# MSU-Bozeman Cover Crop Research

## NPARL Focus Group Meeting

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MONTANA STATE UNIVERSITY EXTENSION

# Today's objectives

- Summarize past cover crop research findings of the MSU Cropping Systems group
- Present results from recent and ongoing MSU cover crop studies

# MSU single species cover crop research since 1999 has found higher grain yields and/or protein after cover crops when:

1. Seeding winter legumes (vs spring legumes)
2. Seeding spring cover crops early (vs late)
3. Terminating at first bloom (vs pod)
4. Tilling cover crop (vs spraying)

Why?

More N fixed (1)

More time for soil water to be recharged and N to become released from residue (1, 2, 3)

Faster N release and fewer N losses (4)

# Questions still to be answered

- Do cover crop mixtures improve yield, protein, and soil health more than single species?
- Do yield and soil health benefits increase with number of cover crop cycles?

# Study 1: Cover crop cocktails, one 2-year cycle, four site years

- Objective: Determine effects of “functional groups” within mixed cover crops on yield and soil health
- 2 sites in Triangle (Dutton and Conrad), 2 sites in Gallatin Valley (Amsterdam and Bozeman)
- 2nd cc cycle at Conrad and Amsterdam was completed in 2014 (but no soil data yet)
- Full field component as well

# Study Sites


3 on-farm conventional
1 university land

3 yr minimum no-till

| Year | Amsterdam, Conrad | Bozeman, Dutton |
|---|---|---|
| 2012 | cover crop | -- |
| 2013 | wheat | cover crop |
| 2014 | cover crop | wheat |
| 2015 | wheat | cover crop |

# Plant Functional Groups & Species

## Nitrogen Fixers

Spring Pea
*Pisum sativum*

Common Vetch
*Vicia sativa*


Lentil
*Lens culinaris*

## Fibrous Root

Oats
*Avena sativa*

Italian Ryegrass
*Lolium multiflorum*


Proso millet
*Panicum miliaceum*

## Tap Root


Safflower
*Carthamus tinctorius*

Purple Top Turnip
*Brassica rapa*

## Brassica

Daikon radish
*Raphanus sativus*

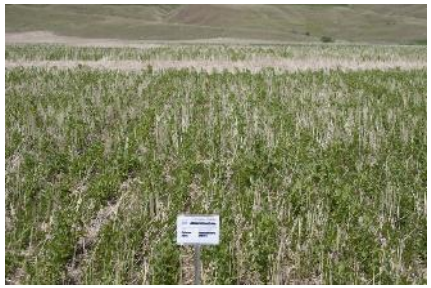
Camelina
*Camelina sativa*


Winter Canola
*Brassica napus*

Fallow

Pea

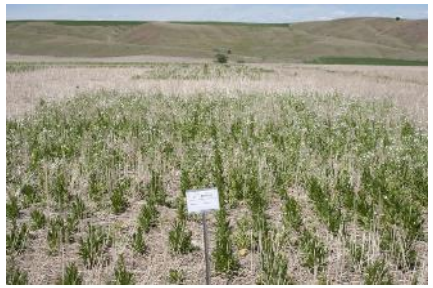
Full (8 species)



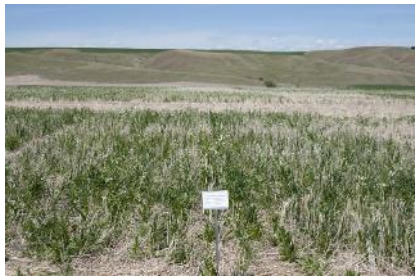
Nitrogen Fixers

Fibrous Roots

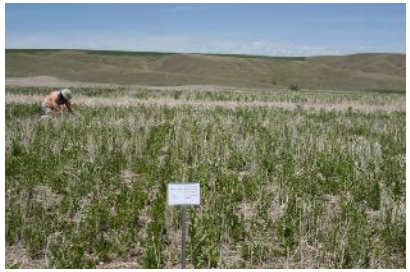
Tap Roots



Brassicas



Minus Nitrogen Fixers



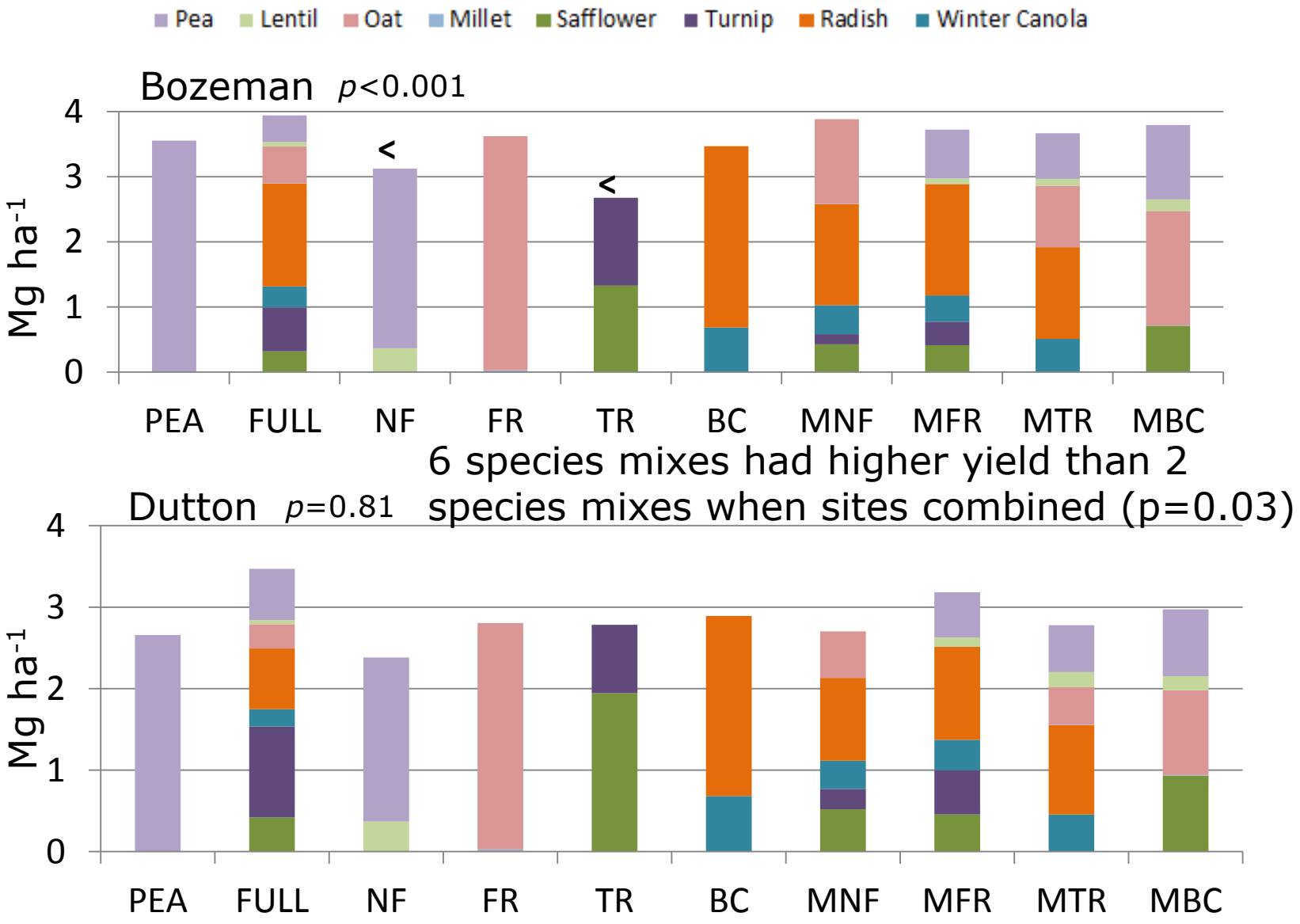
Minus Fibrous Roots

Minus Tap Roots

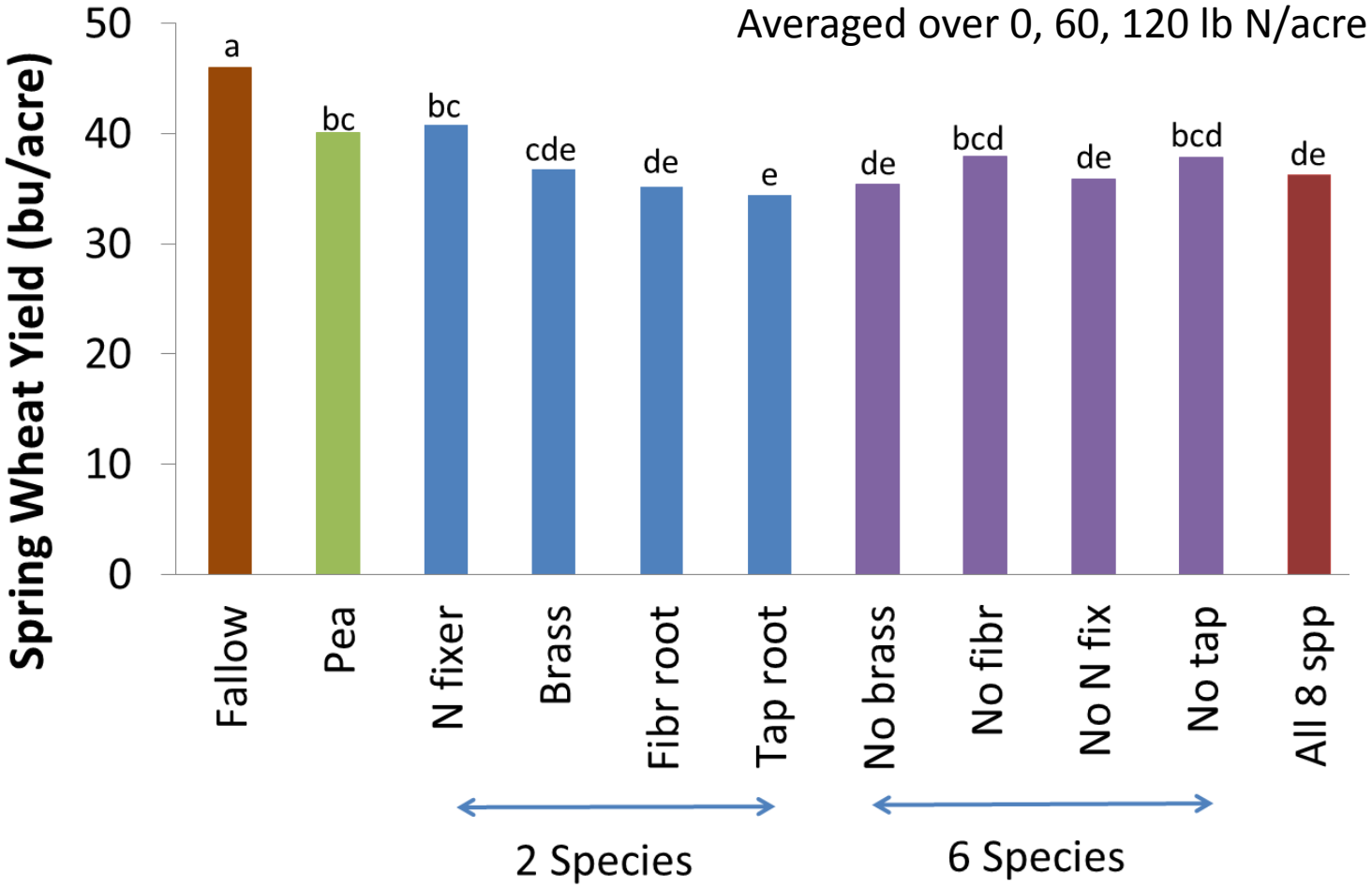
Minus Brassicas
*(no turnip)*

*All photos: Steve Spence; Amsterdam, 14 June 2012*

# 2013 Cover Crop Biomass

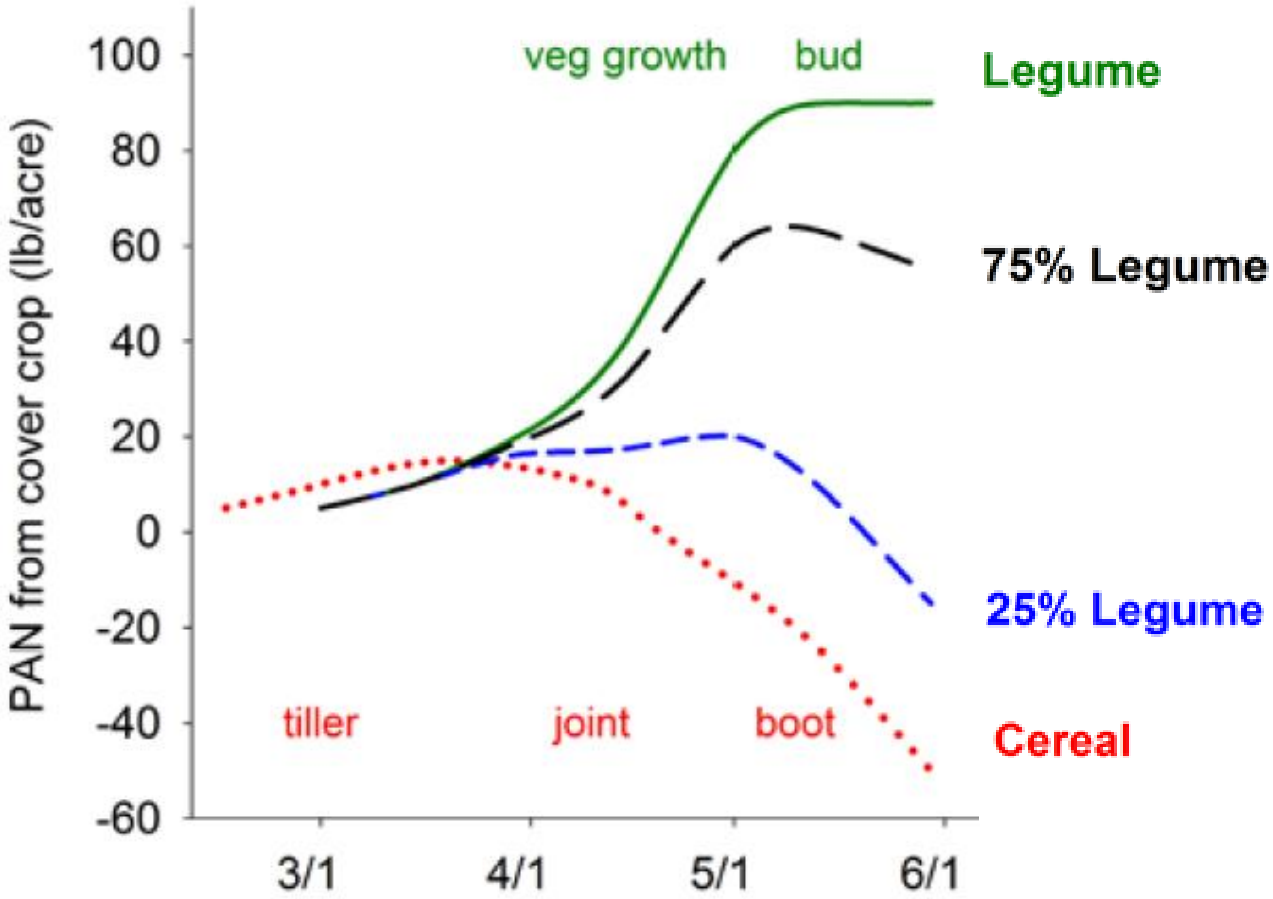


# Effect of cover crop treatment on spring wheat grain yield at Dutton (2014)




Housman et al., unpub. data, Dutton

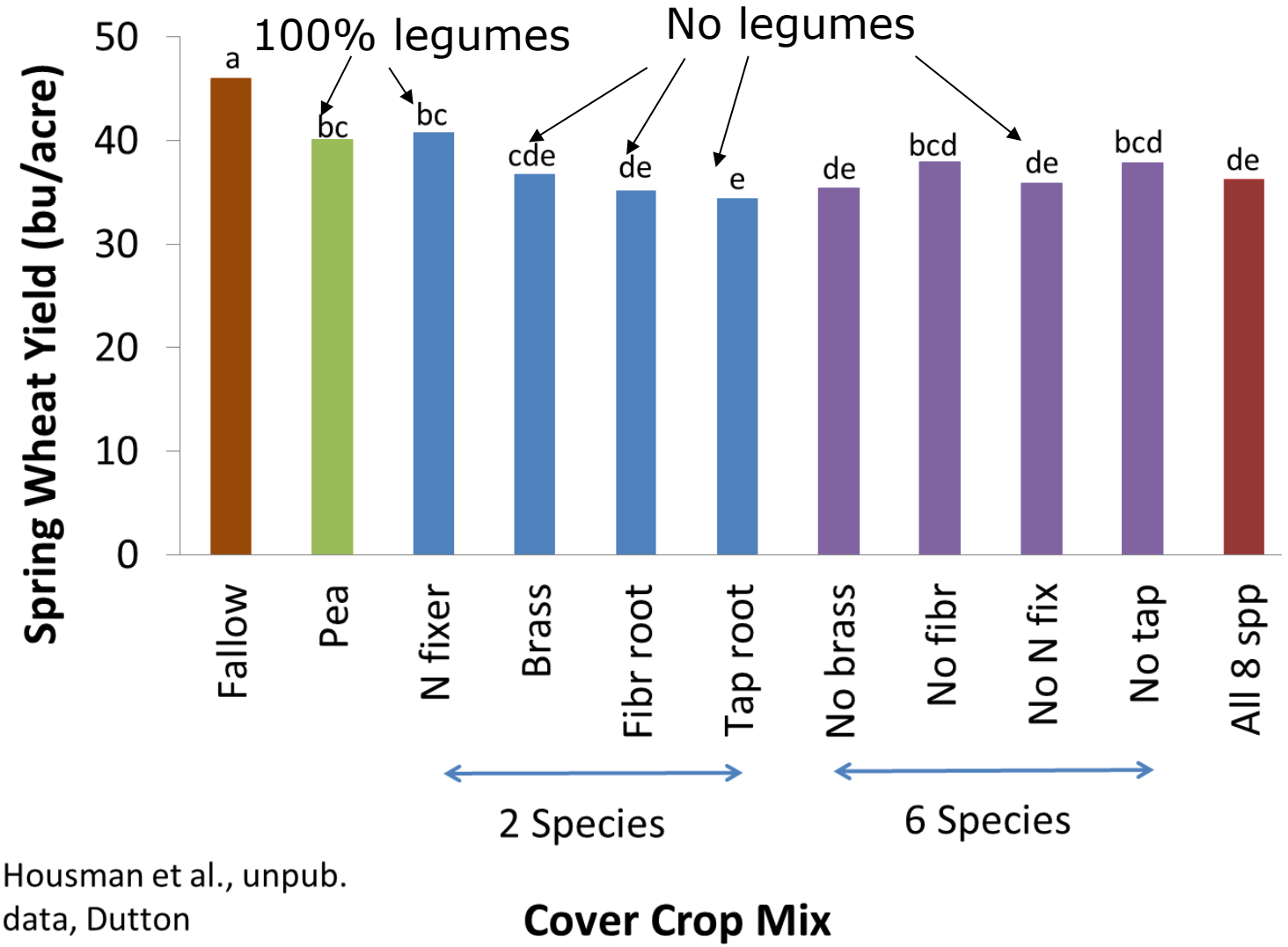
# Percent legume and termination timing affects plant available N (PAN)




**Take home**: Legume % less than 50 can result in low available N esp if terminated late

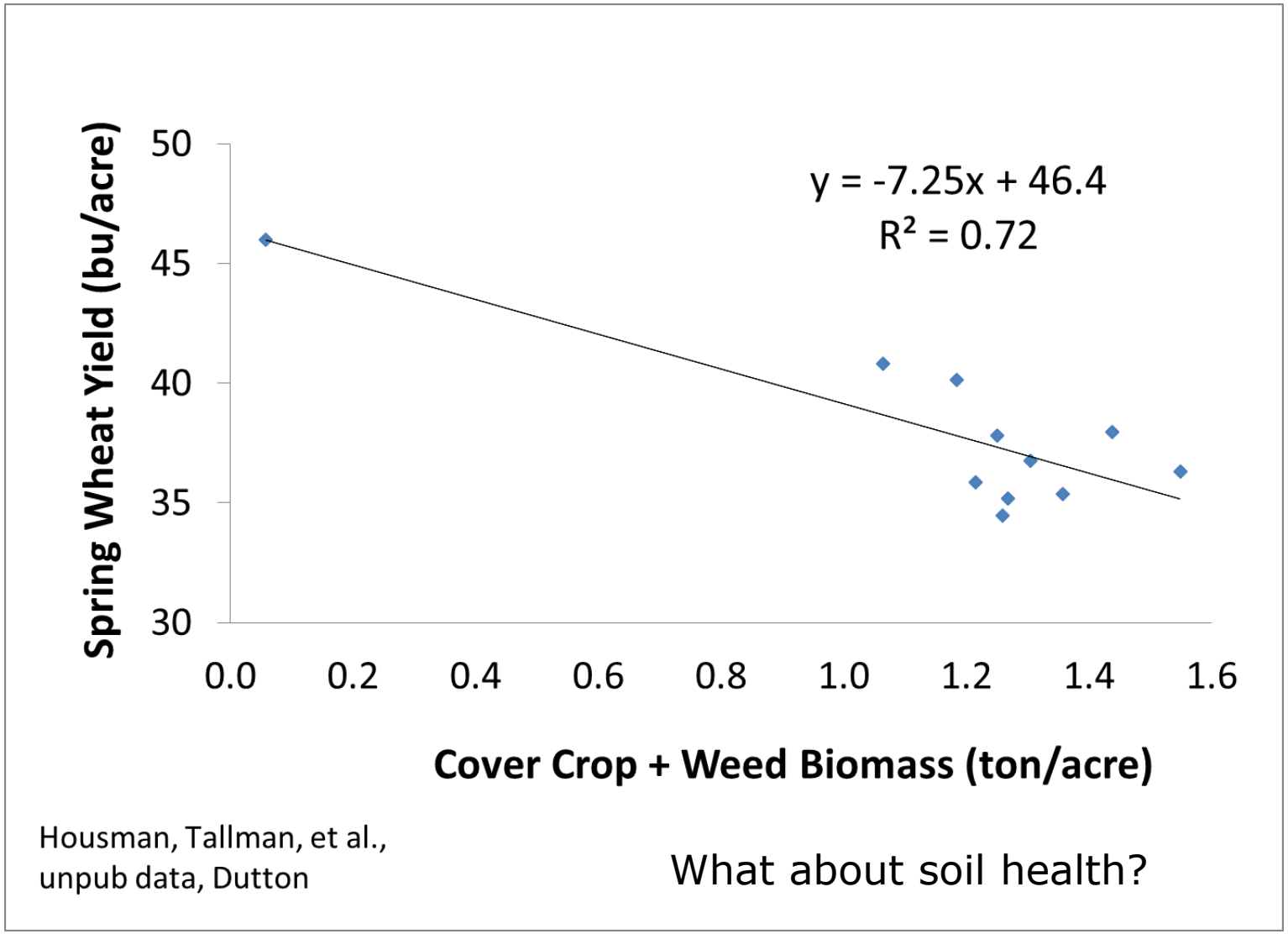
Willamette Valley, Oregon
Sullivan and Andrews, 2012

# Effect of cover crop treatment on spring wheat grain yield at Dutton (2014)




Housman et al., unpub. data, Dutton

# Spring wheat yield at Dutton vs previous year total biomass (cc + weed)

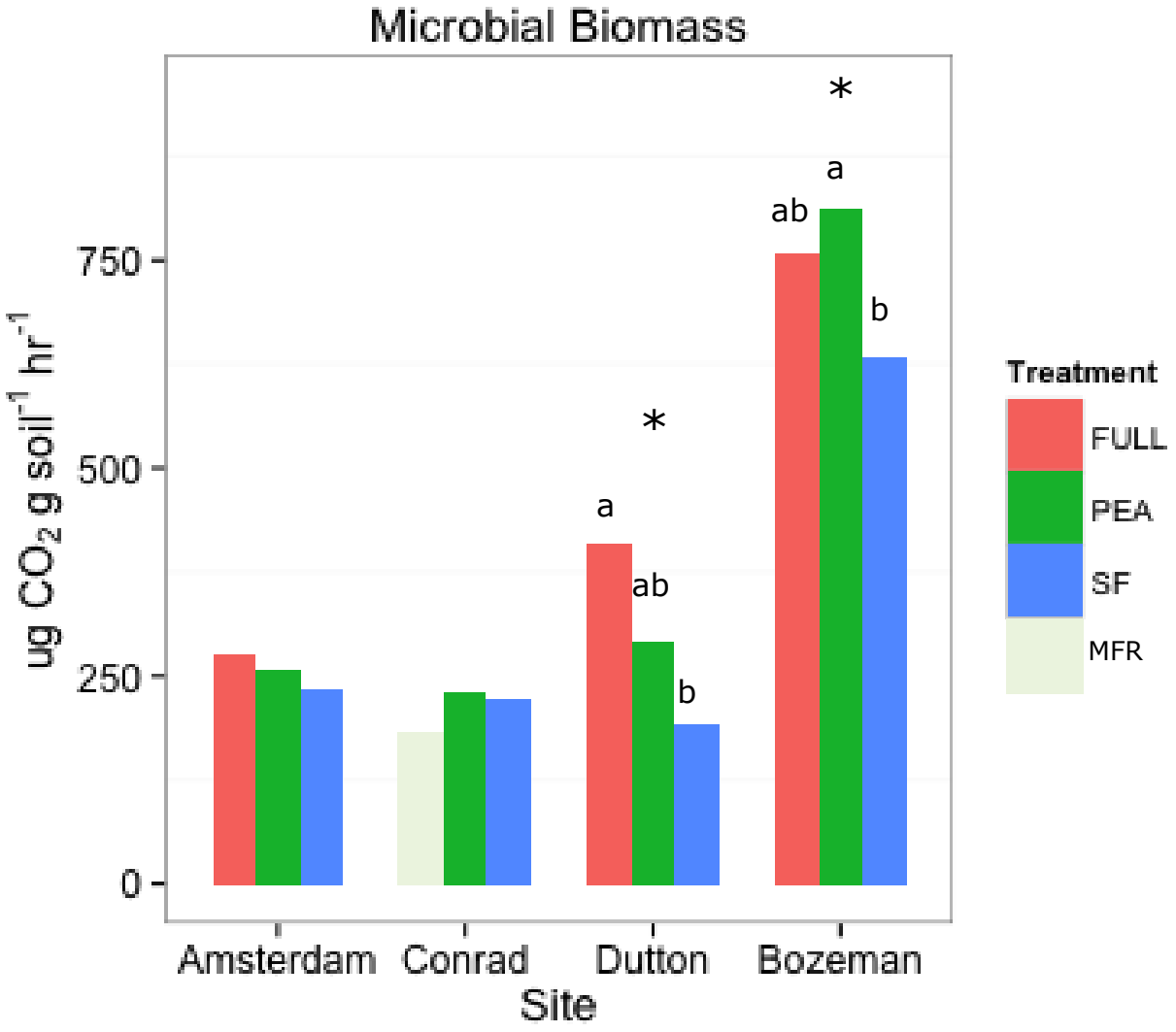



Housman, Tallman, et al., unpub data, Dutton

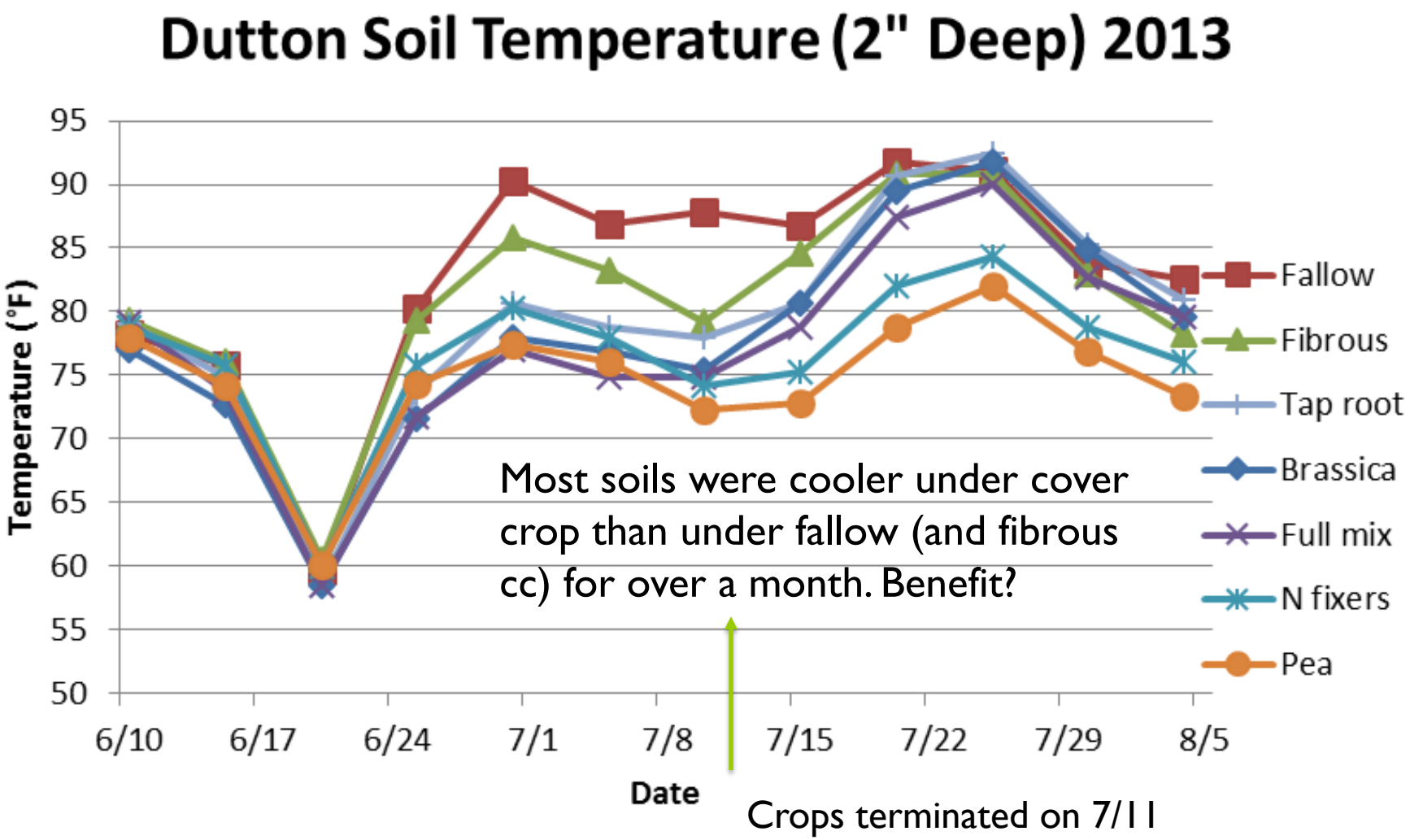
What about soil health?

Preliminary Results

# Microbial Biomass



# Large soil temperature differences among treatments



# Summary after first full rotation

| | Amsterdam | Conrad | Dutton | Bozeman |
|---|---|---|---|---|
| CC Biomass | **ns** | **ns** | **ns** | **ns** |
| Biomass C:N | **8 spec>Pea** | **ns** | **8 spec>Pea** | **ns** |
| Microbial Biomass | **ns** | **ns** | **CCrop>fallow** | **CCrop>fallow** |
| PMN | **CCrop>fallow** | **Pea>MFR** | **CCrop>fallow** | **ns** |
| Olsen P | **ns** | **ns** | **Not analyzed** | **Not analyzed** |
| Max daily temp | **--** | **--** | **fallow>CCrop** | **fallow>CCrop** |
| Penetration resistance* | **ns** | **Pea>MFR** | **ns** | **ns** |

ns – no significant difference between 8 species (full mix) and pea
* - penetration resistance less for fallow than CCs at Dutton and Conrad, likely due to higher water content, not less compaction so only CCs compared.

# Study 1 : Take home messages on yield and soil quality

- After one cycle, spring wheat grain yields higher after pea and N fixers than most other mixes.
- Higher cover crop biomass correlated with lower spring wheat yield, likely b/c of more water and N use.
- Relatively few soil health differences; not unexpected given only one cycle.

# Study 2: Eight-year, plot study

- Objective: Determine long-term effects of legume-containing rotations vs. fallow on subsequent wheat mainly in no-till.
- ~16 inch annual precip. (4 miles west of Bozeman)

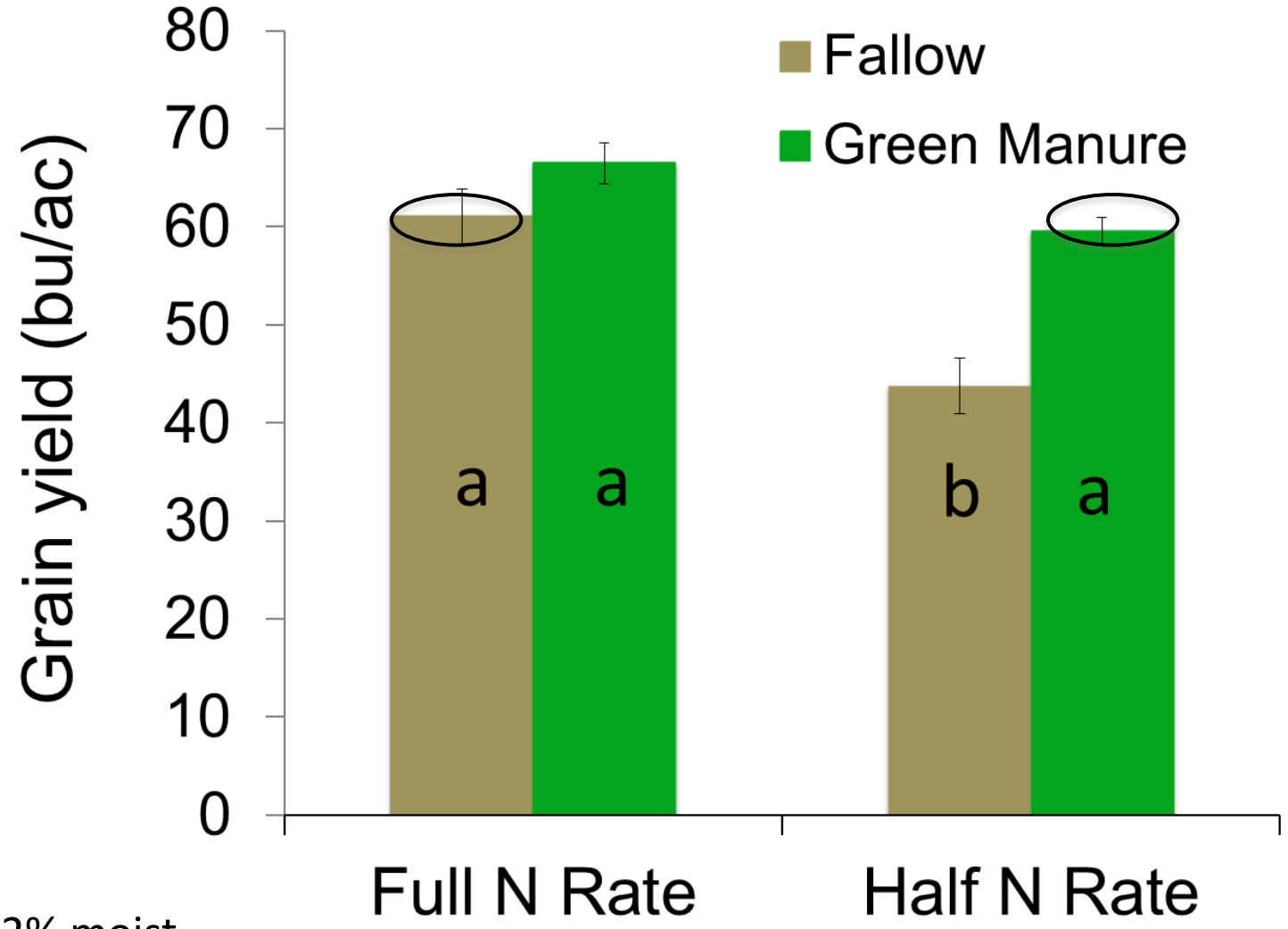
# Study 2. Experimental Design

- Unique feature is deep, uniform silt loam soil and relatively abundant winter precip. to recharge soils
- Focus here on no-till pea forage/legume cover crop-wheat vs. fallow-wheat
- Pea forage grown in 2003, 05, 07 and pea CC grown in 2009, terminated at full pod
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years, 2012 record drought.
- 2 N rates: Full (3 lb available N/bu) and ½ N
- NO differences in wheat yield between CC and fallow in 2004, 2006, and 2008.


Legume or
fallow year

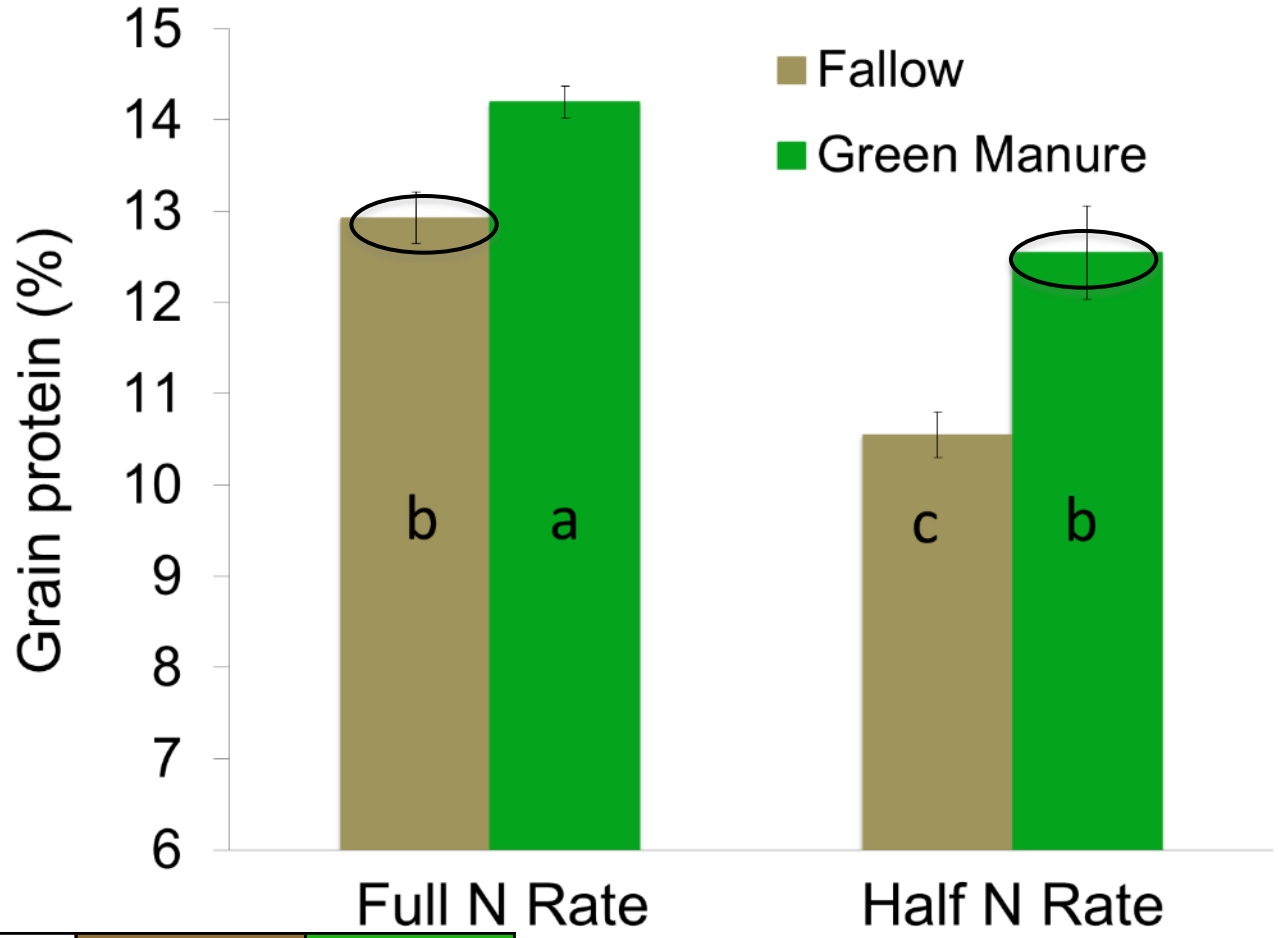

Wheat year

# Study 2: 8 year plot study, Grain yield in 8th year (2010)




@ 12% moist

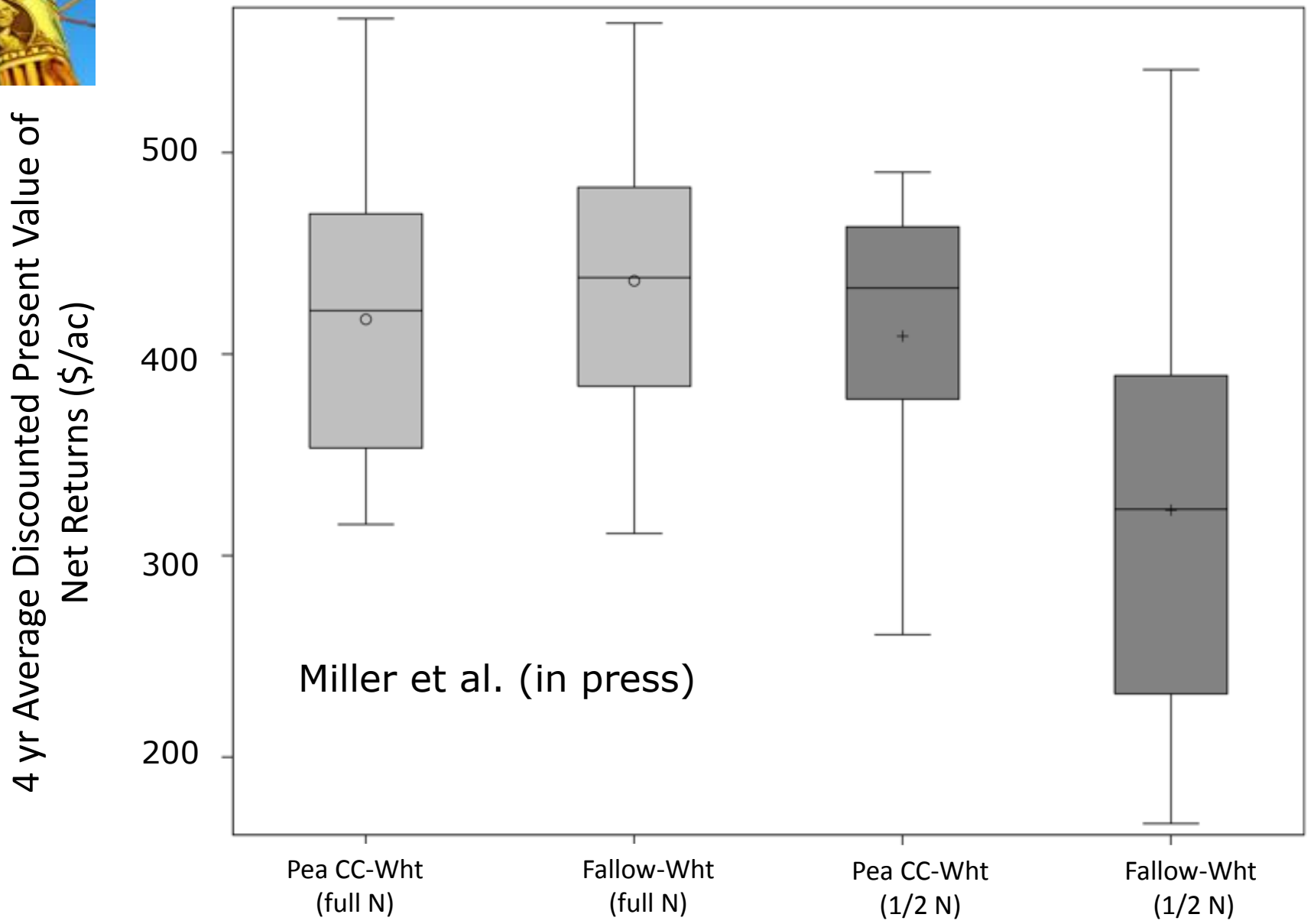
# Study 2: 8 year plot study, Grain protein in 8th year




| * N fertilizer rates | *Fallow-Wheat* | *LGM-Wheat* |
|---|---|---|
| Full N rate (lbs/ac) | 124.00 | 83.00 |
| Half N rate (lbs/ac) | 39.00 | 0.00 |

Pea cover crop after 4 CC-wheat rotations saved **124 lb N/ac** compared to fallow.

# Study 2 Economics (2009 – 2012)



# Study 2: Take home messages

- In the first 3 cycles, wheat grain yield was not higher after legume than after fallow.
- After 4 two-year cycles, wheat grain yield and protein were higher after legume CC than after fallow.
- Higher than normal precipitation in 2010 likely 1) increased release of available N from an increased organic N pool, and 2) made N limiting to growth.
- Over 100 lb N/ac was saved in 2010 following legume cover crop compared to fallow!
- Economic returns were more stable with cover crop (less dependent on N rate)

# Conclusions

- In short term (1 CC-cycle studies), grain yield and protein are generally equal or less than after fallow.
- Early termination (by ~ first pea bloom) is key to preventing yield and protein losses.
- In short term studies, there does not appear to be yield or soil quality advantages of multiple species mixes over pea.
- In long term (4+ cycles), yield, protein, and net revenue can be higher after cover crops than fallow, especially at low N rates, likely from more available N.
- Cover crop value to soil health, subsequent crops, and possibly land value is expected to increase over time.

# Acknowledgments


- USDA – AFRI
- USDA – WSARE
- NRCS – CIG
- Montana Fertilizer Advisory Committee
- Montana Wheat and Barley Committee
- Numerous landowners
- Susan Tallman
- Meg Housman
- Ann McCauley
- Jeff Holmes

# Questions?

For additional information on soil fertility topics including information on cover crops, see http://landresources.montana.edu/soilfertility