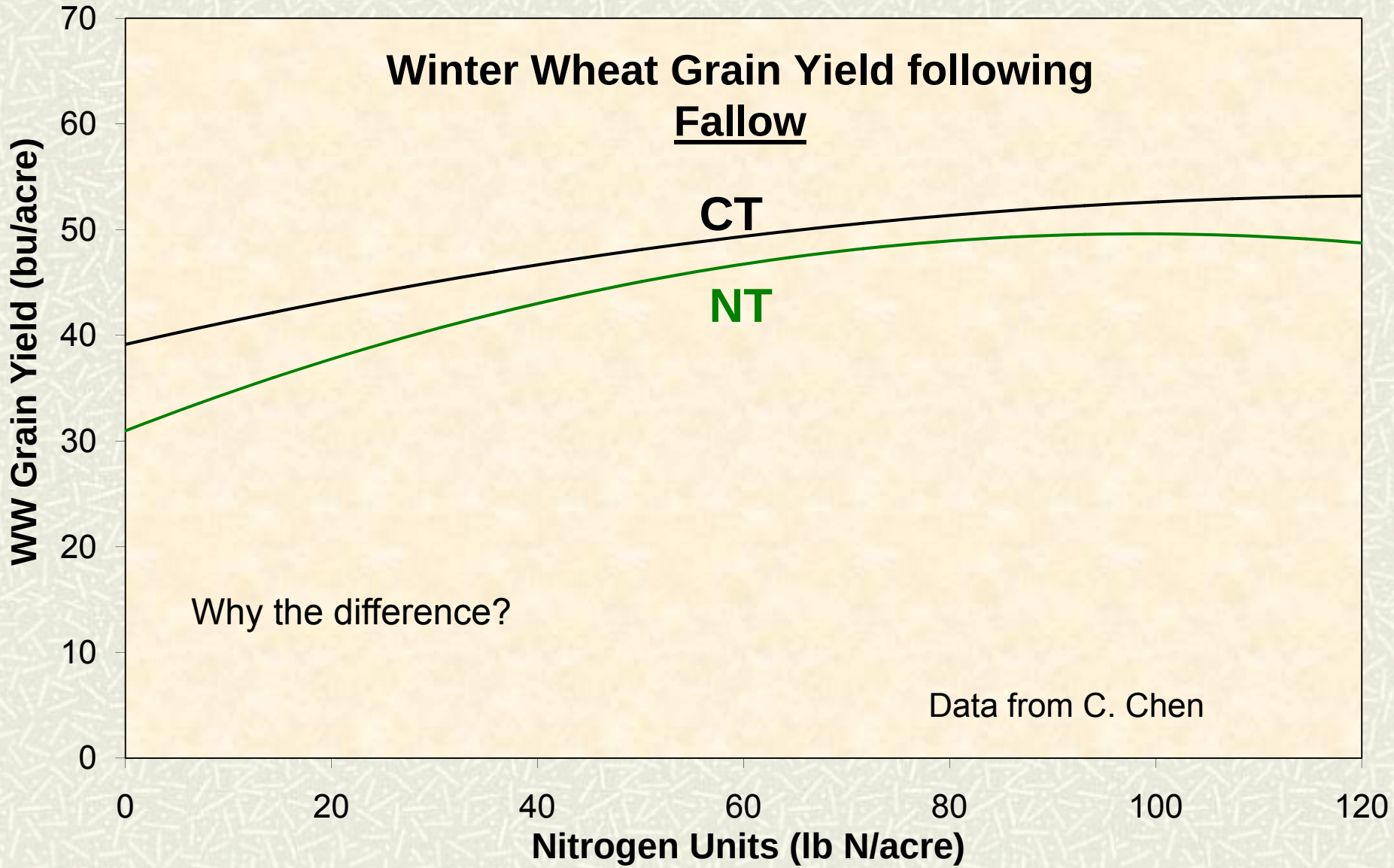
What if don't add anymore N to NT than to CT fields?

- Study site: Moccasin
- Researchers: C. Chen and C. Jones
- 9-yr NT (NTNT) side by side with 30+ yr CT (CTCT). CT = one sweep tillage pass per year (Reduced Till?)
- Organic Matter in top 6 inches was same after 9-yr.
- Part of NT converted to CT in 2005 (NTCT)
- Part of CT converted to NT in 2005 (CTNT)
- Four systems: Fallow, spring pea (grain), winter pea (forage), and spring wheat. All seeded to winter wheat in Fall 2005.

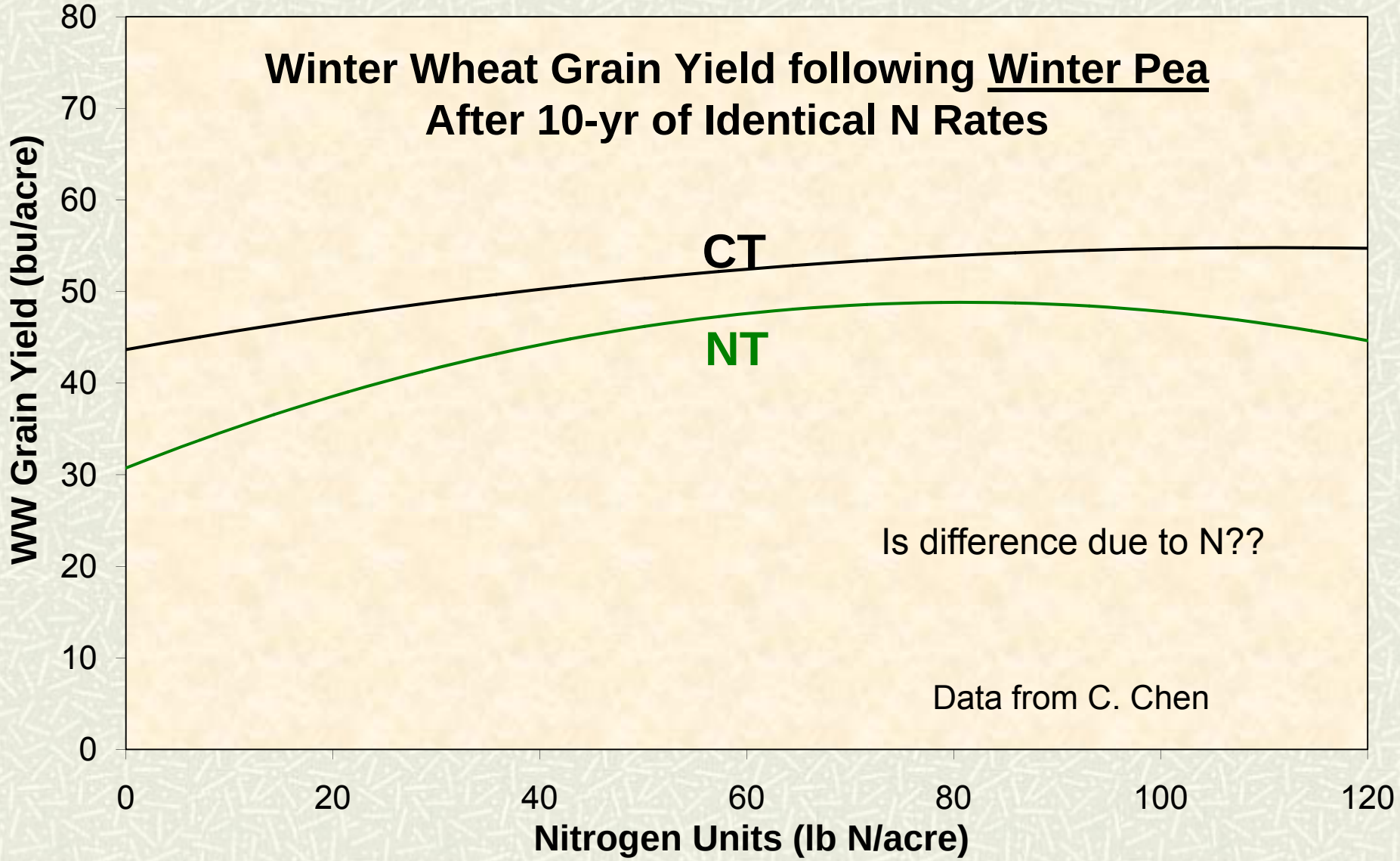
Moccasin, 2005



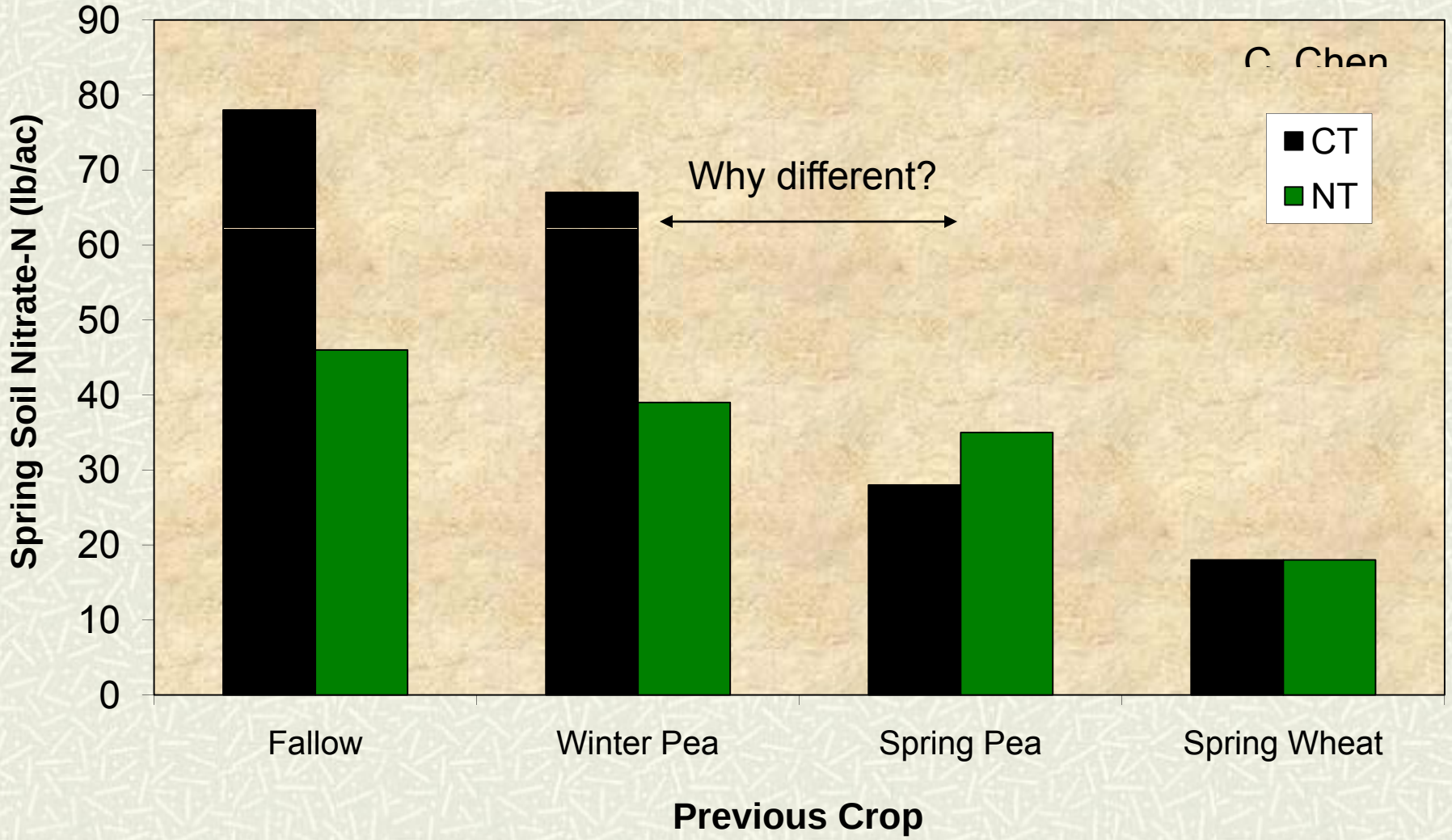
Moccasin, 2006



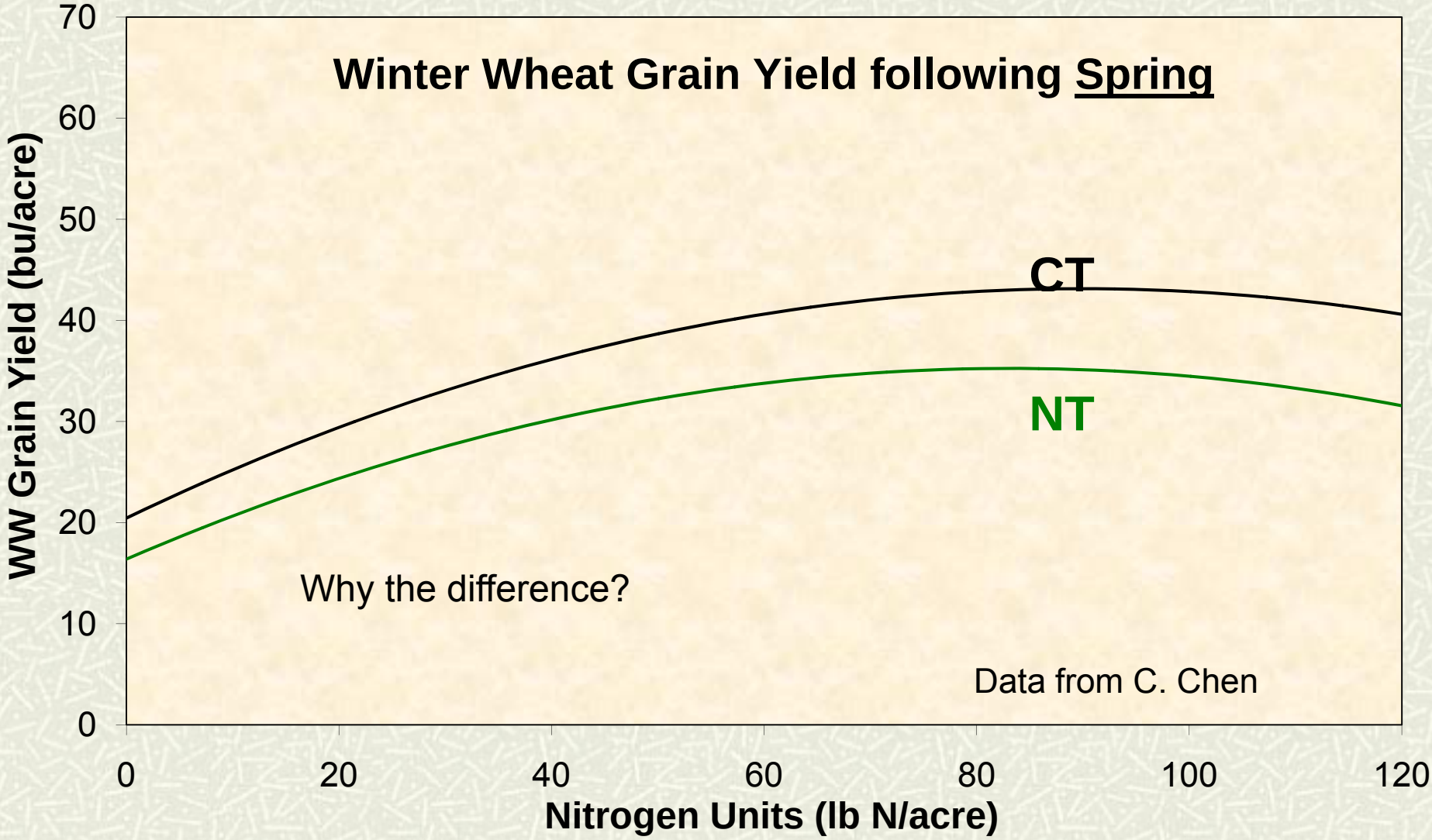
Moccasin, 2006



Spring Nitrate-N (2006) after 10-yr of Identical N Rates



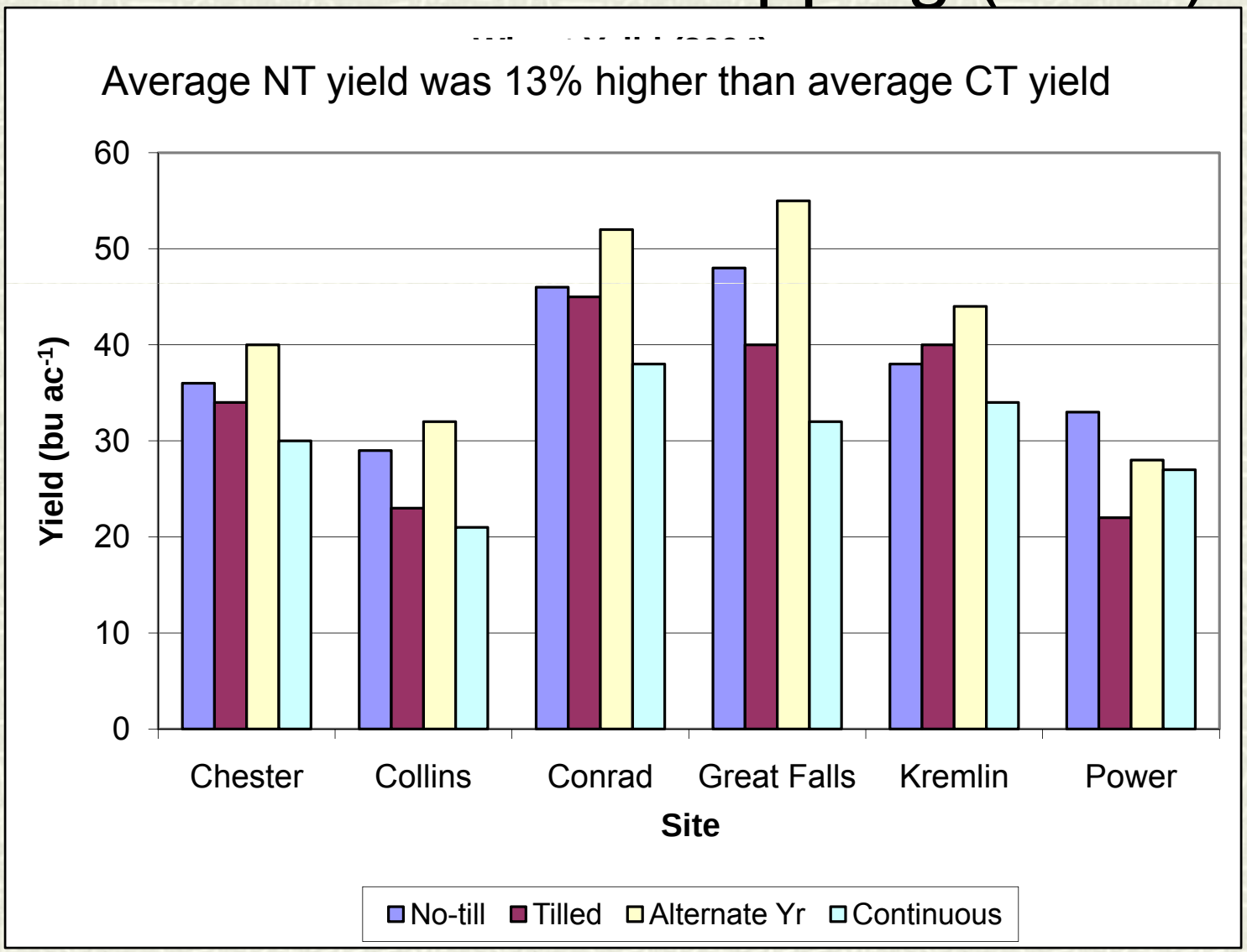
Moccasin, 2006



How do grain yields between NT and CT compare in other Montana studies?

- Bricklemyer and Miller, 2006
- Six sites: NT-CT small plot study.
- Data: From 2nd year of ongoing study.

Wheat Yields for NT, CT, after Fallow, and Continuous Cropping (2004)



Take home messages on N

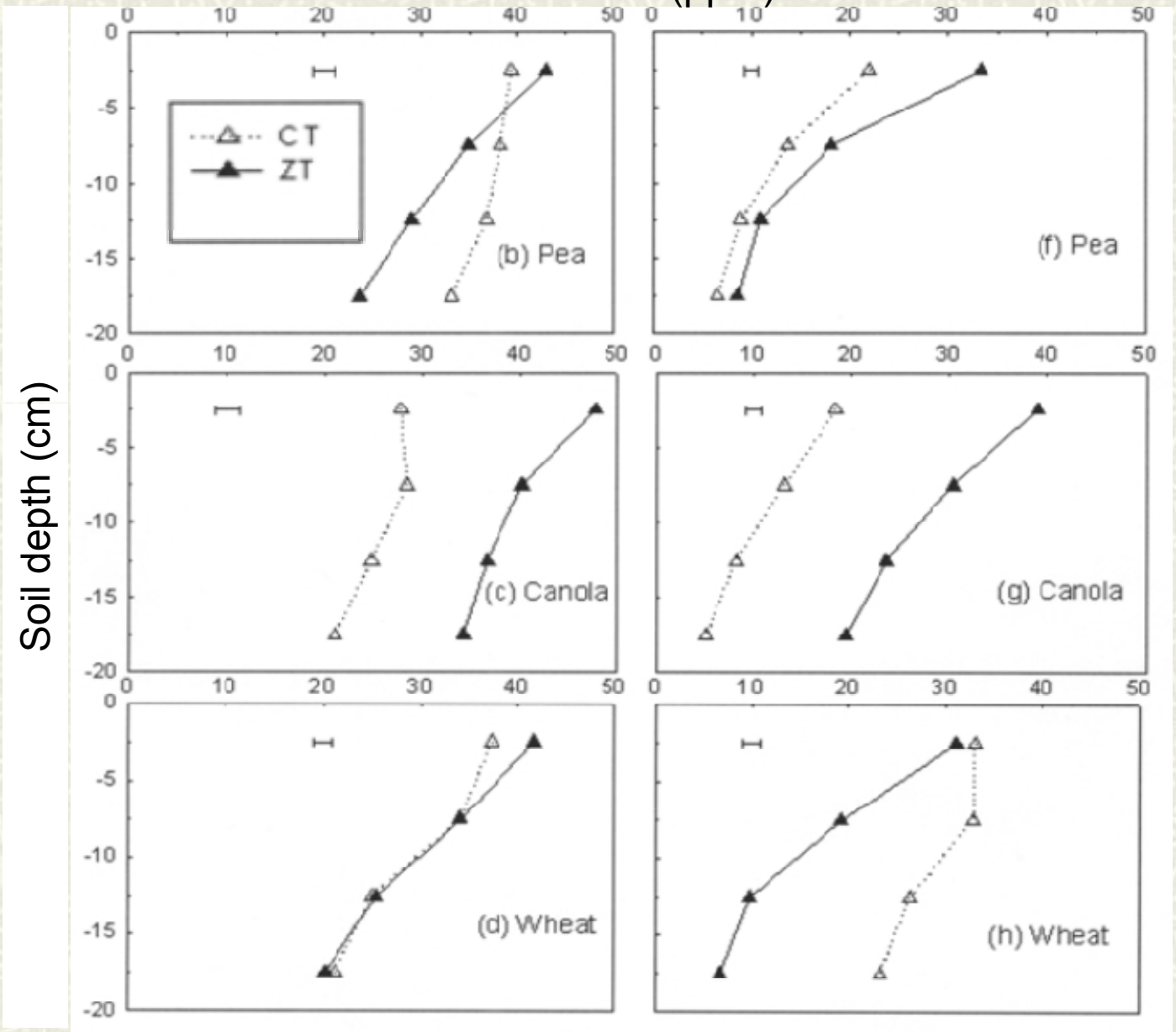
- More N will be needed in first few years after conversion to NT, ESPECIALLY when surface broadcast (10 lb N/1000 lb stubble) .
- In “mid-term” (5-10 yr?), similar N will be needed to maximize yield.
- In long-term, less N will be needed to maximize yield and protein, especially when more N was added in short-term.

QUESTIONS SO FAR?

Basics on P

- Soil pH controls P availability more than mineralization does. Different than N.
- SO, tillage expected to affect P less than N.
- Soil pH is generally somewhat less near surface of no-till field, which should increase P availability near surface.
- Some are asking if P is concentrating near P subsurface bands more in NT than in tilled systems, and if so, how is this affecting P availability?

P Stratification in Alberta (Lupwayi et al., 2006)

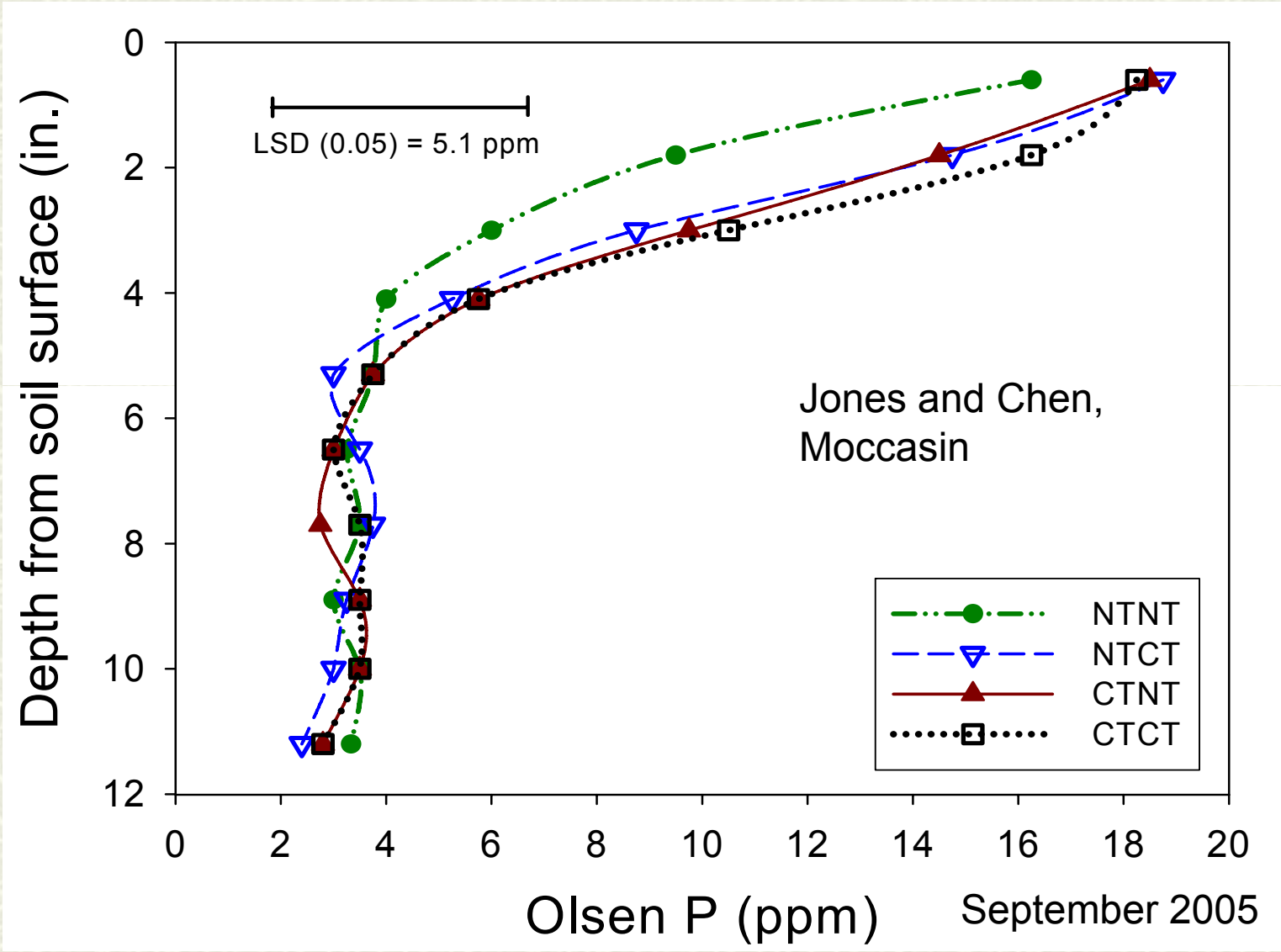


Stratification appears dependent on:

- Year
- Crop
- Tillage

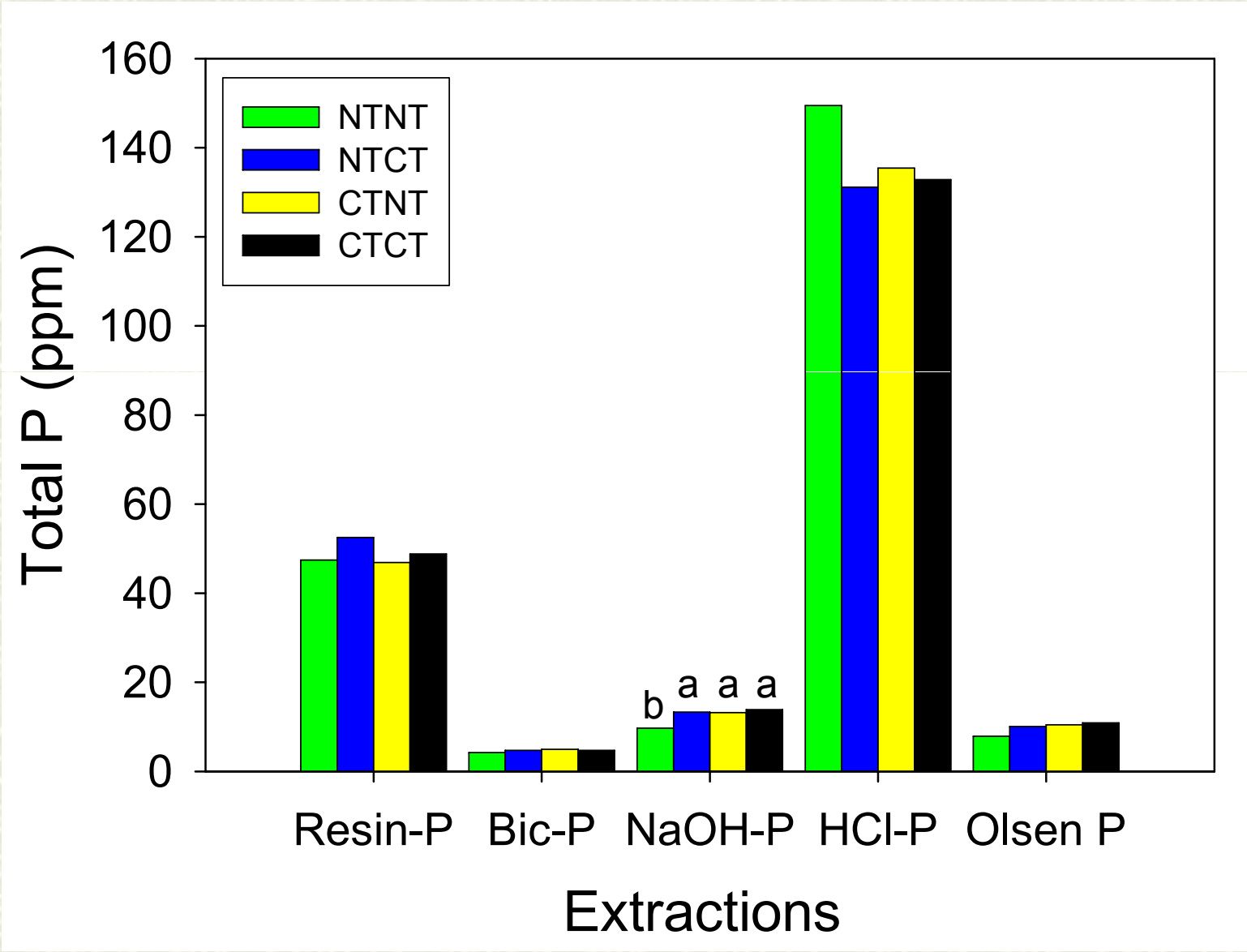
Wheat P uptake was not different between tillage systems, suggesting stratification differences did not greatly affect overall P availability.

Does P stratification happen here in Montana?



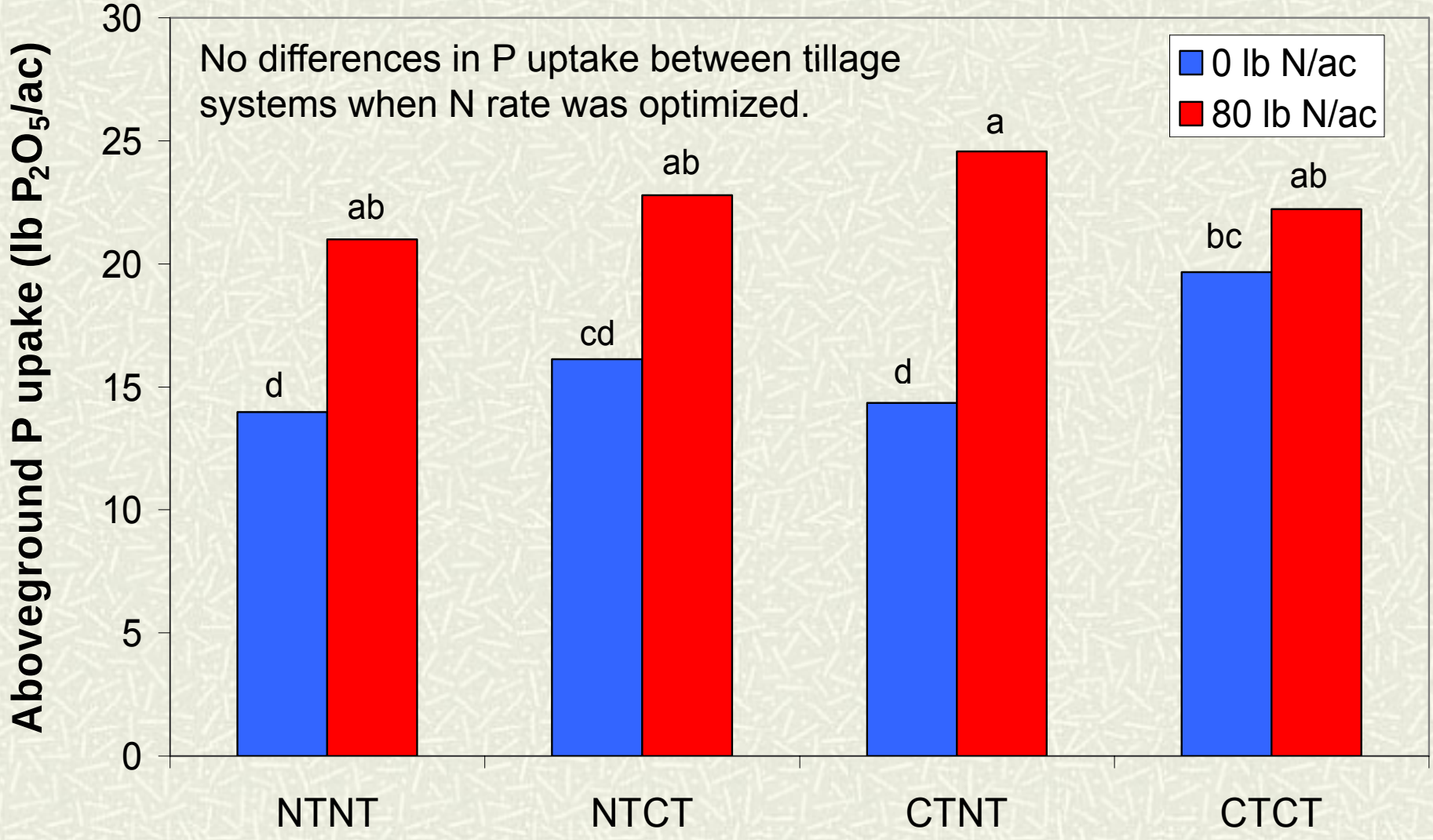
Is Olsen P the only P fraction that could be affected by tillage?

Average P concentration in top 6 inches for different P fractions



Jones and Chen, Moccasin

But the proof is in the pudding…meaning P uptake is likely best indicator of P availability



Is P being ‘stranded’ near the surface in reduced till systems (esp. when broadcast or seed-applied)?

- Apparently, yes.
- Where should P be applied for best uptake?

  We regressed P uptake against Olsen P (and resin P) for each 1.2 inch layer to find the depth with the highest correlation and thus possibly best depth to apply P.

Correlation between Olsen P and 'Resin P' for each 1.2 in. layer and P uptake (Moccasin)

Table 2. Correlation coefficients between Olsen P and resin-P concentrations and aboveground P uptake in individual soil layers and averaged soil depths.

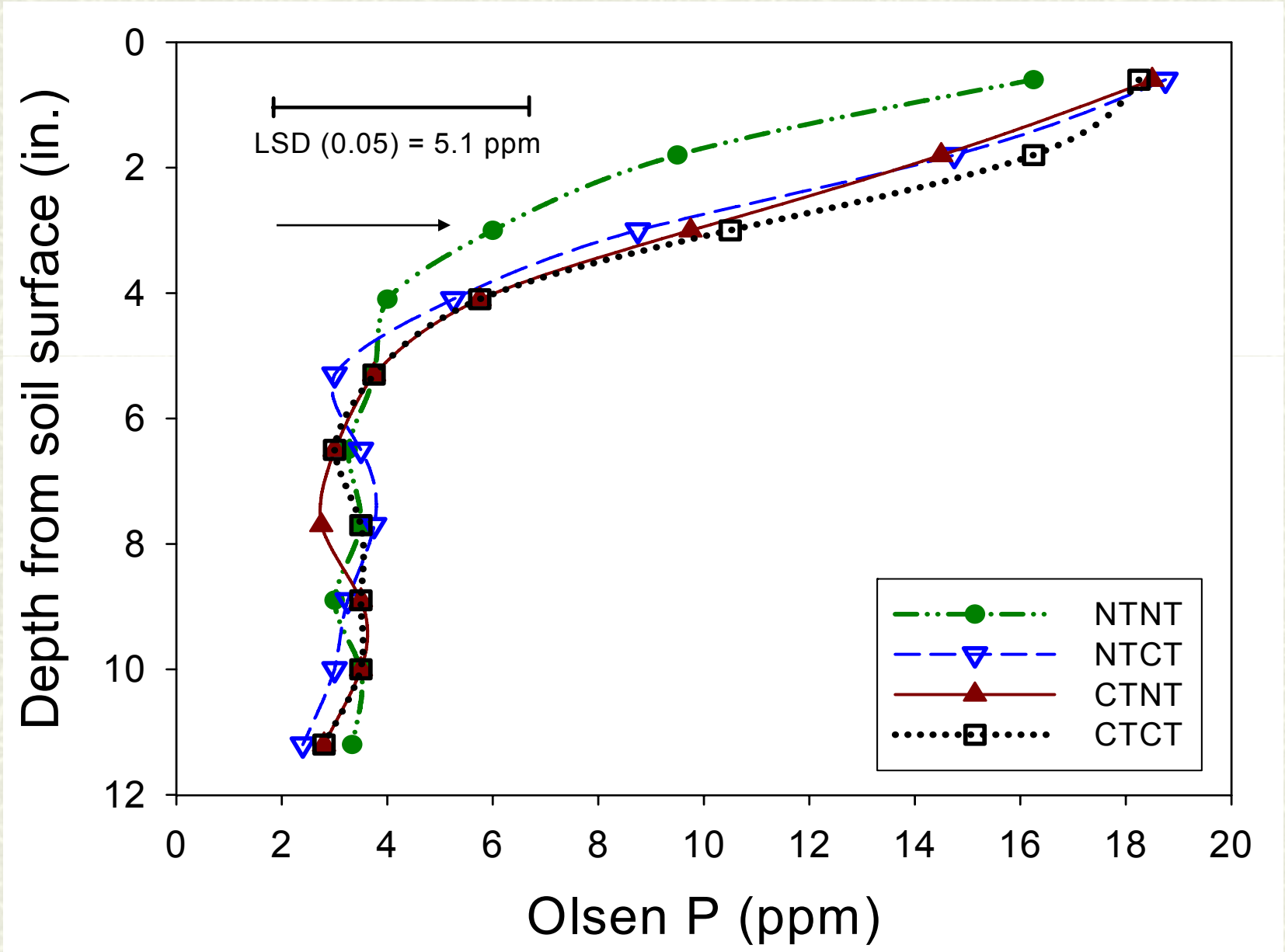
Depth (in.)	Olsen P r^2-value	Resin P r^2-value
Individual layers		
0 - 1.2	0.46**	0.12NS
1.2 - 2.4	0.46**	0.17NS
2.4 - 3.6	0.57***	0.35*
3.6 - 4.8	0.50**	0.13NS
4.8 - 6.0	0.17NS	0.005NS
Averaged depths		
0 - 2.4	0.53**	0.19NS
0 - 3.6	0.57***	0.28*
0 - 4.8	0.59***	0.30*
0 - 6.0	0.57***	0.27*
0 - 8.3	0.54**	
0 - 12.0	0.42**	
2.4 - 4.8	0.60***	0.32*

NS, not significant at P=0.05

*, **, *** significant at P<0.05, 0.01, 0.001 respectively

Best correlation at 2.4 to 3.6 in. below soil surface.

How much available P is there at 2.4 to 3.6 inches deep?



Take home messages on P

- There may be some slight, yet not significant, differences in P availability between tillage systems.
- Olsen P measured to 6 inches appears to be a good estimate of available P, regardless of tillage system.
- P should be placed approximately 3 inches beneath soil surface to avoid stranding it near surface, especially in reduced till systems.

Conclusions

- N rates need to be increased in short term NT to maximize yield and build organic matter. This will save on N in long-term.
- P rates can be based on Olsen P levels in upper 6 inches, and do not need to be adjusted based on tillage system.
- Placement of both N and P may be as important as rate in optimizing yield in reduced till systems.

For more information

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