Nutrient Management and Cropping Systems for Increased Resiliency

MSU/Lewis and Clark County Extension

Helena, March 21, 2017

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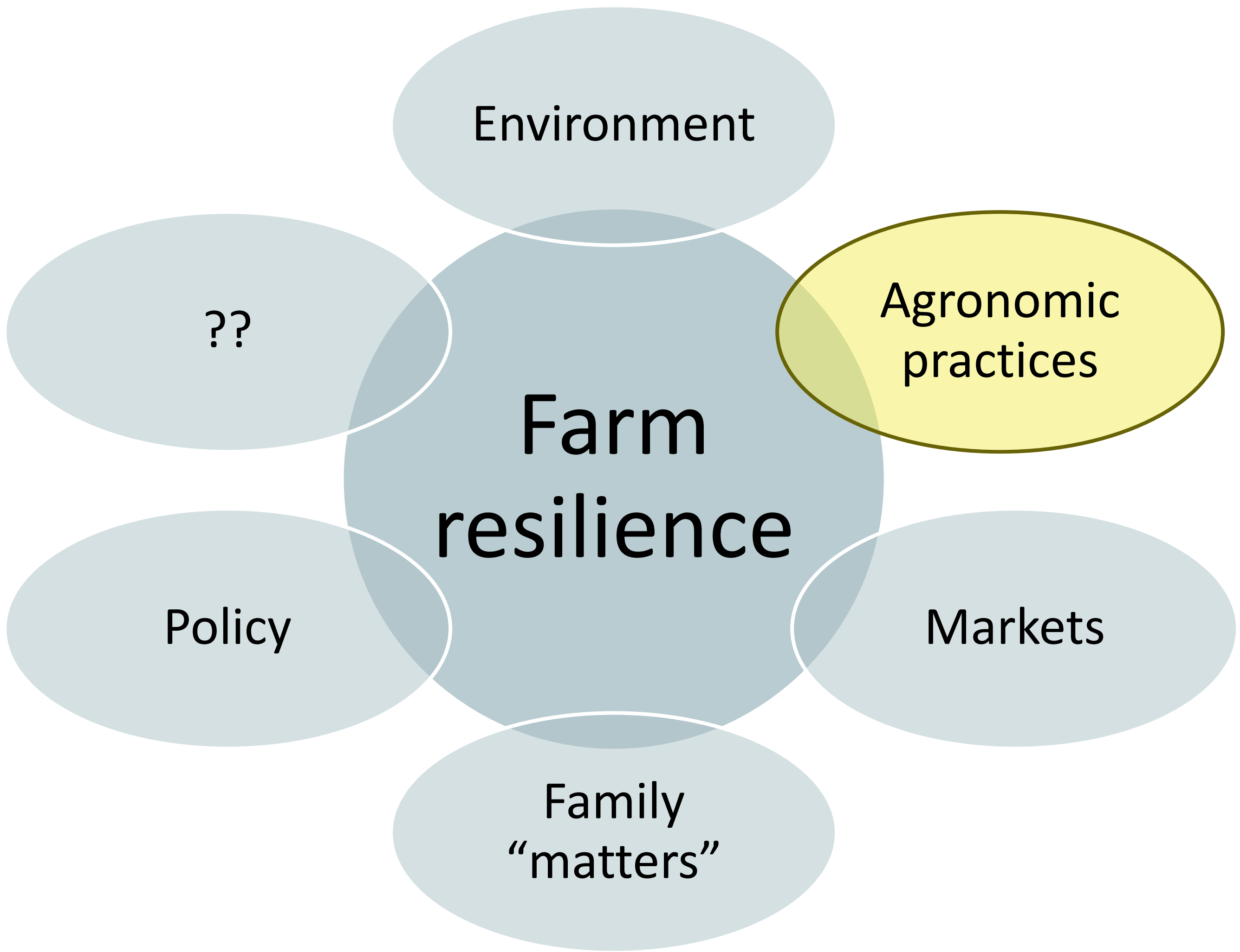
Factors affecting farm resilience



The elements to influence

Water

- Capture and hold
- Minimize soil erosion

Wind, Temperature (T)

- Buffer plant microclimate
- Reduce water evaporation
- Minimize soil erosion

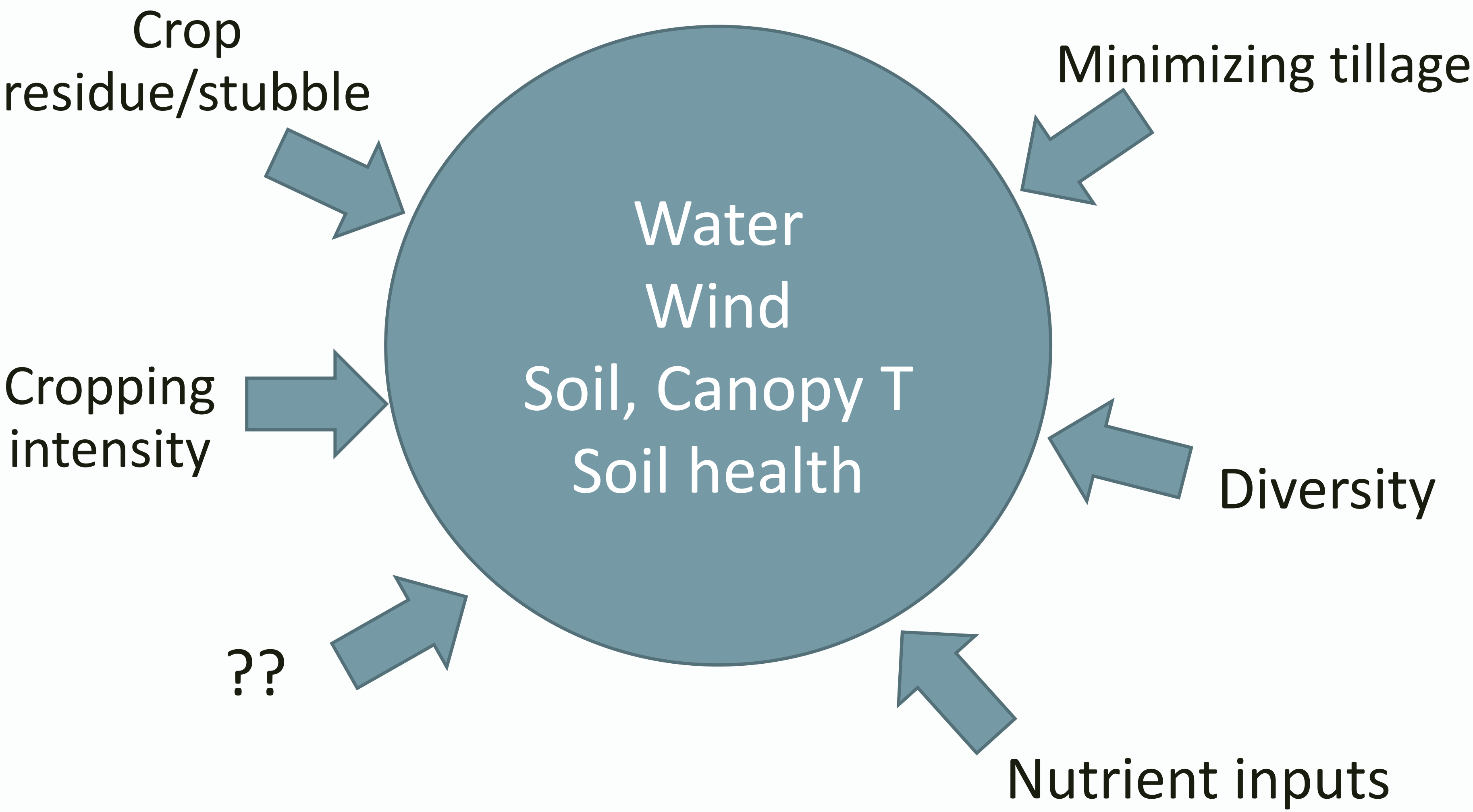
Soil health

- Provide/store nutrients
- Capture and store water
- Enhance biological/ecosystem functioning to reduce reliance on non-renewable external inputs

How?

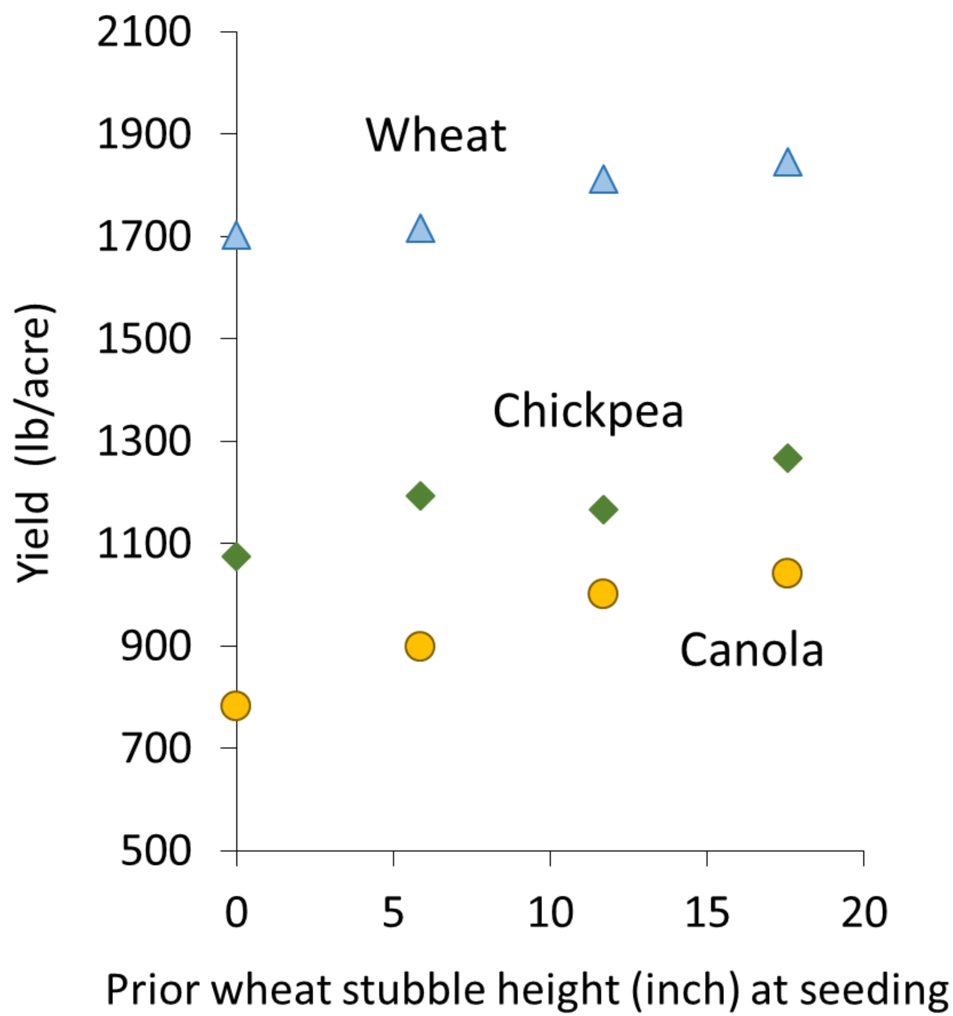
- Minimize disturbance
- Keep soil surface covered
- Keep living root in soil

Agronomic tools



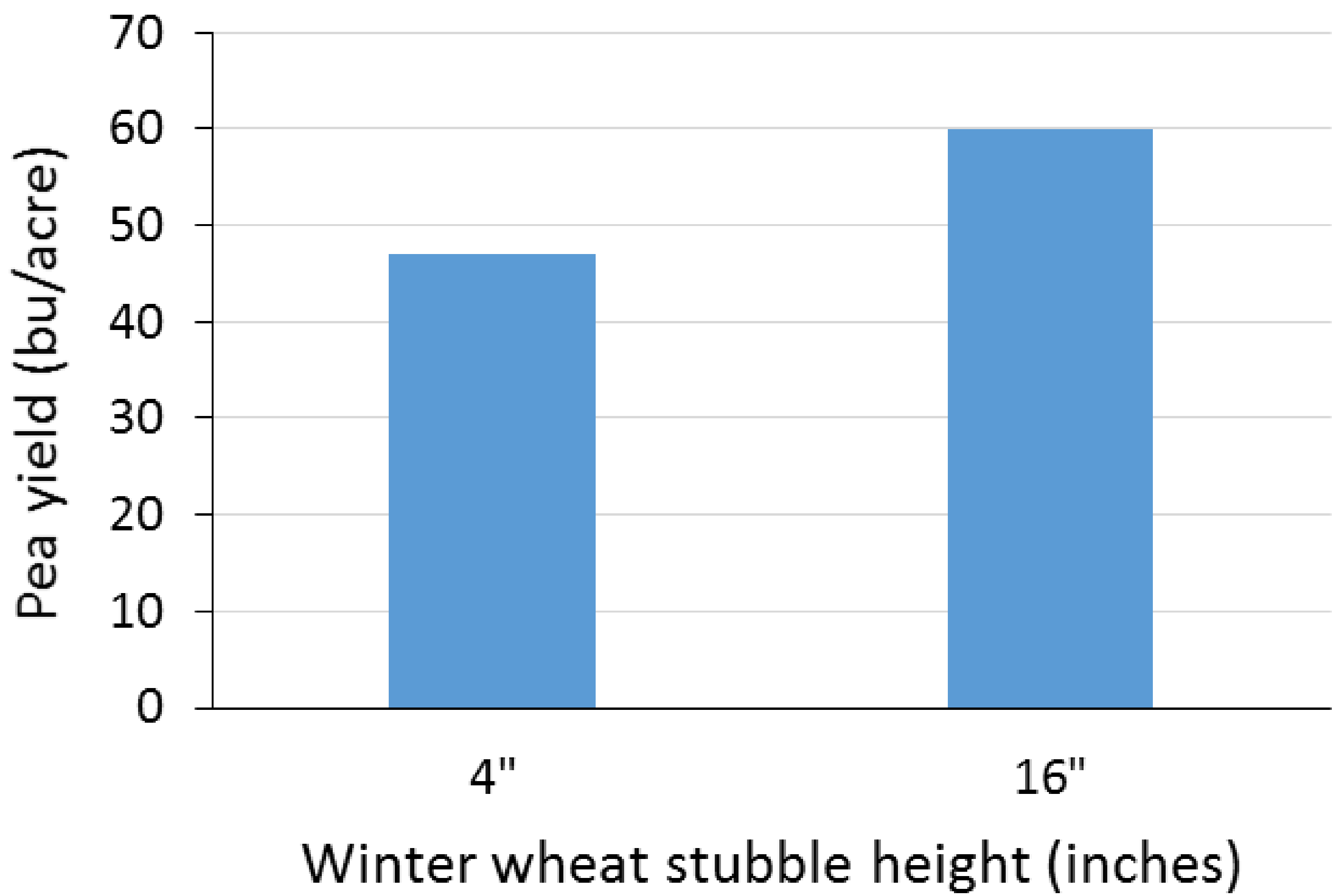
Residue and stubble

- Traps snow
- Reduces wind stress
- Reduces evaporation loss
- Reduces soil temperature
- Increases yields



Cutforth et al., 2011, SK
All started with same soil moisture at seeding

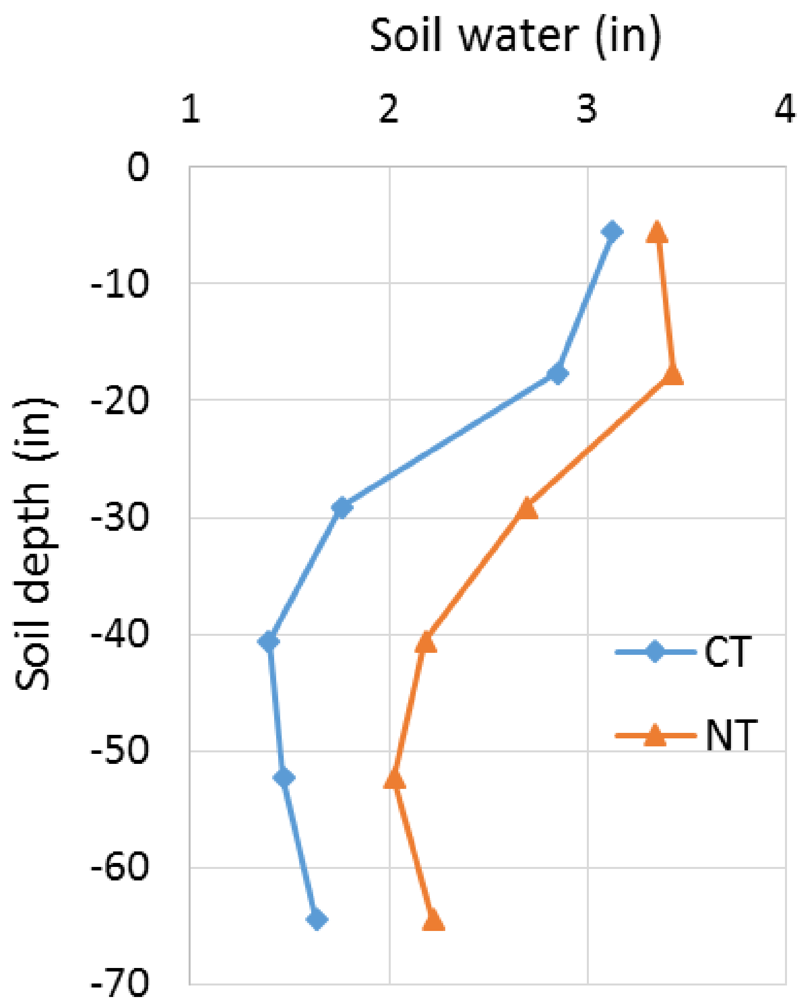
Pea yields in MT for short vs tall winter wheat stubble



Miller and Flikkema, unpub data, Amsterdam, 2004

Direct seeding/no-till

- Retains surface residue
- Reduces evaporation loss
- Reduces soil temperature via crop residue
- Increase water infiltration & storage
- Improves soil aggregation



Nielsen and Vigil, 2010. CO
10-yr average, pre-plant for winter wheat

Estimated wind erosion loss rates for conventional-, minimum- and no-till in wet and dry years

	Soil loss		N loss[a]		P_2O_5 loss[a]	
Tillage system	tons/ac		lb/ac			
	Wet	*Dry*	*Wet*	*Dry*	*Wet*	*Dry*
Conventional	0.062	10	0.15	25	0.08	28
Minimum	0.068	7	0.16	17	0.08	19
No-till	0.002	5	< 0.01	11	< 0.01	13

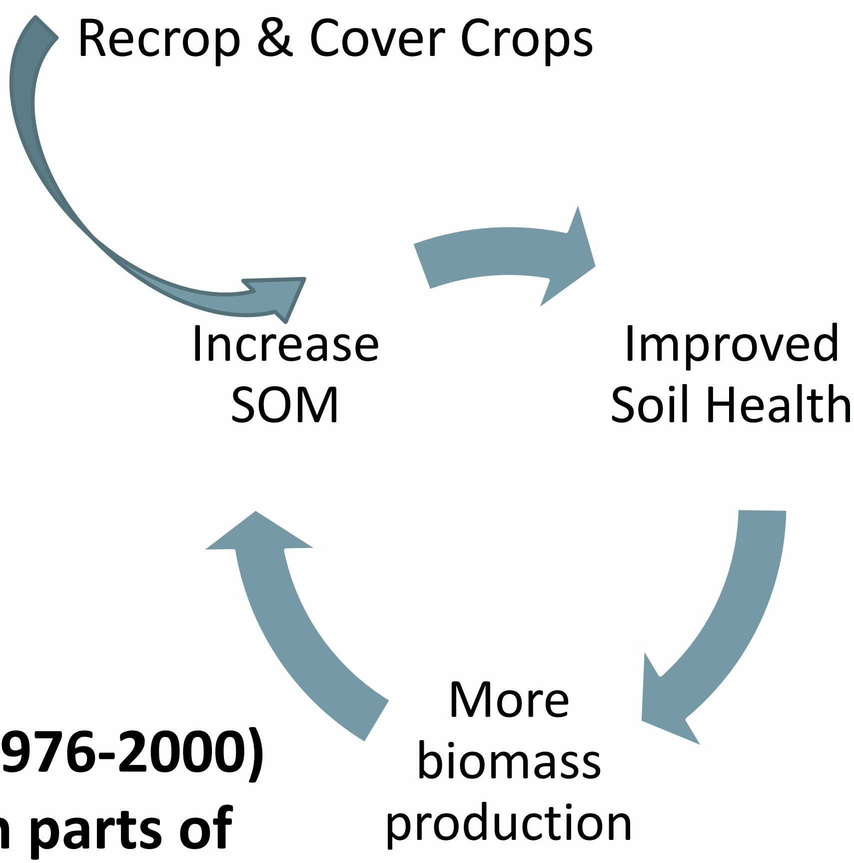
Note that P_2O_5 lost in tilled fields is similar to what is often applied. Decreases resilience.

[a]Assumes soil contains 0.12% N and 0.06% P

RWEQ model; Merrill et al.,1999

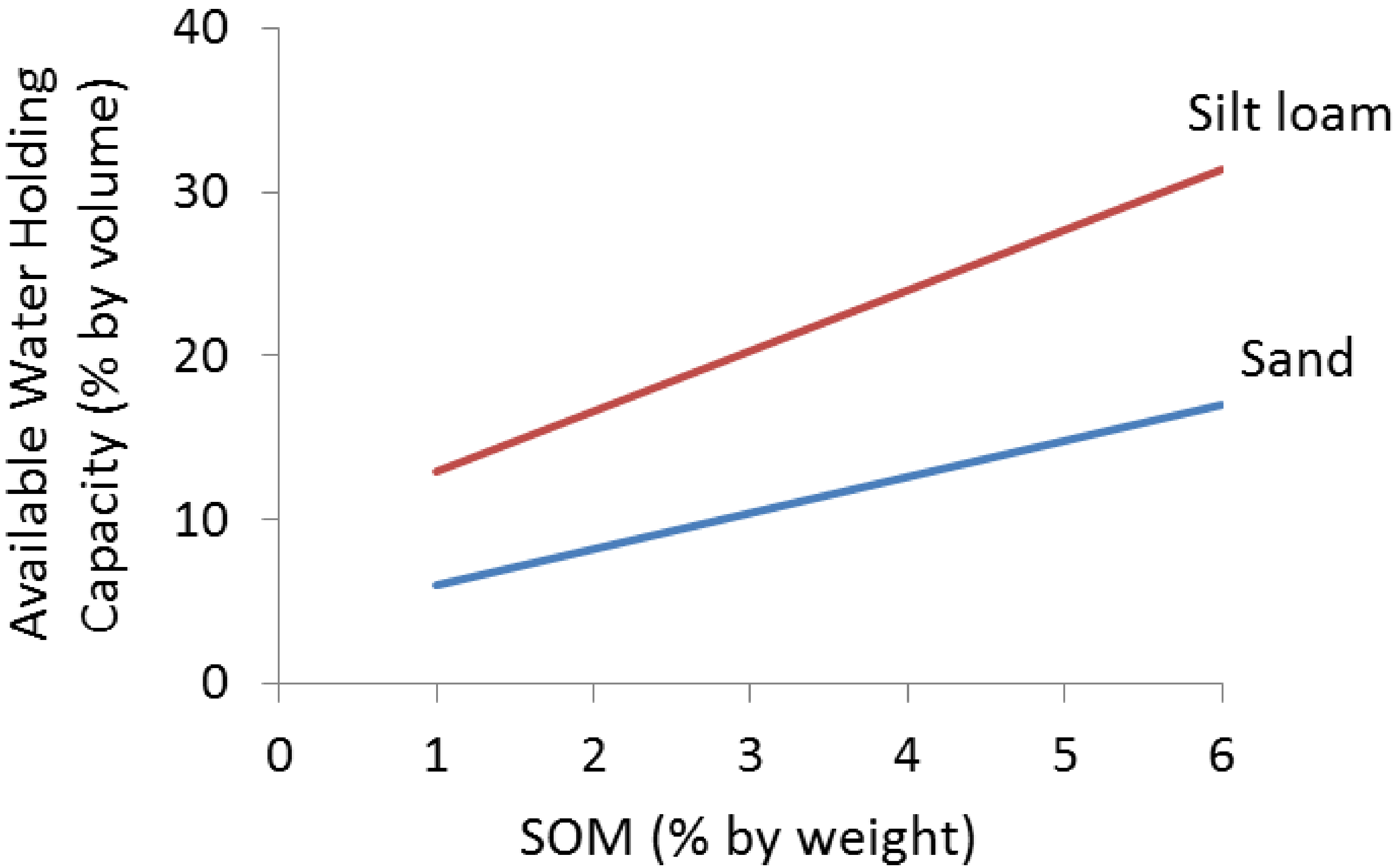
Cropping intensity – recrop or cover crop

- Increases SOM
  - Takes time
  - Increases water holding capacity
  - Provides nutrients for crop and soil microbes
  - Improves soil health
- Increases and retains active root in soil for longer
- Reduces soil temperature AND regional temperature



Mid-June to July 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)

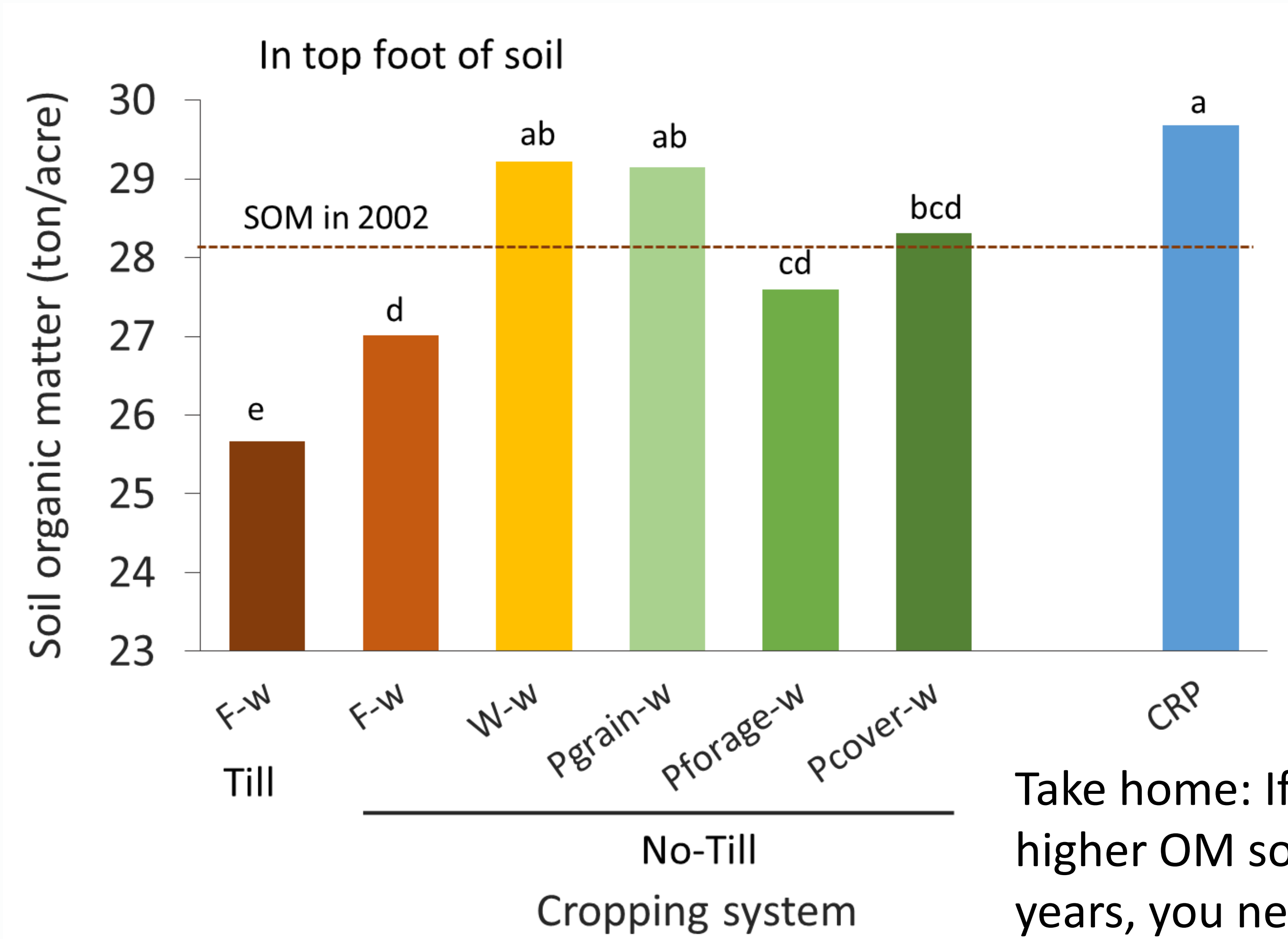
SOM increases available water holding capacity



Hudson 1994

Guesses on how long to increase SOM from 2.0 to 2.2% (meaning by 10%)?

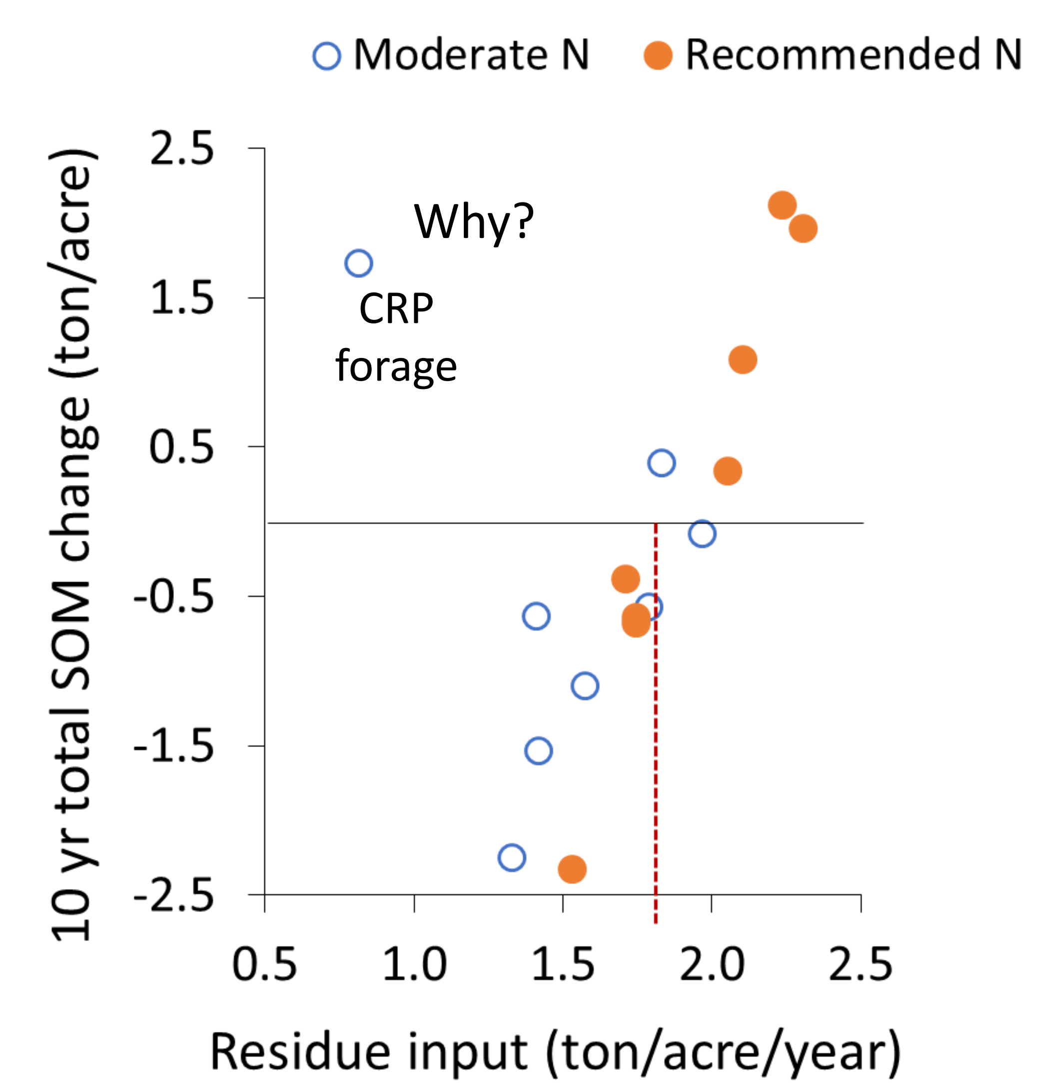
SOM after 10 years of cropping systems (2012)



Take home: If want to have higher OM soil in say 20 years, you need to start NOW.

Engel, in press, MSU Post Farm, 4 miles west of Bozeman

SOM change depends on residue returned, which depends partly on inputs



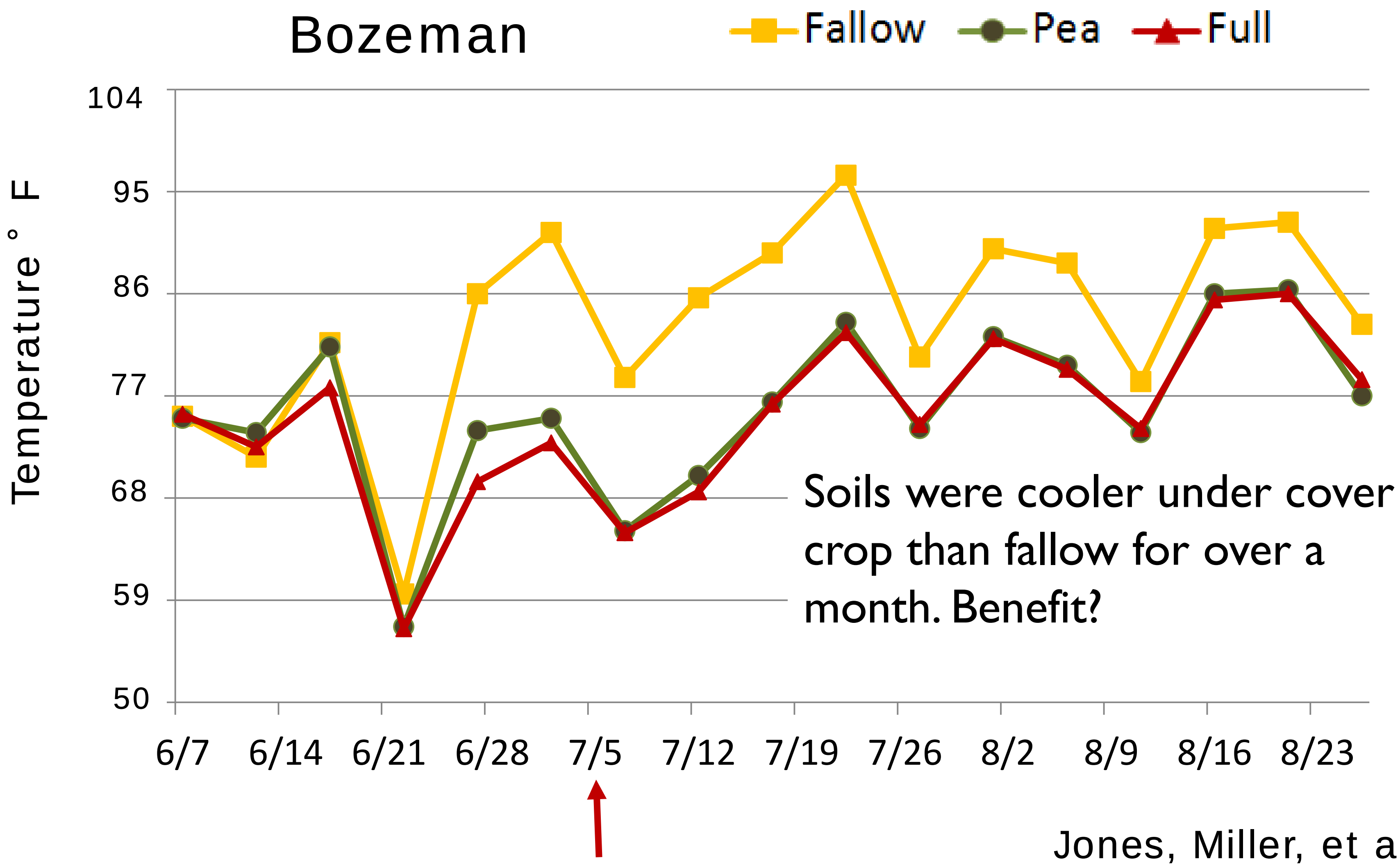
- Residue
- Active roots
- Organic material with high N,P, and S

(Wuest and Reardon, 2016, OR)

Take home: Best way to increase SOC is to increase amount of residue returned. Need about 1.8 ton residue/acre per year from annual crops to break even. Best way: recrop and apply recommended N rates, or grow perennials.

Engel et al., 2017, Bozeman

4 pm daily soil temperature at 2" deep higher under fallow than cover crops (but no differences between pea and full)



Cover crops terminated on 5 July

Jones, Miller, et al. unpublished

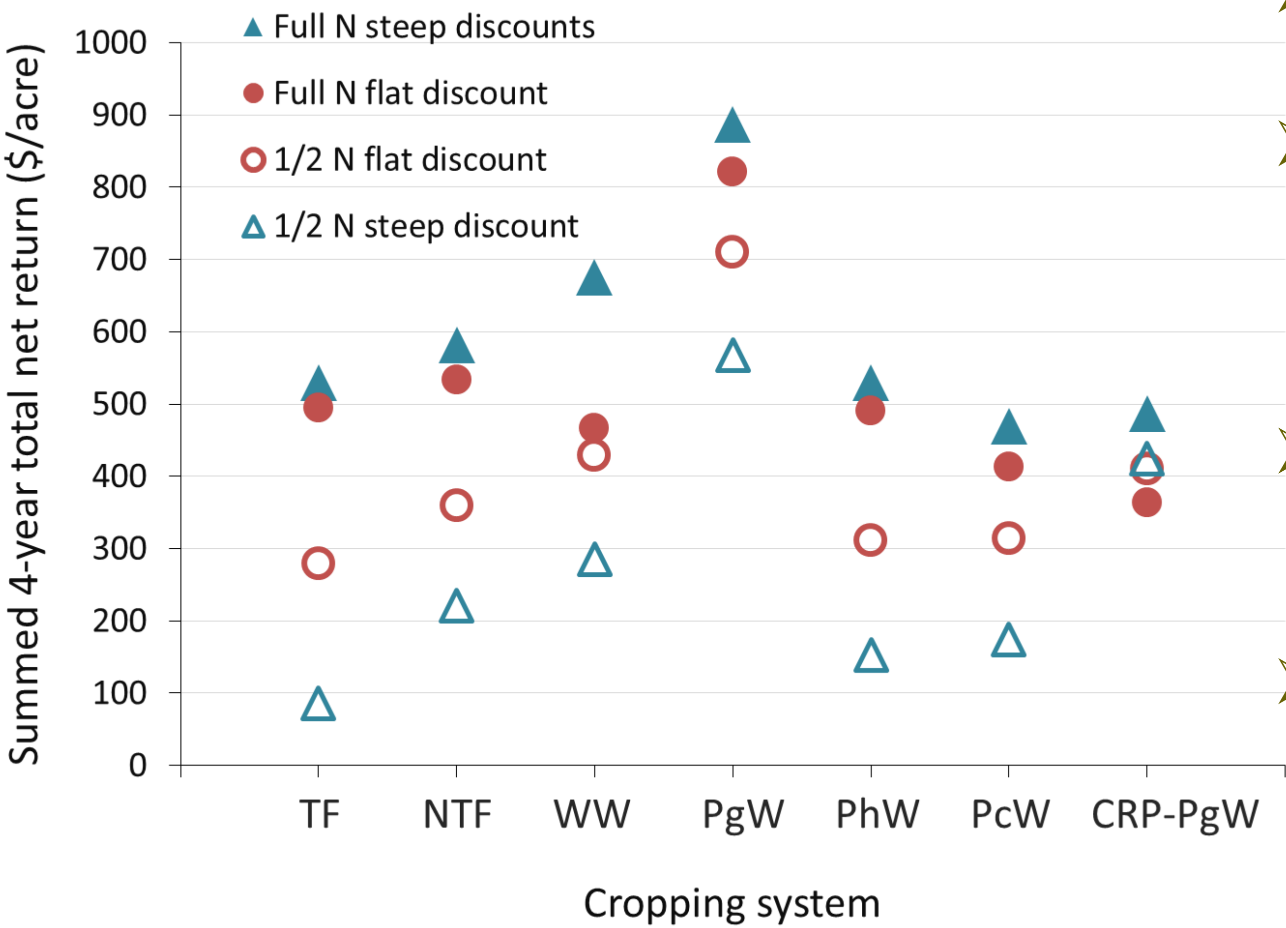
Diversify – how could you & how would it help?

- Structural diversity in field, e.g., stubble strips
- Genetic diversity
- Intersperse fields with non-crop vegetation
- Polycultures – mix species w/in field
- Mix of winter and spring crops

- Interrupt pest/disease cycles
- Buffer microclimate extremes
- Increase production
- Increase yield stability, reduce risk

Would you consider using pulse or cover crops to diversify?

Cropping systems and economic resilience



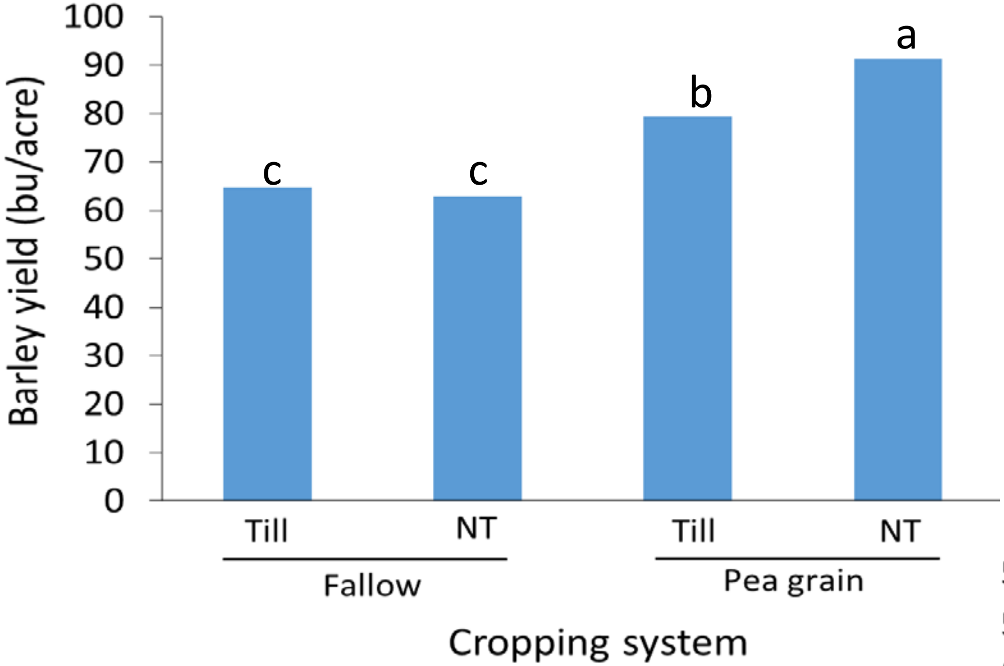
Take home:

- Pea-grain big revenue winner
- Pea hay or cover crop similar revenue to fallow or continuous W
- Pea-grain at ½ N = revenue of fallow at full N.
- <u>Biggest economic winner also built SOM</u>

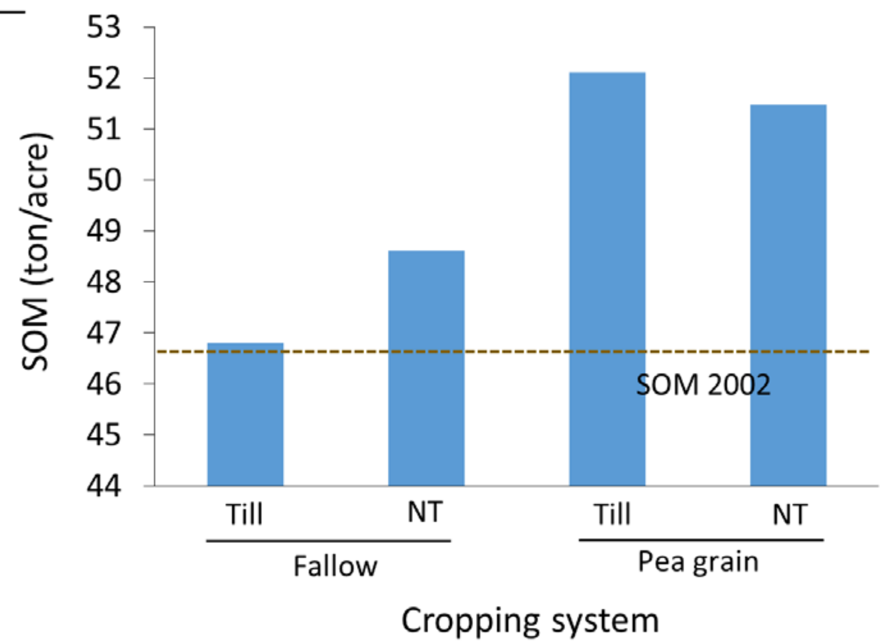
14-yr plot study, 2013-2016 = dry years
MSU Fertilizer Fact # 72 by Miller et al. (2017)

How do results compare to locations outside Gallatin Valley?

Crop rotation and tillage system effects



After 10 years of cropping system. Barley yield and SOM in 2012 after fallow for both systems (pea field too wet).

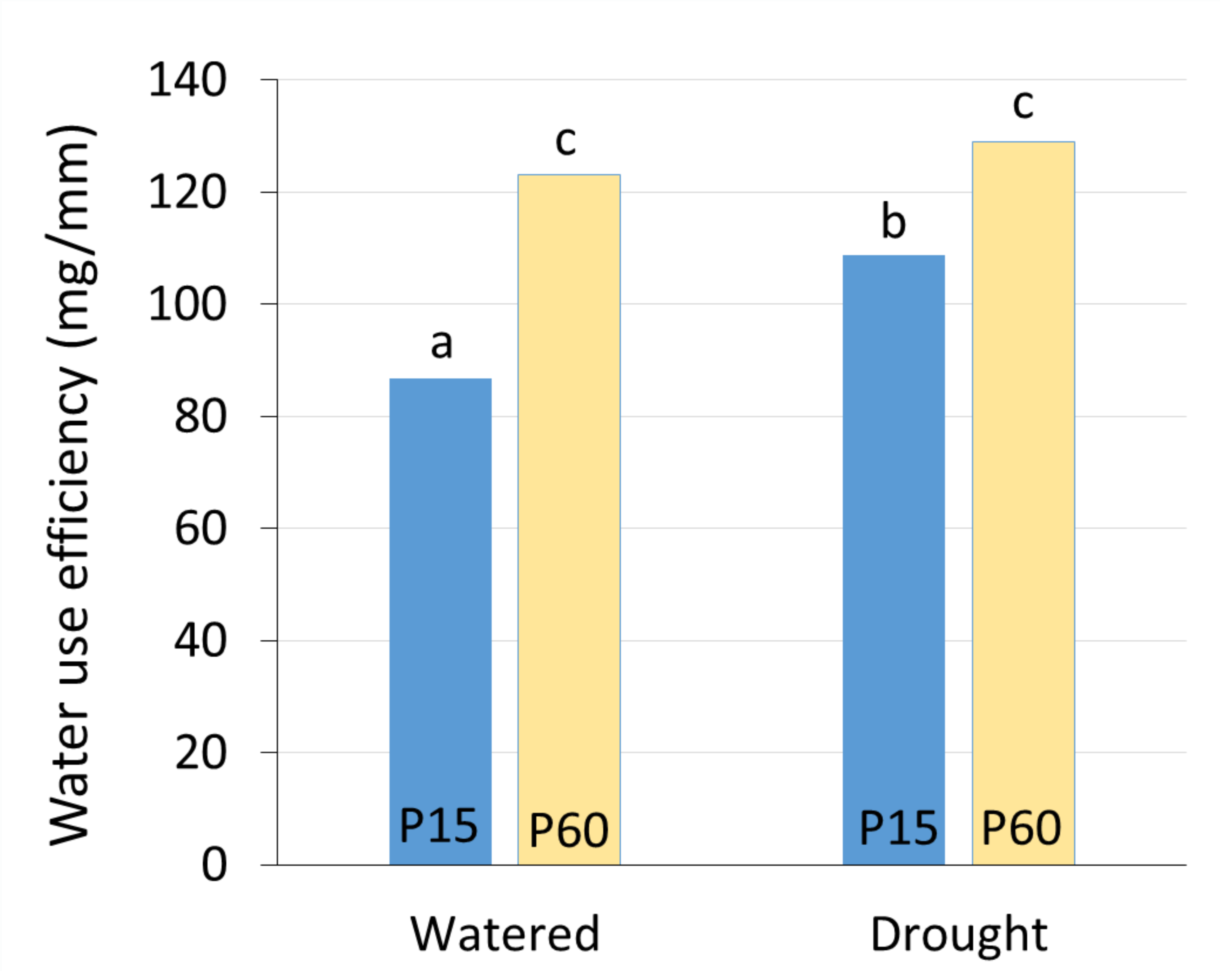


P. Miller and R. Engel, unpub. data, Fife, MT

Fertilizer management

- Lower early N – allows flexibility for given year's precip, prevents excess vegetative growth
- Fertilizer N > Removal N rates or can't build OM
- 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.*
- P and K for improved water use efficiency/stress tolerance
- Mycorrhizal association enhances N, P and micronutrient uptake under water stress (Tobar et al., 1994; Al-Karaki et al., 1998)

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

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)

Climate-smart agriculture summary

Tools to cope with the challenges of climate change:

Adaptations

- Develop and use tolerant varieties
- Increase diversity
- Use cropping associations, rotations, and sequences
- Manage for efficient water capture, retention, use

Resiliency

- Build and maintain healthy soils now with adequate fertilization
- Enhance and capitalize on natural biological processes
- Avoid degradation of natural resources
- Reduce reliance on non-renewable external inputs if possible

QUESTIONS?

For more info go to:
http://landresources.montana.edu/soilfertility