Soil Testing and Nutrient Management in and after Dry Years

Central Ag Research Center Research Roundup

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Questions for you

- What nutrient issues did you see this year?
- Were your nitrate-N levels this fall any different this year than last few?
- How was protein?

Image by Ron Nichols, NRCS

Goals for today

- Explain how drought directly impacts plant nutrients
- Offer suggestions to increase drought resiliency
- Describe soil testing
- Discuss drought effect on next year's fertilizer needs

Drought affects plant nutrients

Plants

- Roots don’t reach nutrients or deep water
- Lacking evapotranspiration to “suck up” nutrients
- Poor N-fixation

Nutrients

- Low nutrient availability from soil
- Nutrients don’t move easily in dry soil to reach roots

Agronomic practices to improve soil water

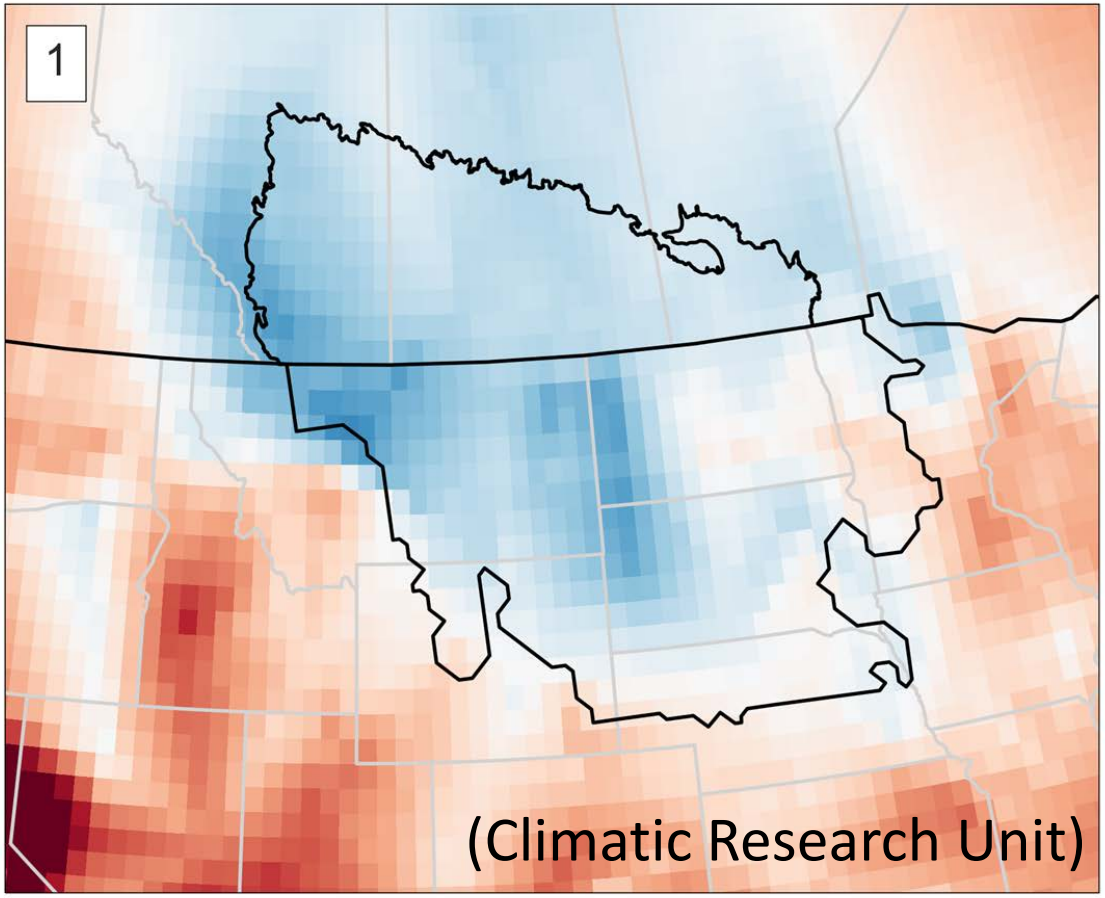
Reduce tillage, increase residue and stubble to:

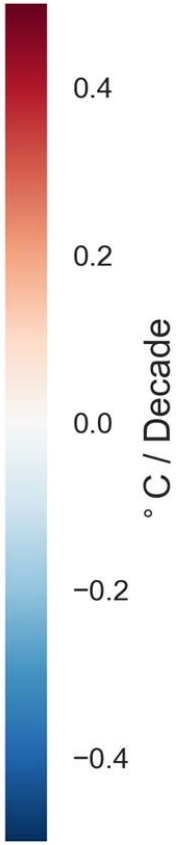
- Trap snow
- Reduce wind stress
- Reduce evaporation loss
- Reduce soil temperature
- Increase water infiltration and storage

Increase cropping intensity – recrop or cover crop

- Increases SOM
  - Takes time
  - Increases water holding capacity
- Rely more on legume N or manure N than fertilizer N if possible. *Both release more N when wet which is when you need more.*

Reduced fallow has apparently reduced regional spring and summer air temperature





April - June average temperature trends

1970-2015

June 15 to July 15 maximum temps (1976-2000) have DROPPED almost 3°F/decade in parts of Canadian Prairies likely due to large decrease in fallow acres (Gameda et al., 2007)

Encourage mycorrhizal association for N and P uptake

Mycorrhiza reach places roots can't.

Plants with better nutrient status can manage drought stress better.

There is not a lot of evidence that mycorrhizae improve response to drought, where nutrients are not limiting.

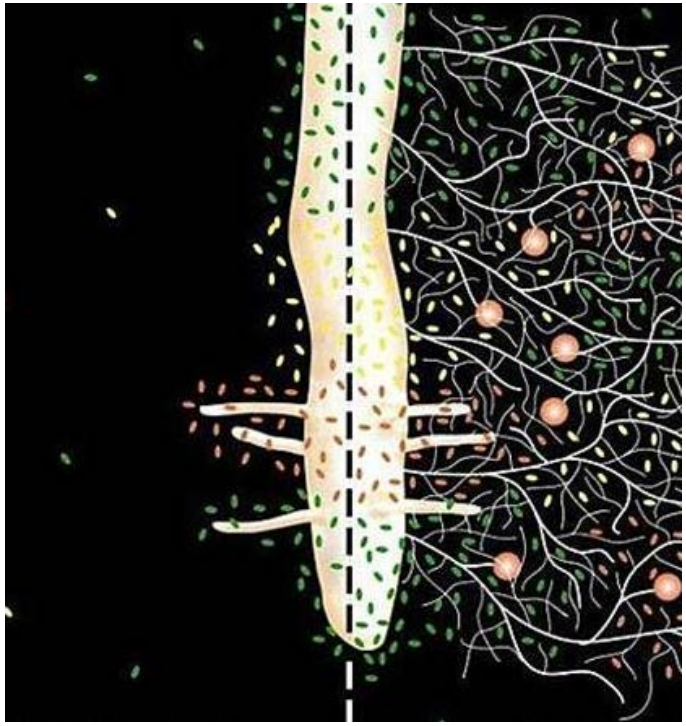


Image by Earth's Internet & Natural Networking

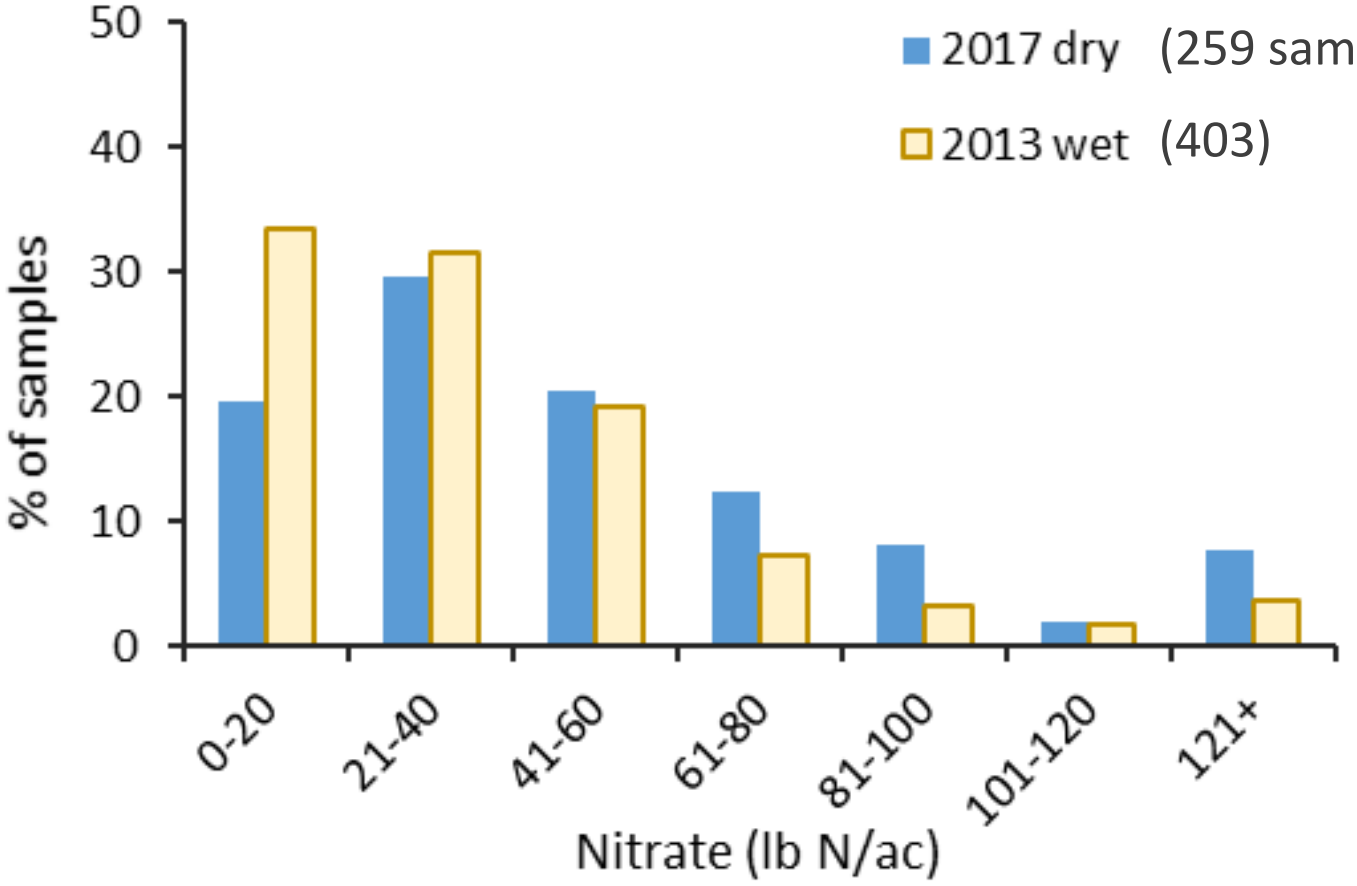
Questions?

On to soil testing and N

Drought on the following year fertilizer needs

Lower yields = higher residual soil N, as long as not leached

Fall soil nitrate in a wet vs dry year in central and north-central MT



Adjust N for next season
Capture with a fall planted crop or a shoulder cover crop

Data from AgVise

Drought on the following year's fertilizer needs

Lower yields = less nutrients removed by harvest

Change in material harvested (grazed or salvaged hay vs grain) changes nutrients removed

Approximate N, P, K and S removed by harvest of wheat grain, straw and hay (from *Fertilizer Guidelines for Montana Crops*)					
	Amount/acre	N	P_2O_5	K_2O	S
		..... lbs			
Grain	40 bu	50	25	15	3
Straw	1.8 ton	26	7	45	7
Hay	2 ton	50	20	76	4

Change in decomposition of residue

- immature residue decomposes faster than mature residue
- decomposition is slower in dry soils

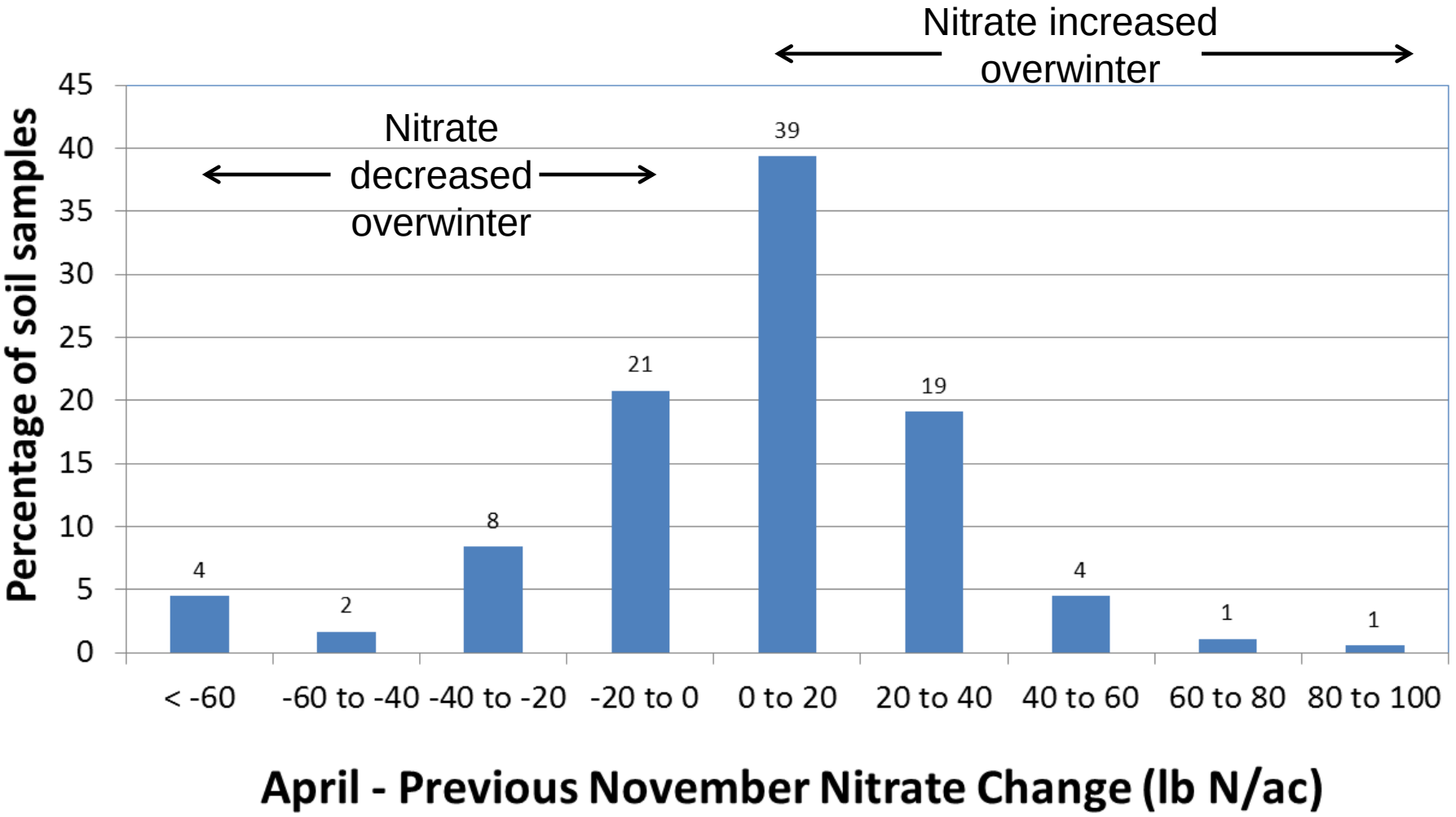
P and K recycling changes depending on fall precip

So with all these unknowns, what should you do?

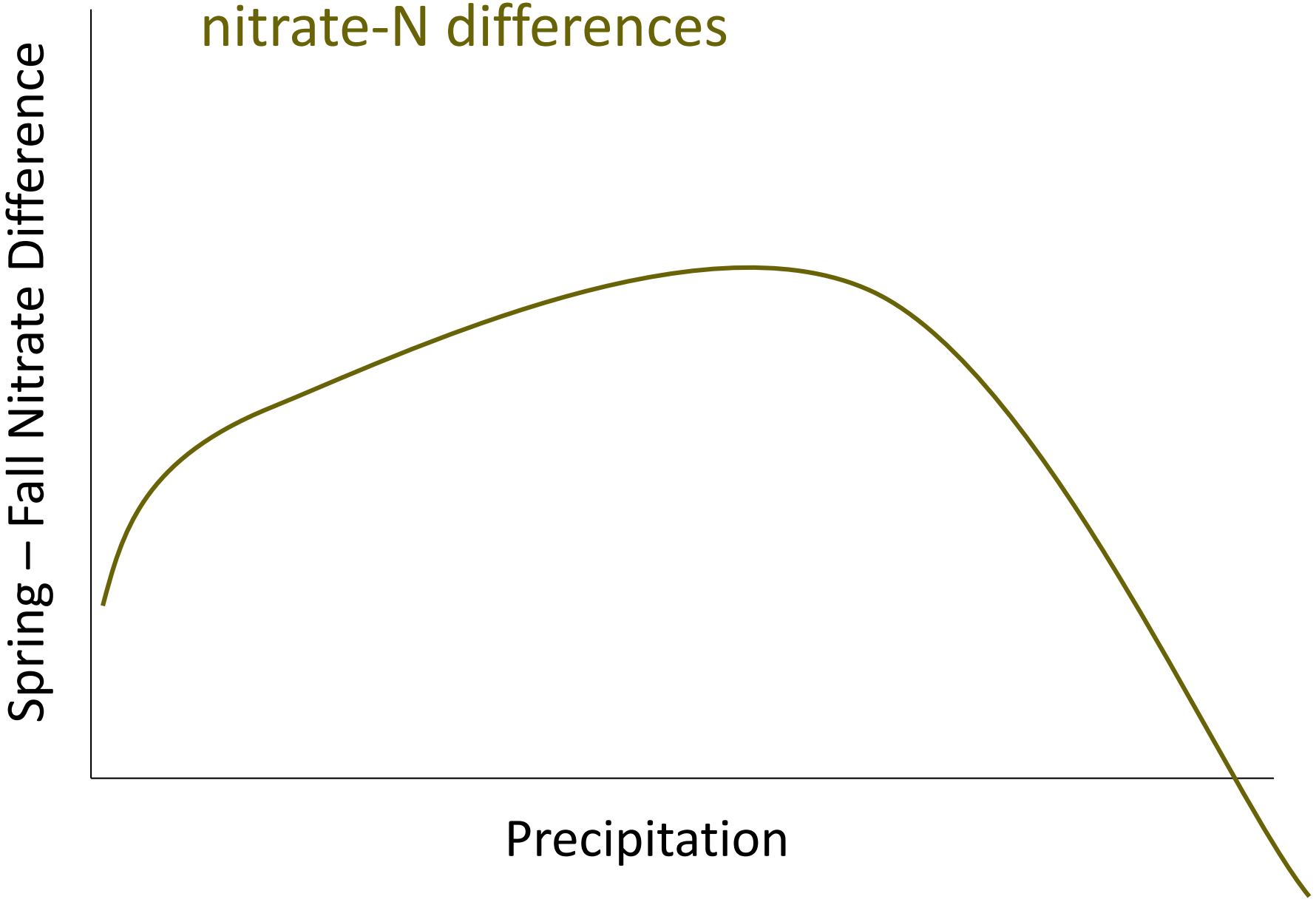
Soil Test!

- Take to 2 ft depth for N, 6” for P and K
- Consider sampling N to 3 ft if didn’t reach yield goal on previous crop or two
- Ideally taken in spring for N to adjust for overwinter changes, avoid under- or over-fertilization

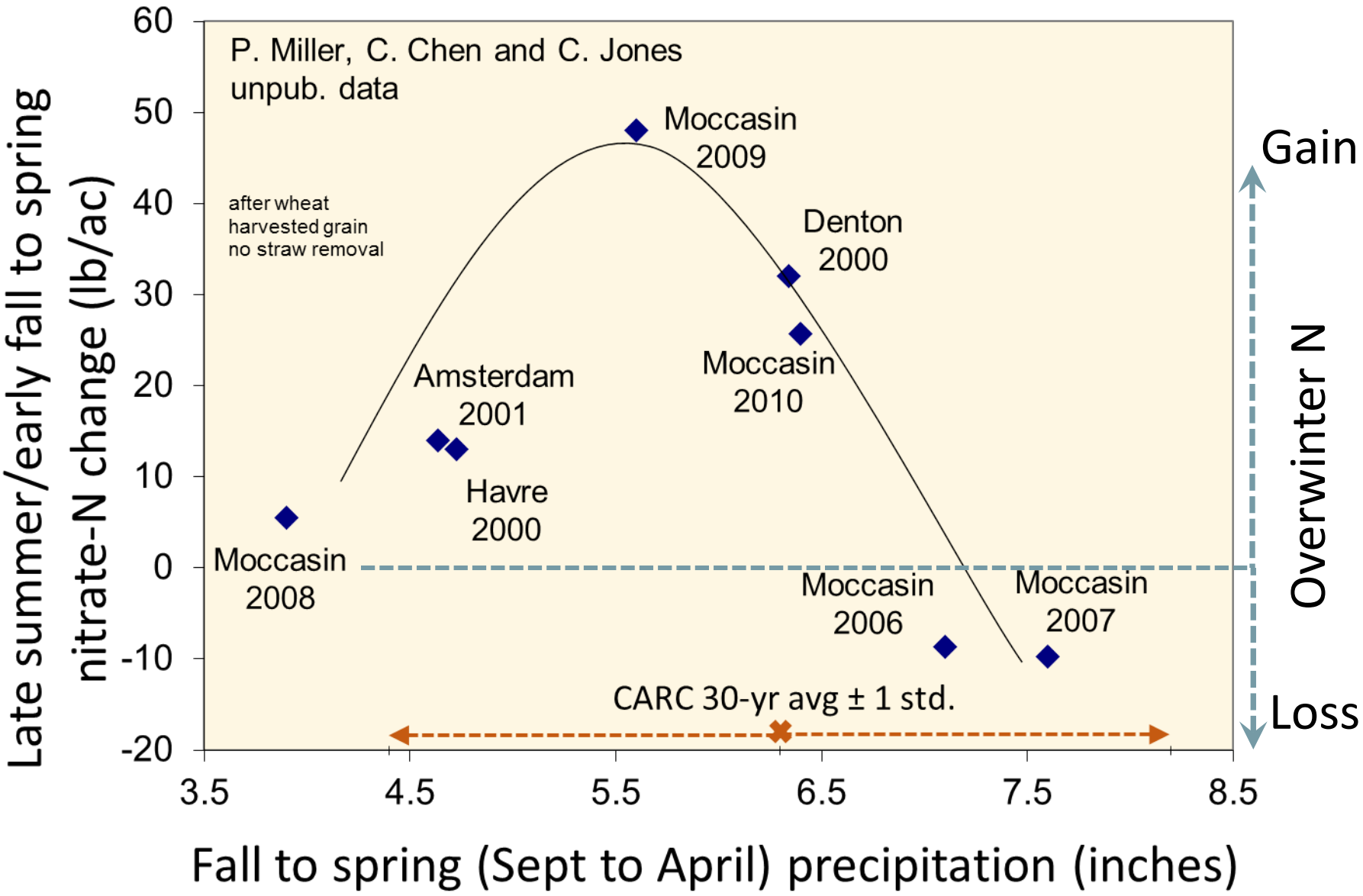
November to April nitrate changes, Montana data based on 180 samples (Jones et al. 2011)



Conceptual spring to fall soil nitrate-N differences



Actual Montana Data



What else will affect overwinter soil nitrate differences?

- Organic matter
- Temp
- Soil texture
- Previous crop
- Initial soil nitrate and moisture
- Coarse and shallow soils (< 2 ft) and soils with > 60 lb N/acre in the fall are most likely to have lost N overwinter

Soil testing tips

- After unusual weather years, not a good time to invest in intense grid sampling b/c might be misleading for future years.
- Taking ‘good’ core samples in dry soil can be challenging – try to wait for some soil moisture
- Yields may be more variable across a field in drought, thus nutrient uptake and removal is more variable – on the go yield monitors can be helpful

Recommendations for Nitrogen

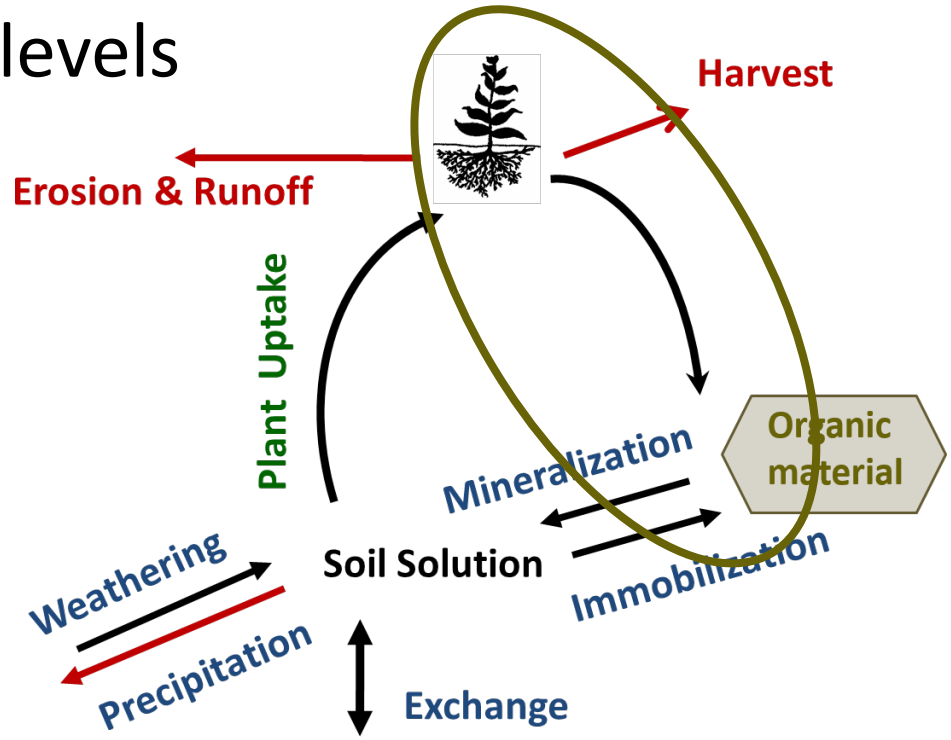
- Ideally, sample in early spring to avoid over- or under fertilization. Late fall if not possible.
- Apply additional N if needed. Lower N rate if fall to early spring is dry (since limited leaching).
- Lower early N – allows flexibility for given year's precip, prevents excess vegetative growth
- N credits will be lower than 'usual' after drought because they are partially biomass dependent

Questions?

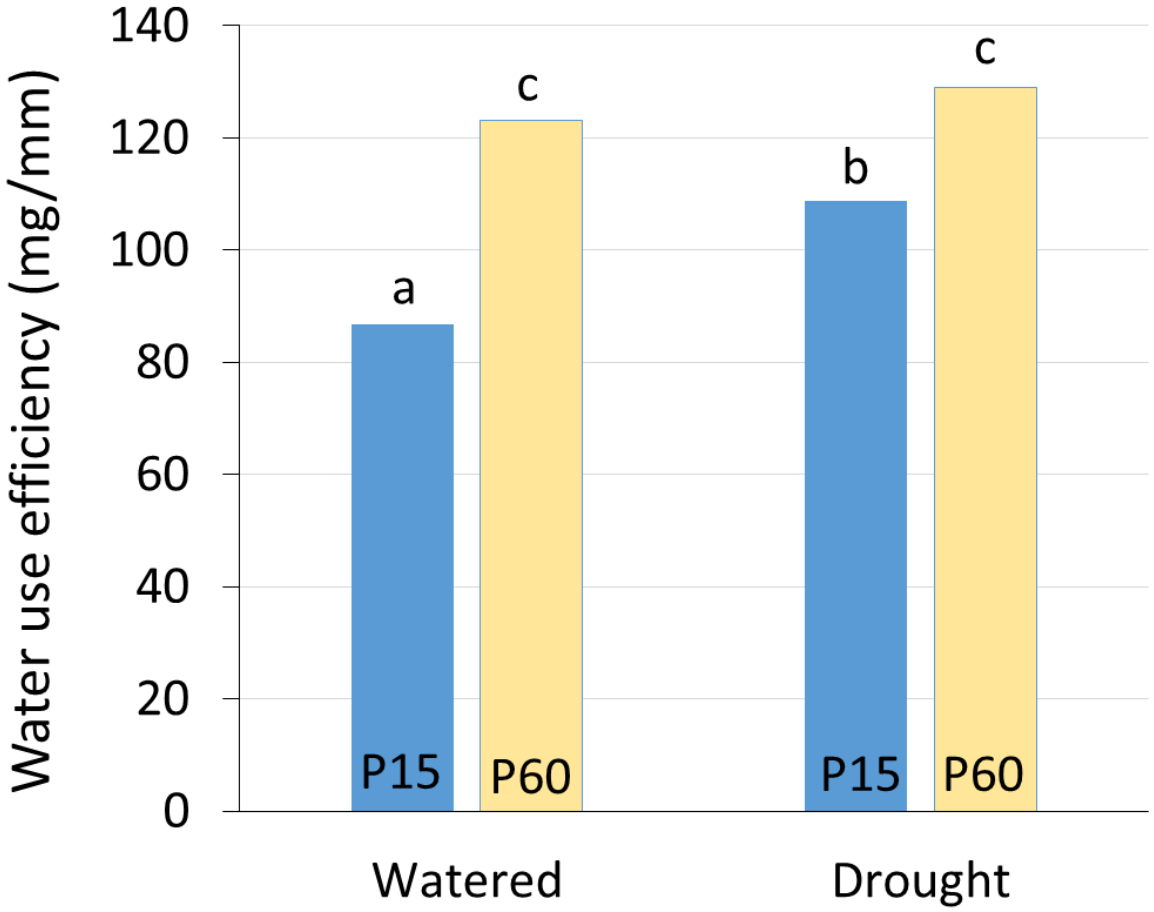
On to P and K

Drought on soil P and K

- P and K soil levels may be higher than average
- Long wet fall conducive to more decomposition of residue, increasing K levels
- Dry fall would lead to less P and K recycling from residue to soil.



P increased water use efficiency, thus drought tolerance, when initial soil test P was “low”

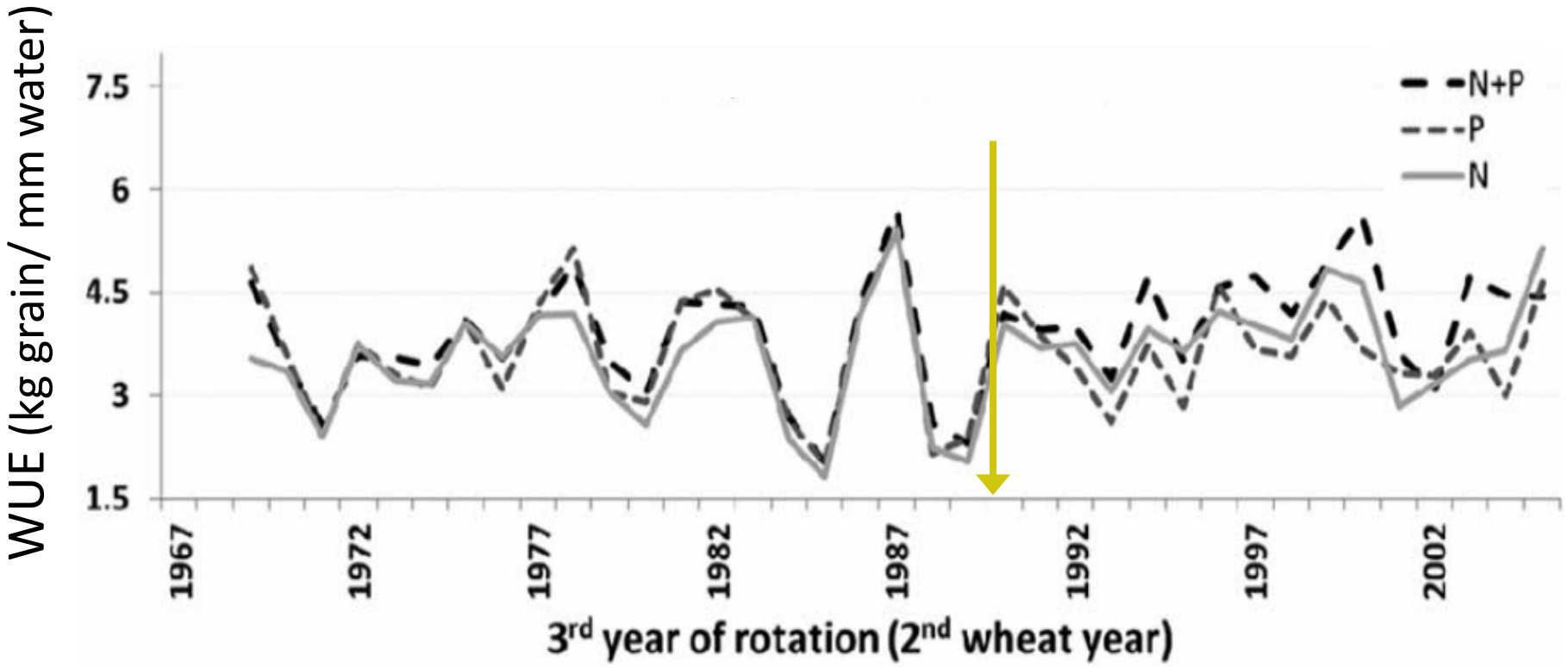


“drought” = no water for 21 days starting at initial flowering

Jin et al., 2015, Australia, field pea grown in buried cylinders under field conditions

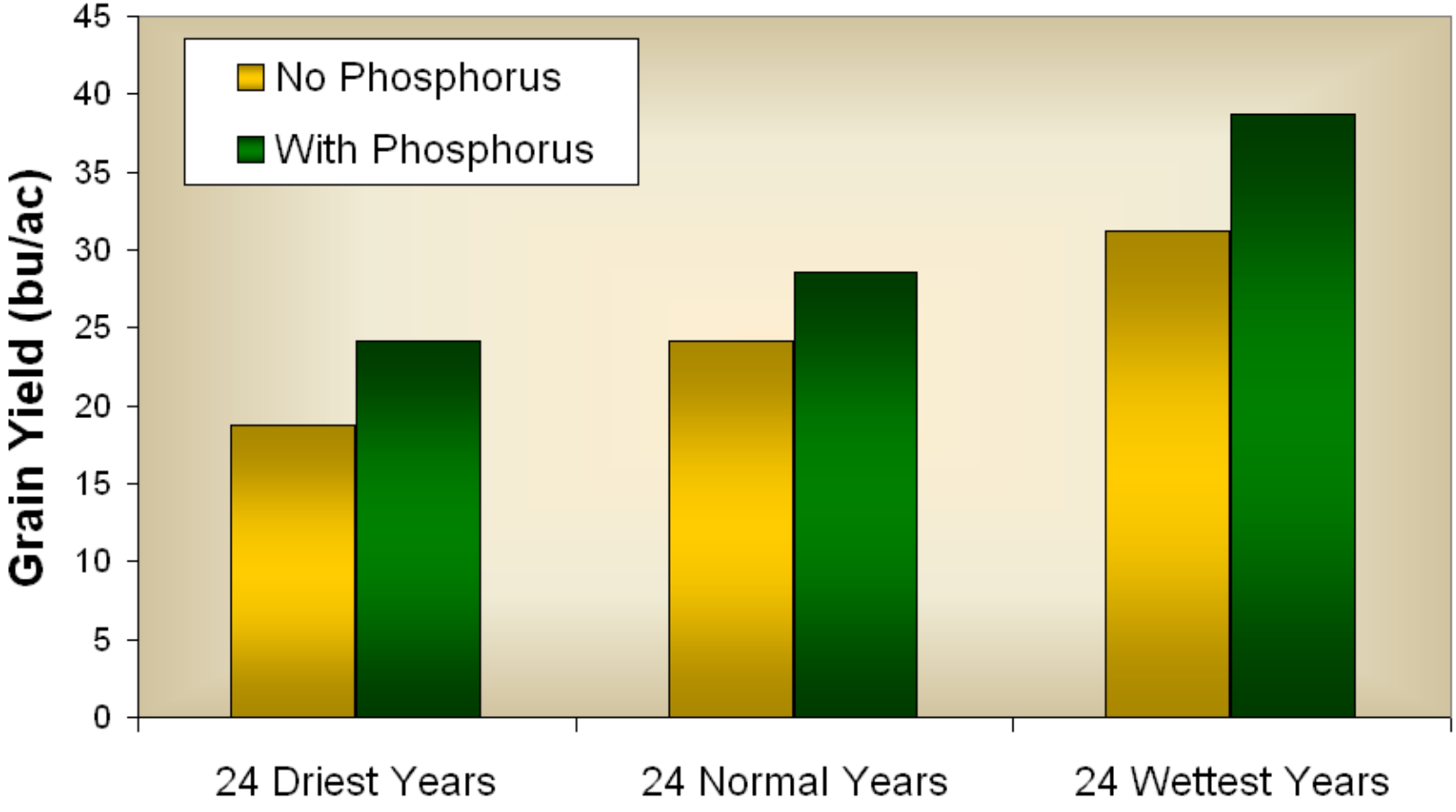
Balanced N and P result in highest water use efficiency

Especially when start pushing the system with high N
In 1990 N rates started doubling



Kroebel et al., 2012. SK

In dry years, it's tempting to back off on all fertilizer, including P and K, best choice?



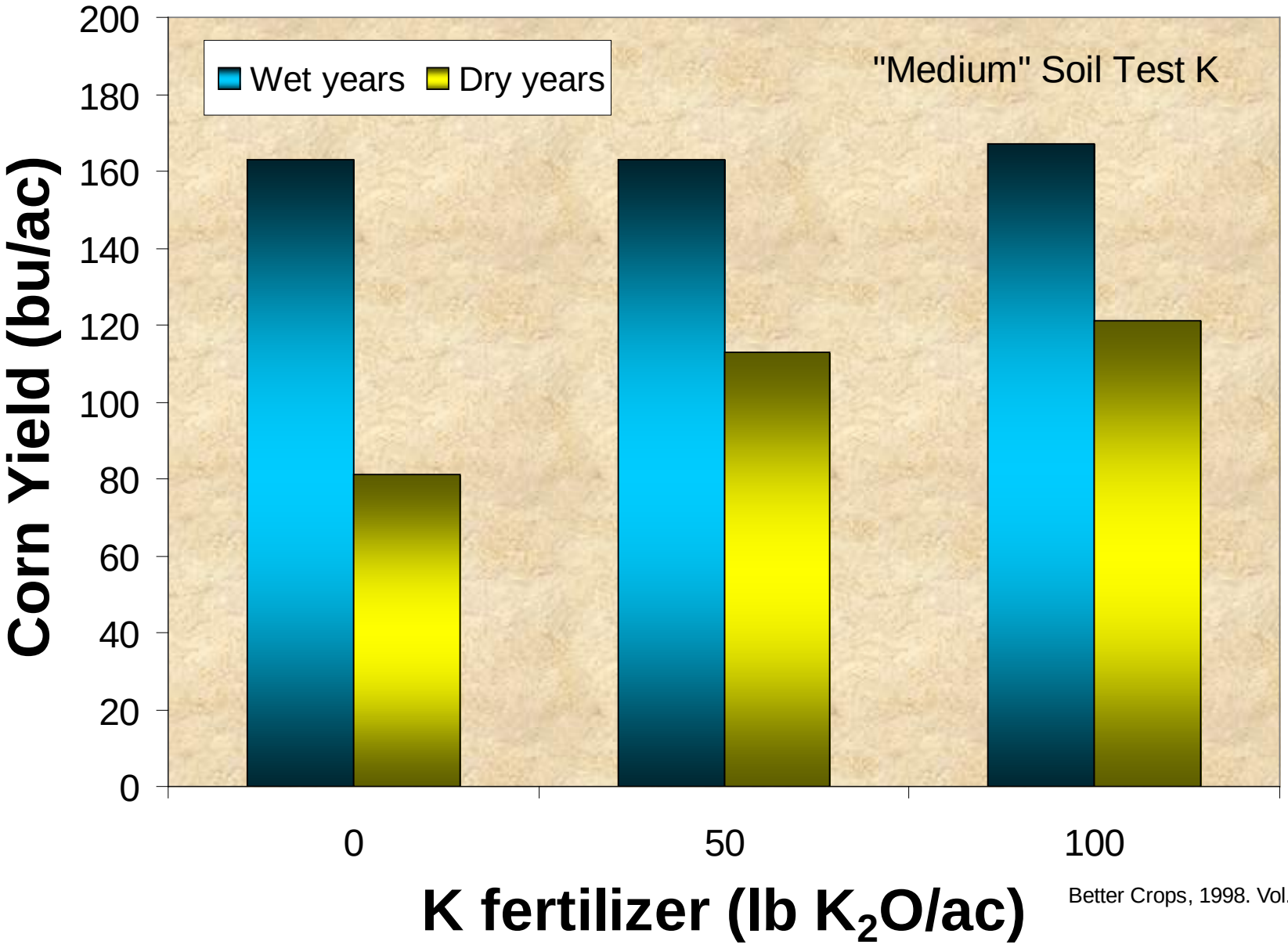
(Olsen P = 16-20 ppm; added 30 lb P_2O_5/ac; Scott, SK)

(Brandt, S. 2007. Phosphorus fertilization boosts yields in fallow wheat production. Better Crops with Plant Food. 91:15.)

Environmental stress and K

- Higher K for drought, cold, heat, high light, salinity tolerance (Wang et al., 2013)
- Stressed plants may actually need more K
- “Luxury consumption” may be insurance against environmental stress (Kafikafi, 1990)
- Foliar K between 2 weeks before anthesis to grain fill can improve yield in drought stress (Shabbir et al., 2016, Pakistan; Raza et al., 2013, Pakistan)

Effect of K on Corn Grain Yield



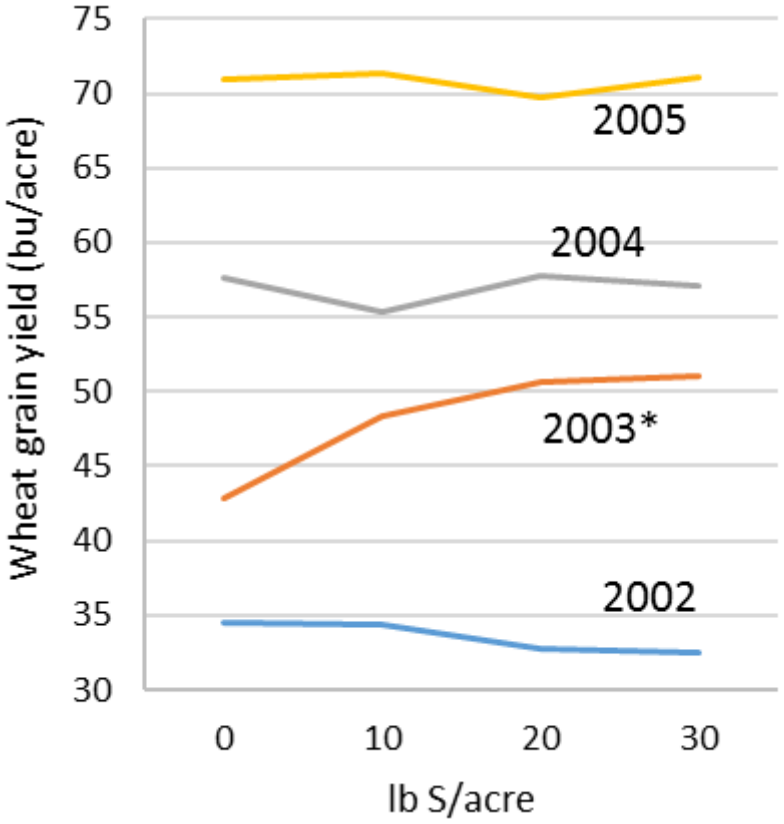
Better Crops, 1998. Vol. 82(3).

Recommendations for P and K

- In dry years, use the same amount of P and K fertilizer as in a “normal” year

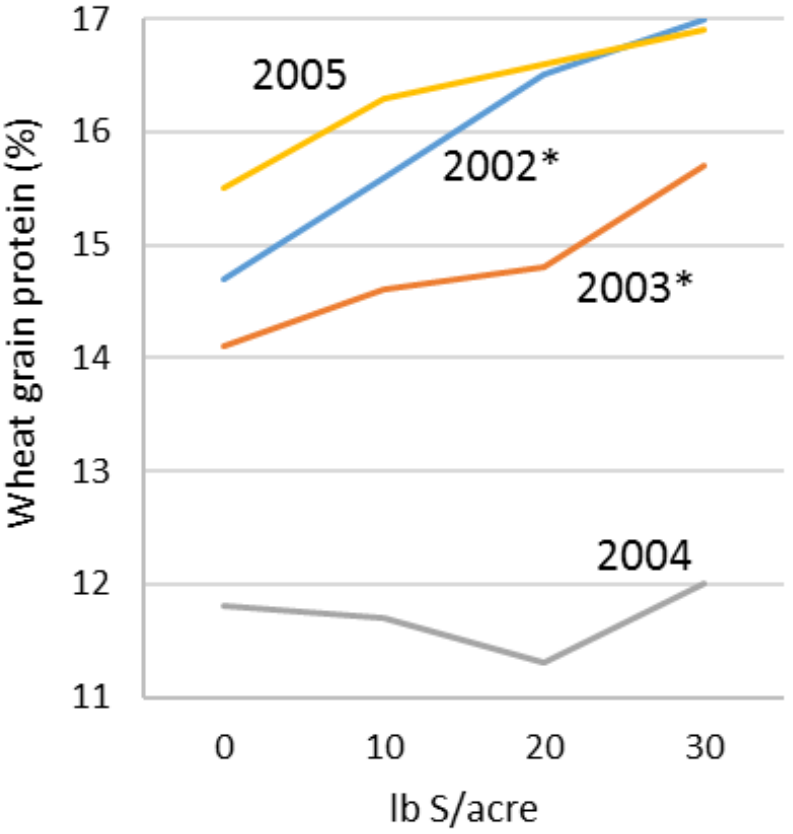
- P, K and S important for legume nodulation – don’t ignore

Sulfur can increase WW yield in drought years



In severe drought (2002), water, not S, limited yield. In moderate drought (2003), perhaps less gypsum dissolved and less SOM mineralized to provide S

And protein in both wet and dry years



Ffact No. 41, Knees, MT

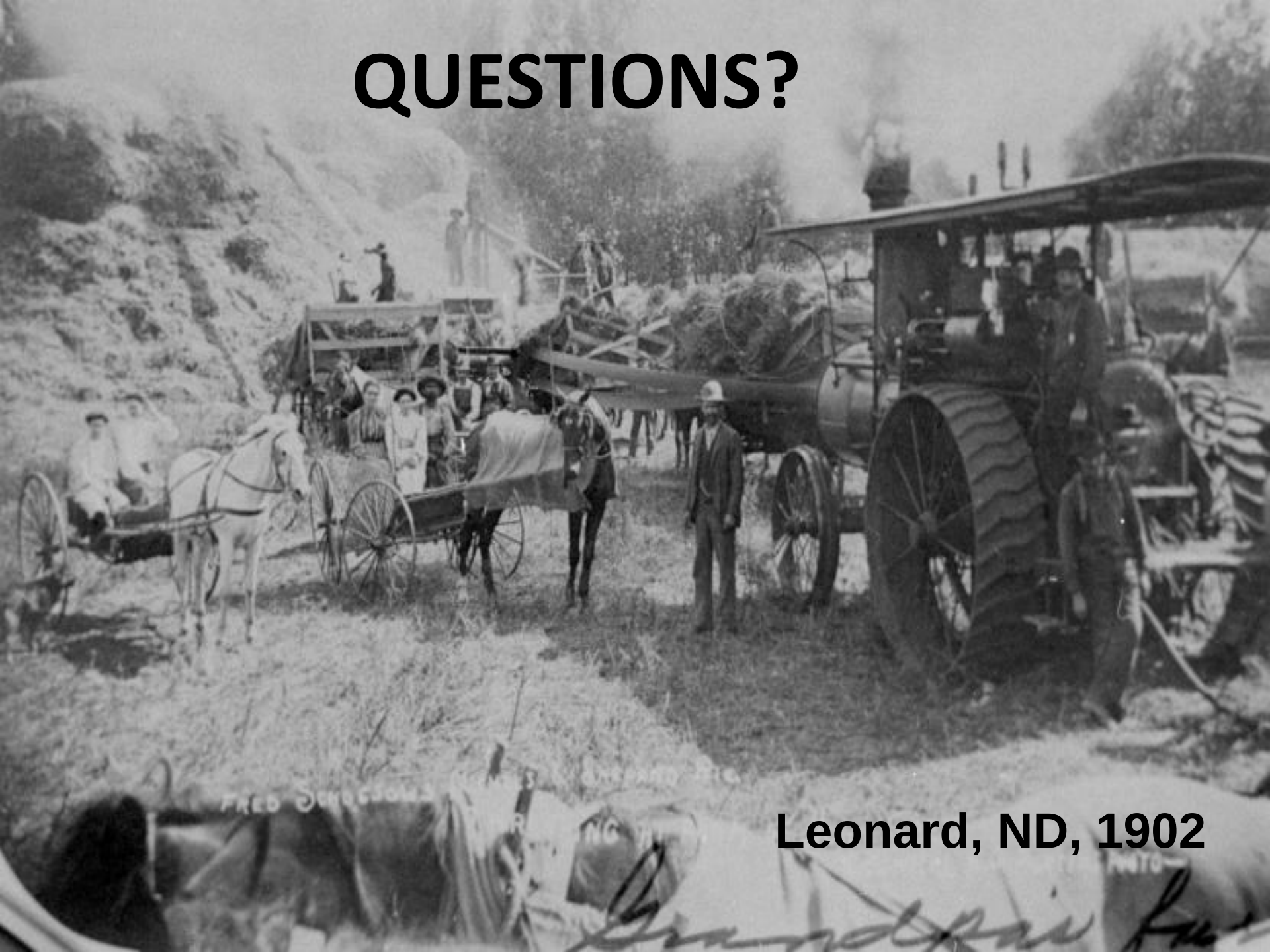
Summary

- Consider management to increase O.M. and water capture and retention for long term resiliency.
- Account for nutrient removal by harvest, plant part harvested, maturity of residue
- Fall conditions influence decomposition rate, N availability, P and K recycling
- Catch residual N with a fall planted cover or cash crop. Soil test and adjust N rate in spring.
- P and K likely different from average, adjust according to 6” soil test.

For more information

http://landresources.montana.edu/soilfertility

QUESTIONS?



Leonard, ND, 1902