

Pulses in Rotation: 101 and Beyond

CARC Research Update
Dec 11, 2018



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Outline

1. 101 Review of pulses in dryland rotations.
2. Long-term pulse effects in no-till systems.
3. Future challenges – what role to pulses have to play?
4. Fun with pulses! – chickpea-flax intercrop?

101 Review

- i. Pulse crop adaptation to dryland regions
- ii. Nitrogen vs non-N rotational benefits – Can you make a N credit disappear?
- iii. Time lags with N benefits?

Pulse crops evolved in semiarid regions

- Association with rhizobium so don't need root system to scavenge nitrate-N



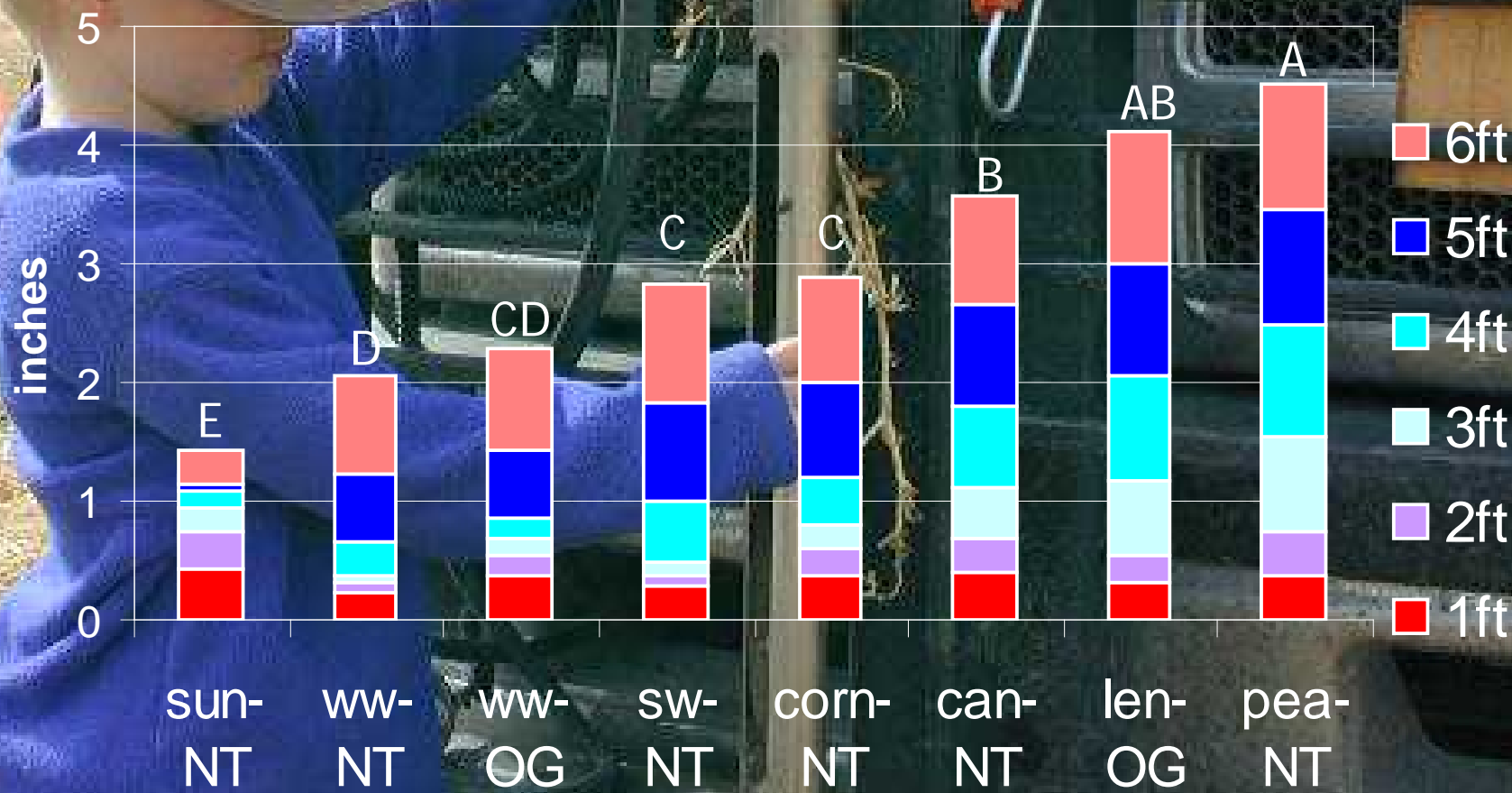
Photo – J. Holmes

you have over Iowa



Miller, P.R., and J.A. Holmes. 2012. Comparative soil water use by annual crops at a semiarid site in Montana. Can. J. Plant Sci. 92:803-807

Residual crop available water to 6 ft
Bozeman, MT 2001-03





Wa
\$U

PeaY

PeaG

HRSW

ChpD

ChpK

Lentil

Discussion about pulse adaptation?

Could pulse crops be grown in the Brown soil zone of Sask?
... and would we see rotational benefits of wetter areas?
- tillage x crop rotation study southwest Sask (Doug Derksen)

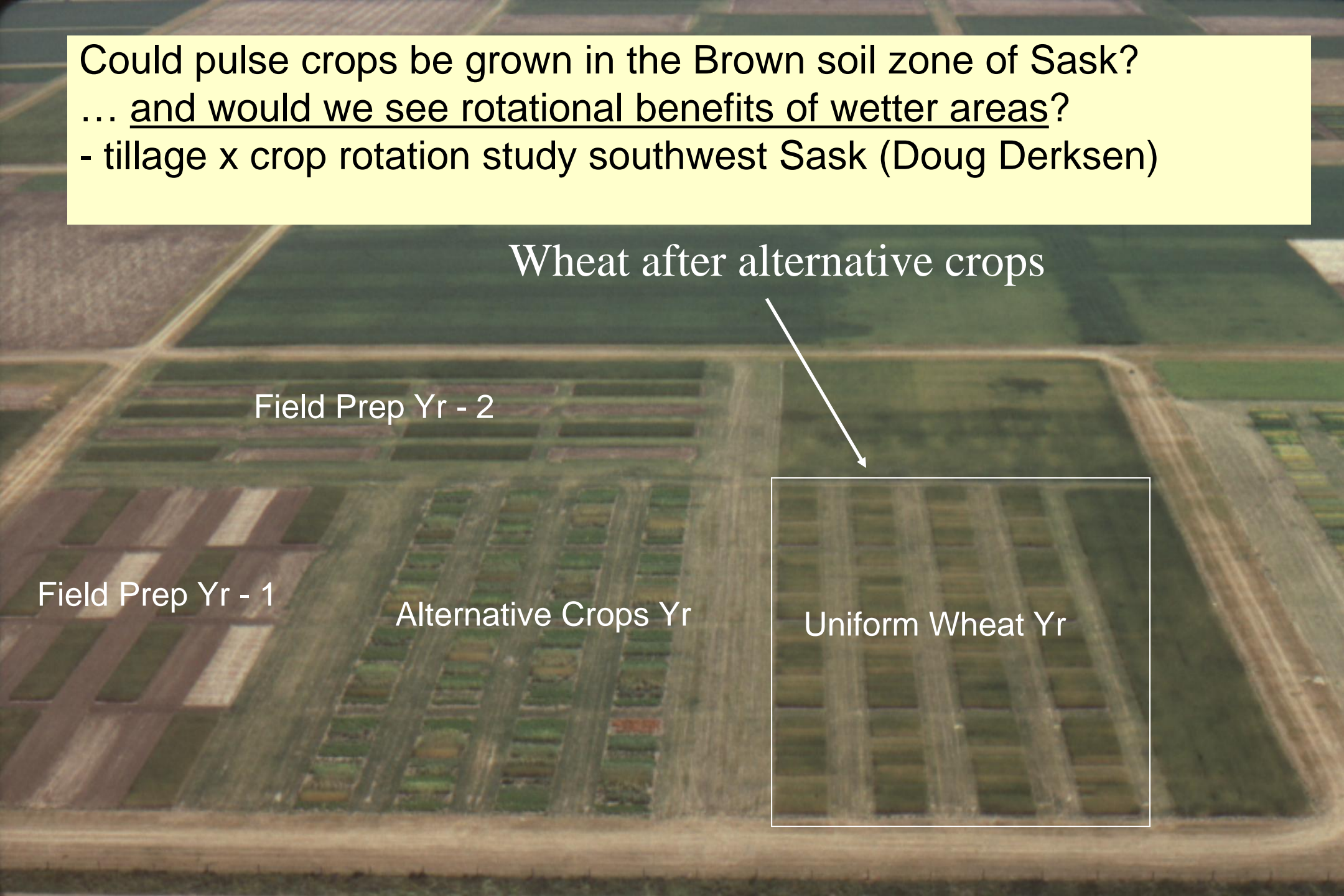
Wheat after alternative crops

Field Prep Yr - 2

Field Prep Yr - 1

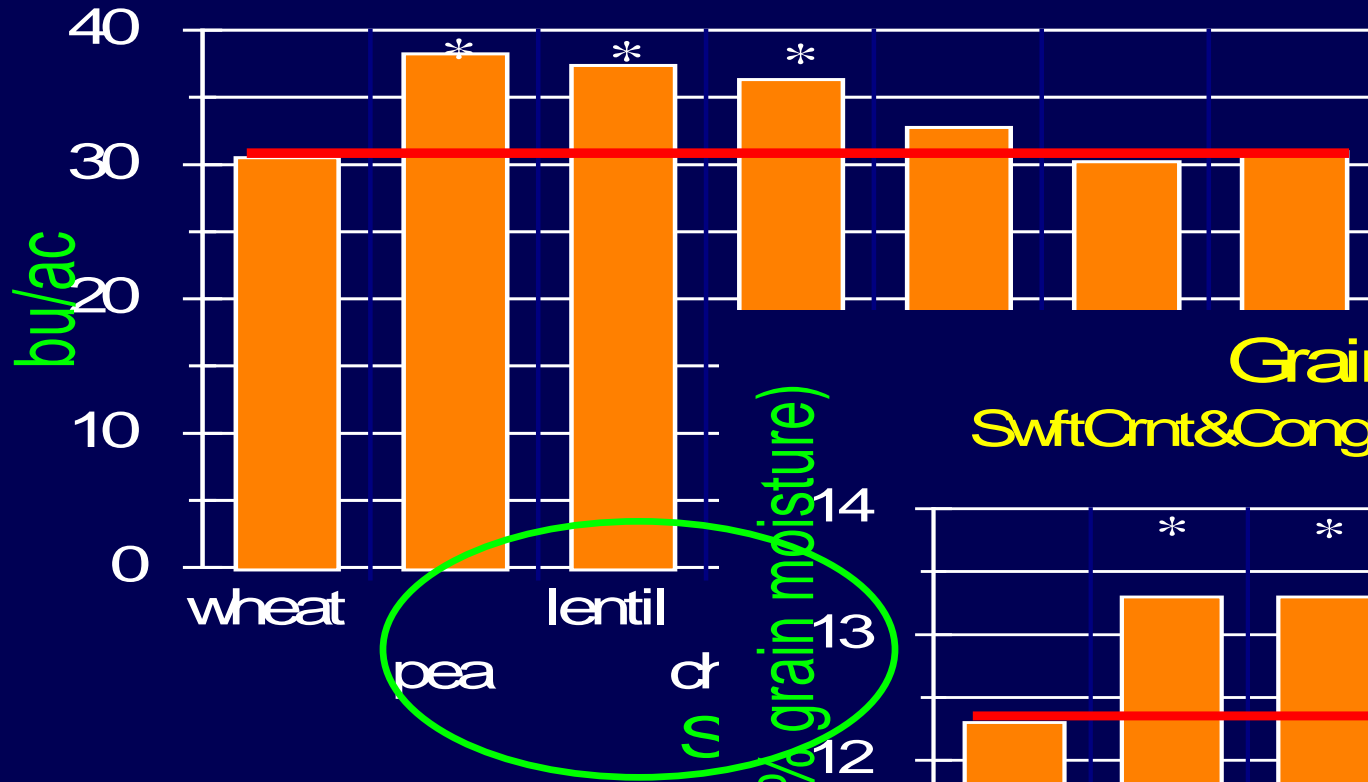
Alternative Crops Yr

Uniform Wheat Yr



Yield of Wheat Recrop

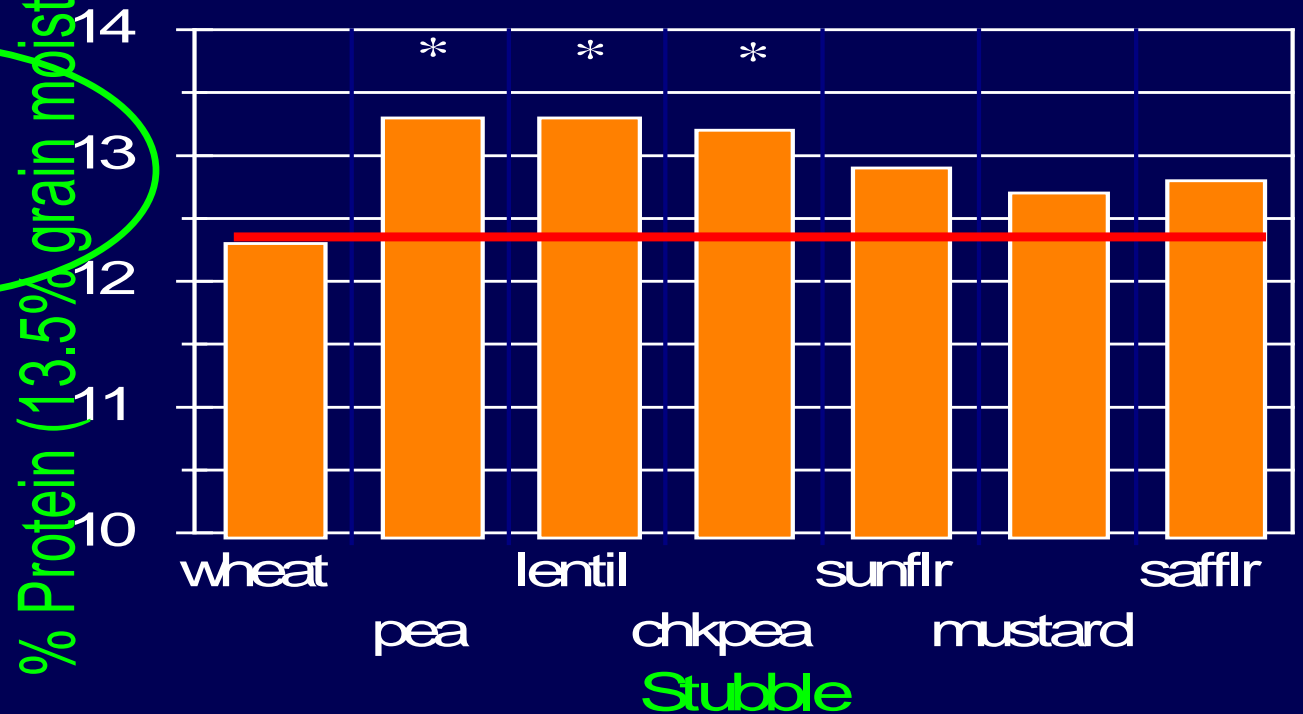
SwiftCnt&Congress, 1993-97 (Miller)



23% avg yield increase on pulse stubble!

Grain Protein

SwiftCnt&Congress, 1993-97 (Miller)



+ protein boost!

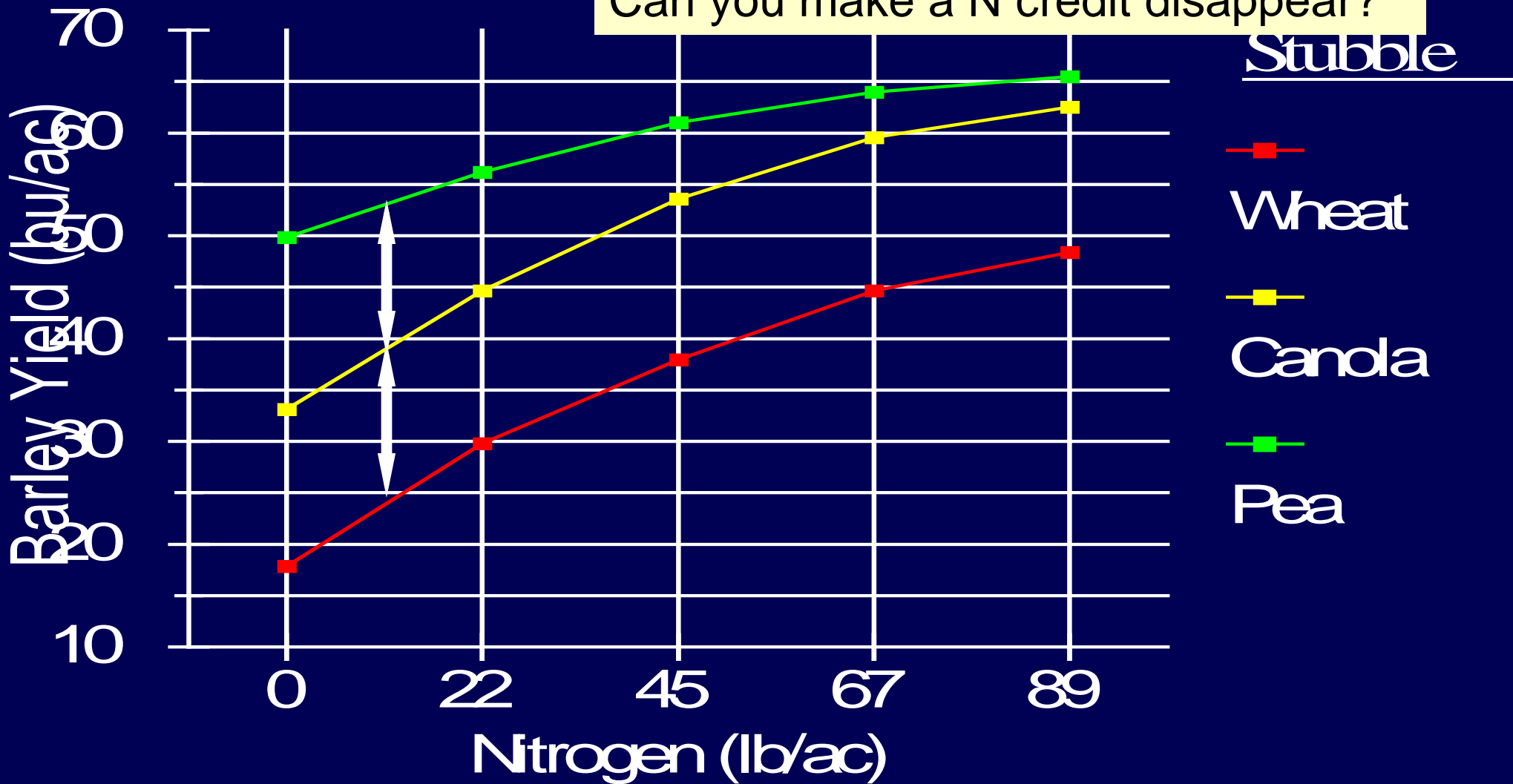
% Protein (13.5% grain moisture)

Stubble

N vs Non-N Rotational Benefit

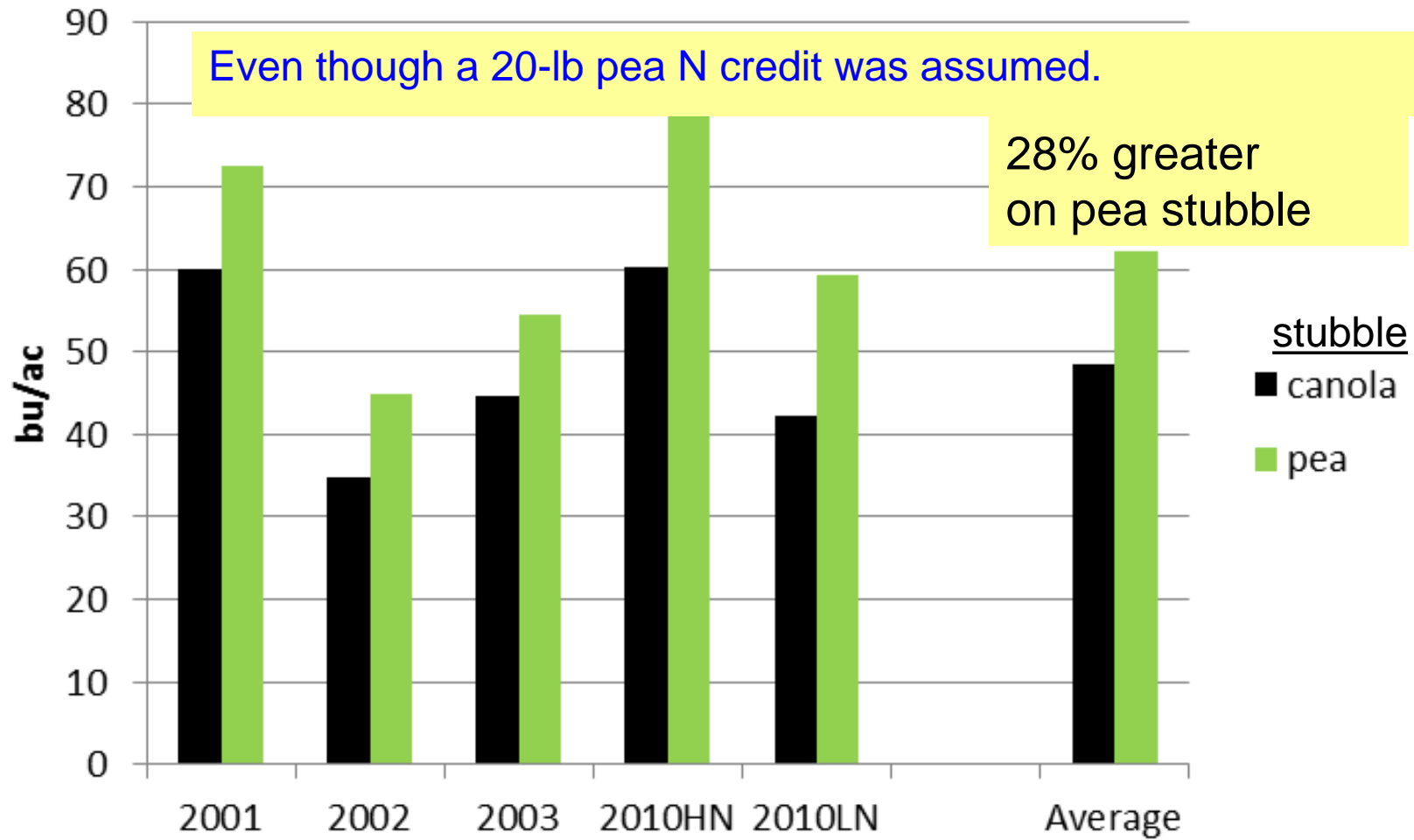
Beckie and Brandt 1997

Can you make a N credit disappear?



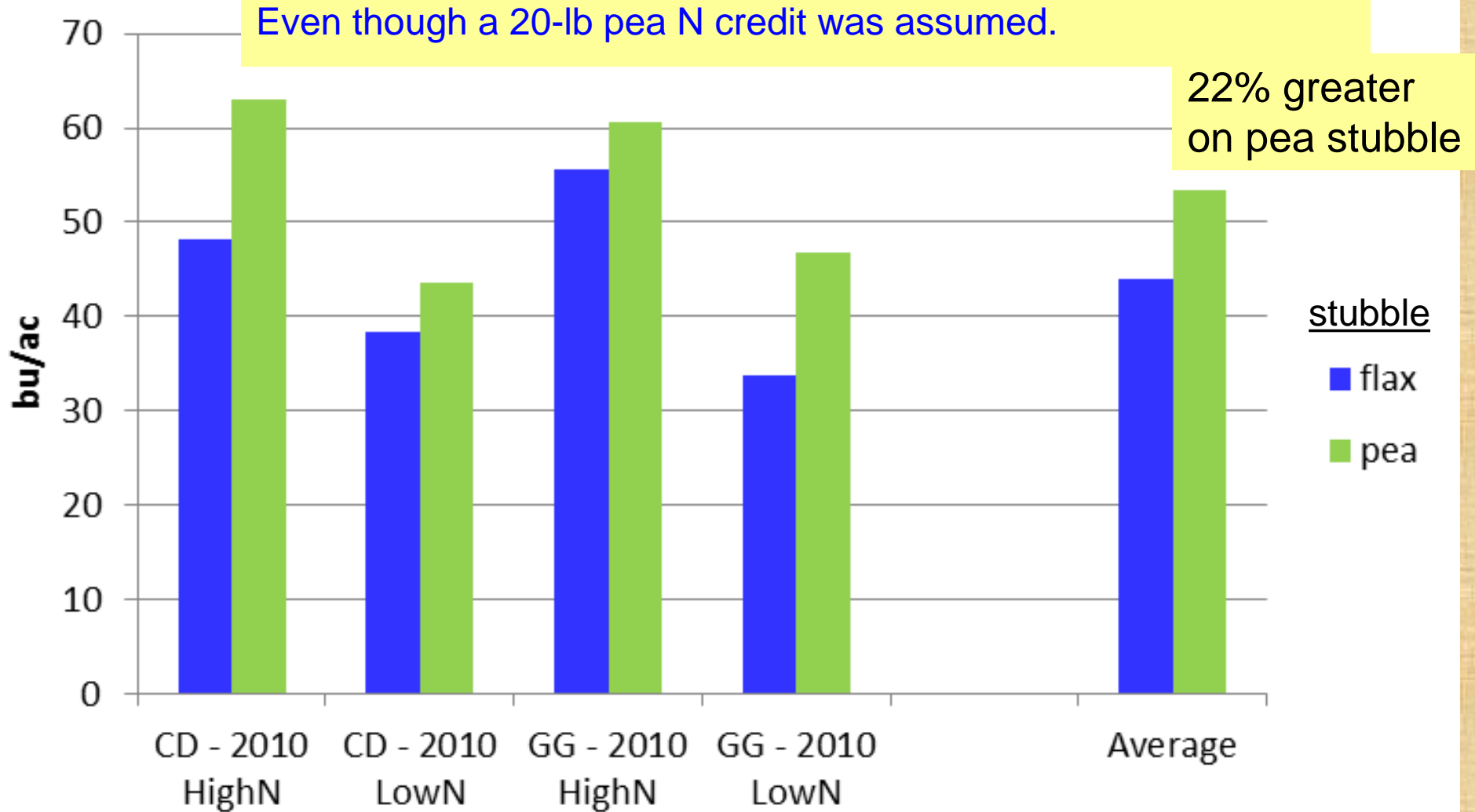
N Credits in Crop Diversity Rotation Study at Bozeman

Winter Wheat - Yield



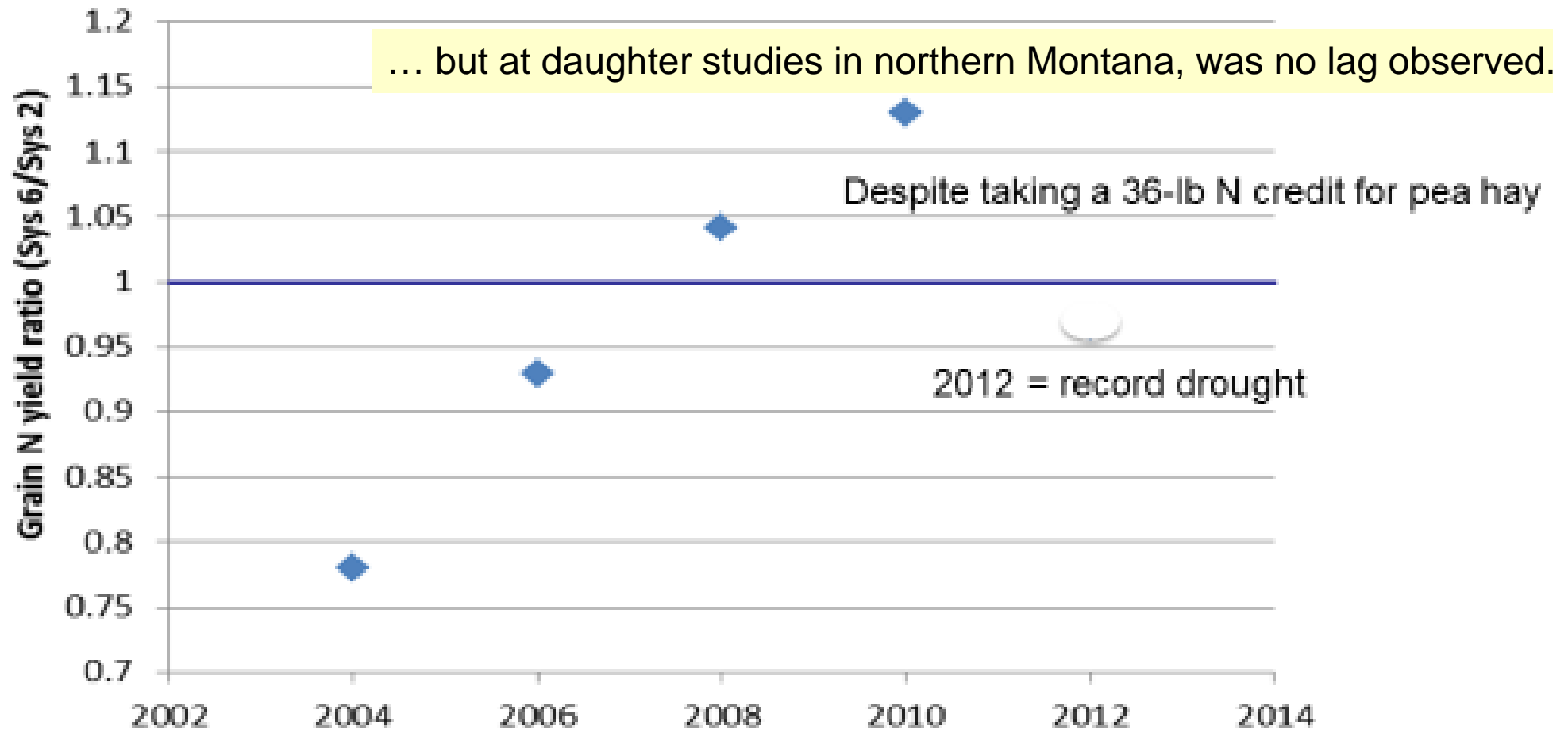
N Credits in Two Rotation Studies at Bozeman

Spring Wheat - Yield



Nitrogen cycling time lag? - Bozeman

Change in soil N supply over time; pea hay (Sys 6) vs chem fallow (Sys 2)



Discussion about N cycling/credits?

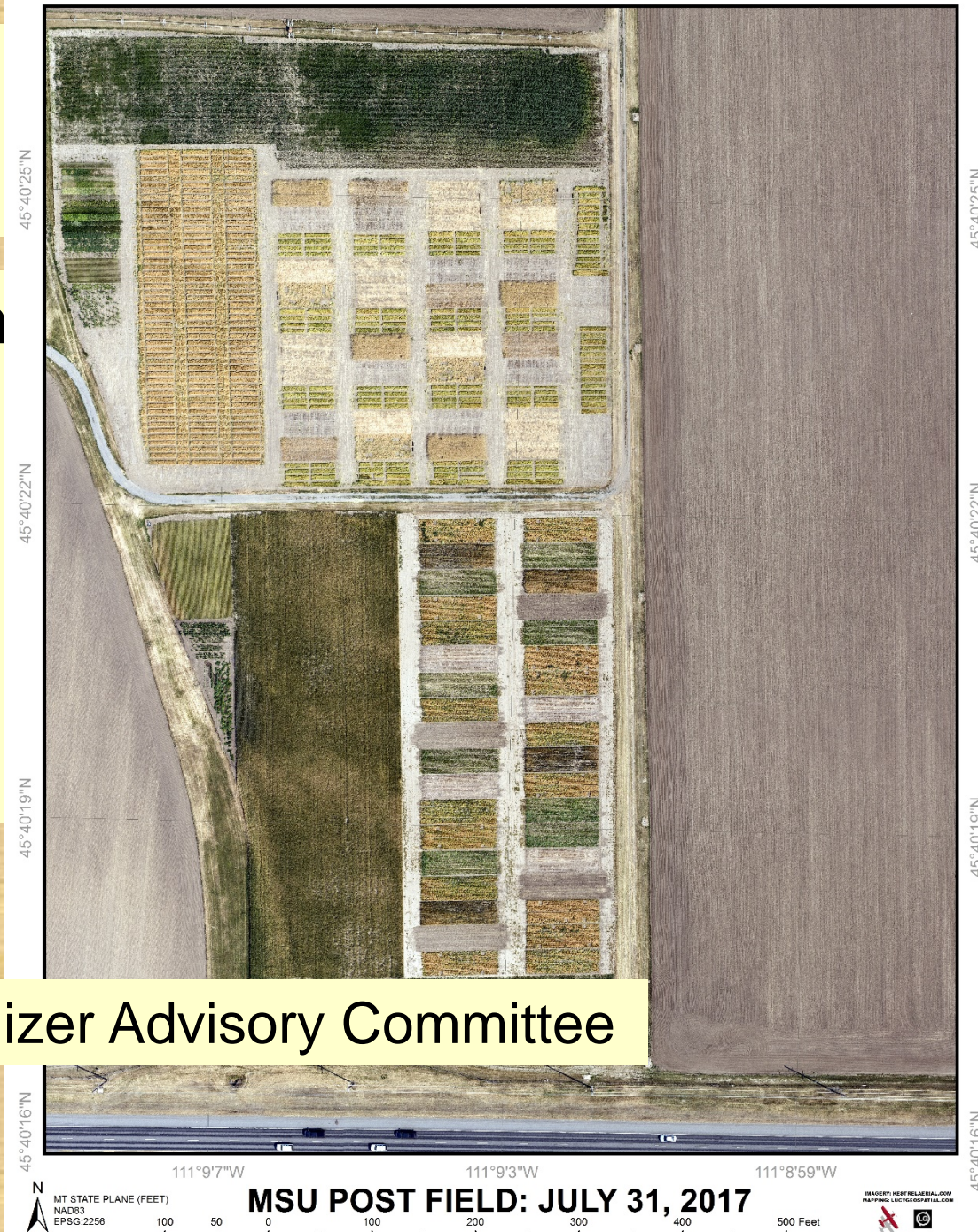
2. Long-term effects of pulses in rotation

- i. 14-yr study Bozeman
 - Economics
 - Soil carbon and other soil attributes
- ii. 6-yr 'daughter' studies at Dutton and Big Sandy

Long-term Sites

- Bozeman – deep silt loam
– begun 2003
- Big Sandy – loam
– 2012 – 2017.
- Dutton – clay loam
– 2011 – 2016

Funding mainly by Montana Fertilizer Advisory Committee



Bozeman Exp. Design – MSU Post Farm

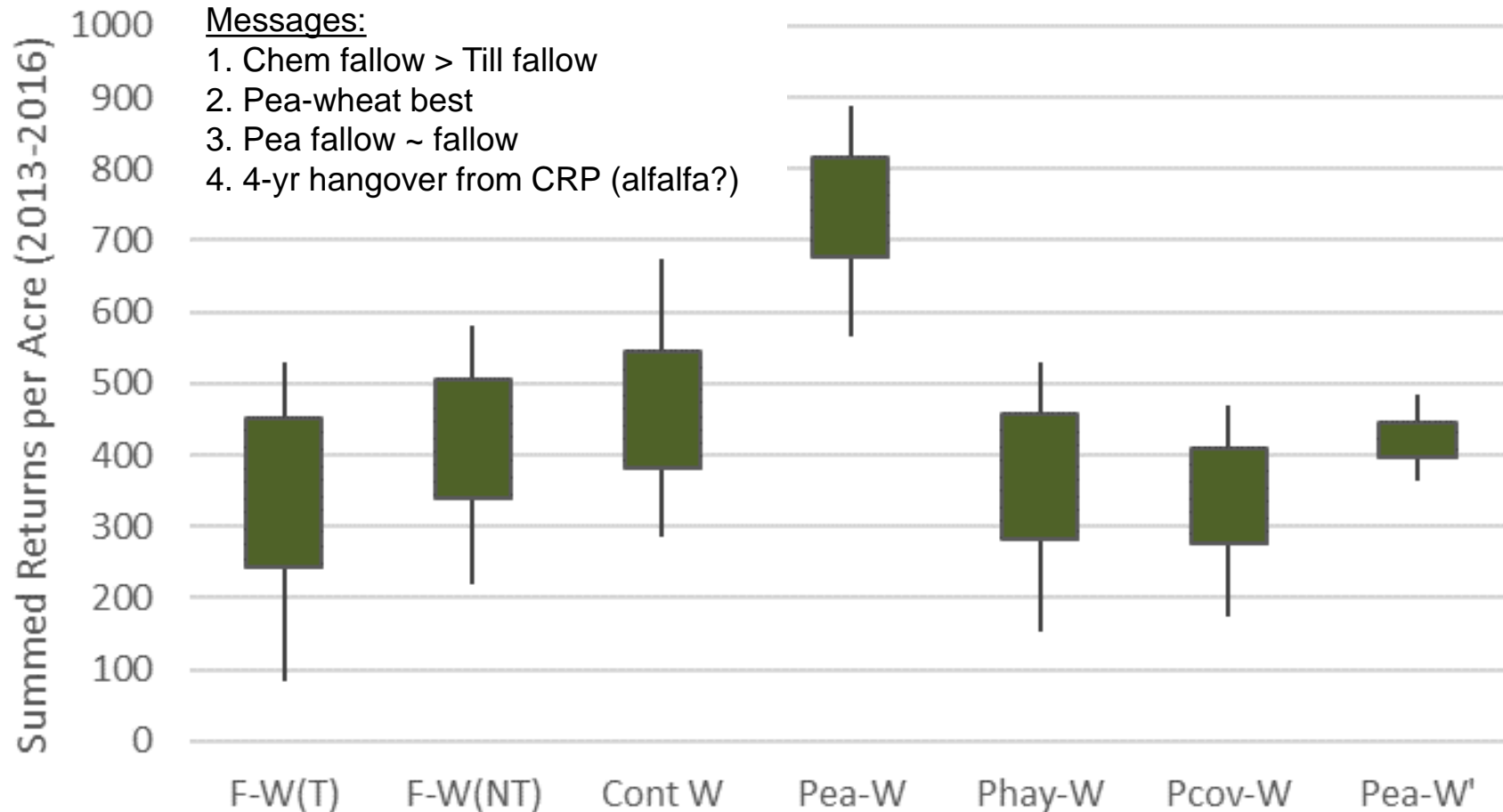
Table 1. Recent crop rotation in nine cropping systems in GGRS study begun at Bozeman in 2003.

<u>System</u>	<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>2016</u>
1) Fallow-Wheat (Till)	Fallow	Spring Wheat	Fallow	Winter Wheat
2) Fallow-Wheat (NT)	Fallow	Spring Wheat	Fallow	Winter Wheat
3) Continuous Wheat	Spring Wheat	Spring Wheat	Winter Wheat	Winter Wheat
4) Oilseed-Wheat	Flax	Spring Wheat	Winter Canola	Winter Wheat
5) Pea(seed)-Wheat	Spring Pea	Spring Wheat	Winter Pea	Winter Wheat
6) Pea(hay)-Wheat	Spring Pea (Hay)	Spring Wheat	Winter Pea (Hay)	Winter Wheat
7) Pea(brown manure)-Wheat	Spring Pea (BM)	Spring Wheat	Winter Pea (BM)	Winter Wheat
8) Pea(green manure)-Wheat (ORGANIC)	Spring Pea (GM)	Spring Wheat	Winter Pea (GM)	Winter Wheat
9) ex-CRP/alfalfa: Pea(seed)-Wheat	Spring Pea	Spring Wheat	Winter Pea	Winter Wheat

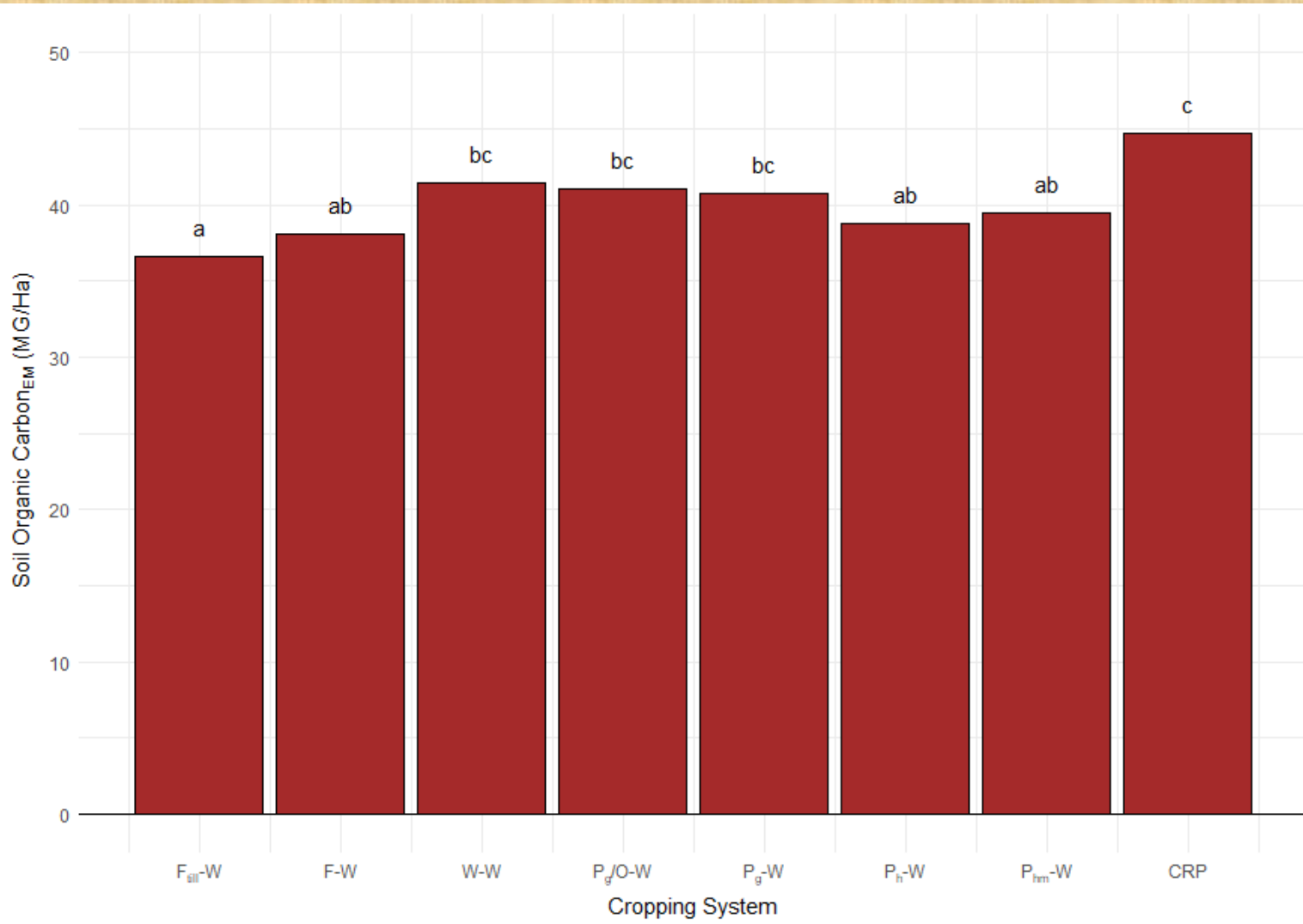
Systems 1-7 and 9 all split into Full and Half recommended N

2013-16 Net Returns to Land and Management (excl. insurance)

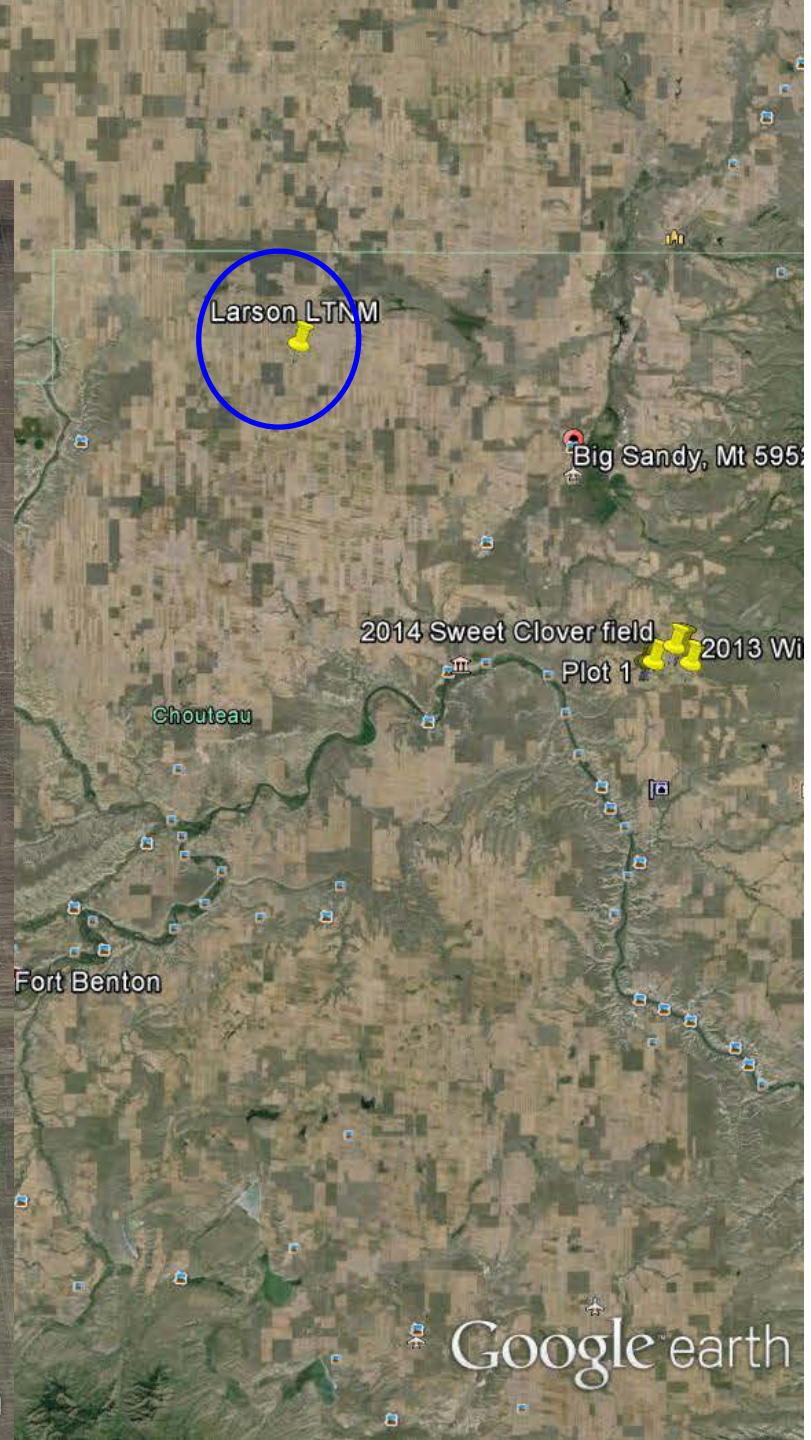
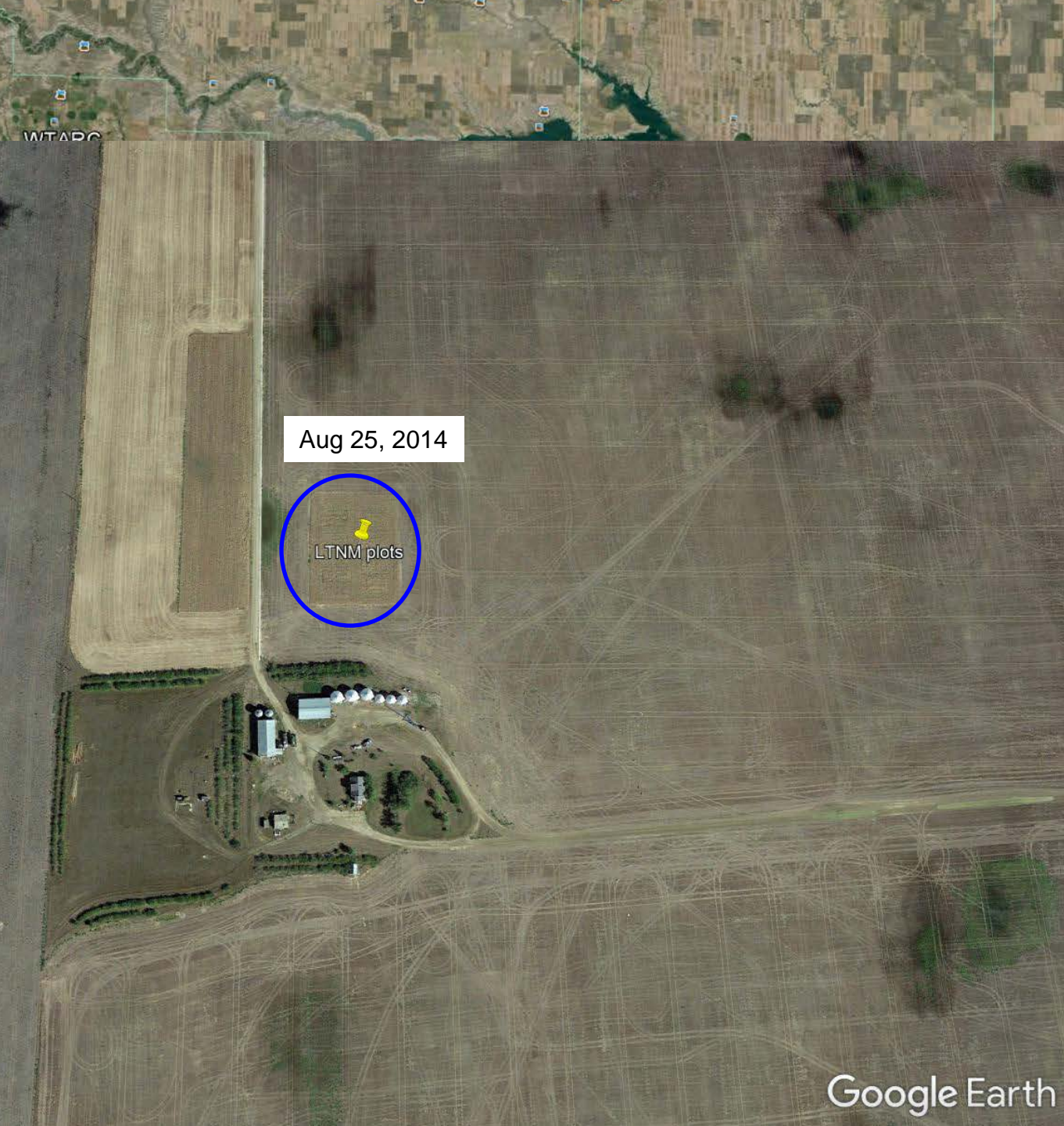
Range in Net Returns at 2 N levels and 2 Protein Schedules



Soil carbon measured Fall 2016 after 14 yr – Stephanie Ewing



- 1) Ex-CRP plot differentiating AFTER conversion back to annual cropping
- 2) N rate associating positively with SOC gain
- 3) All annual grain systems equal
- 4) Pea hay/manure systems = chem fallow



Cont Wht



Pea - Wht



Pea Cover - Wht

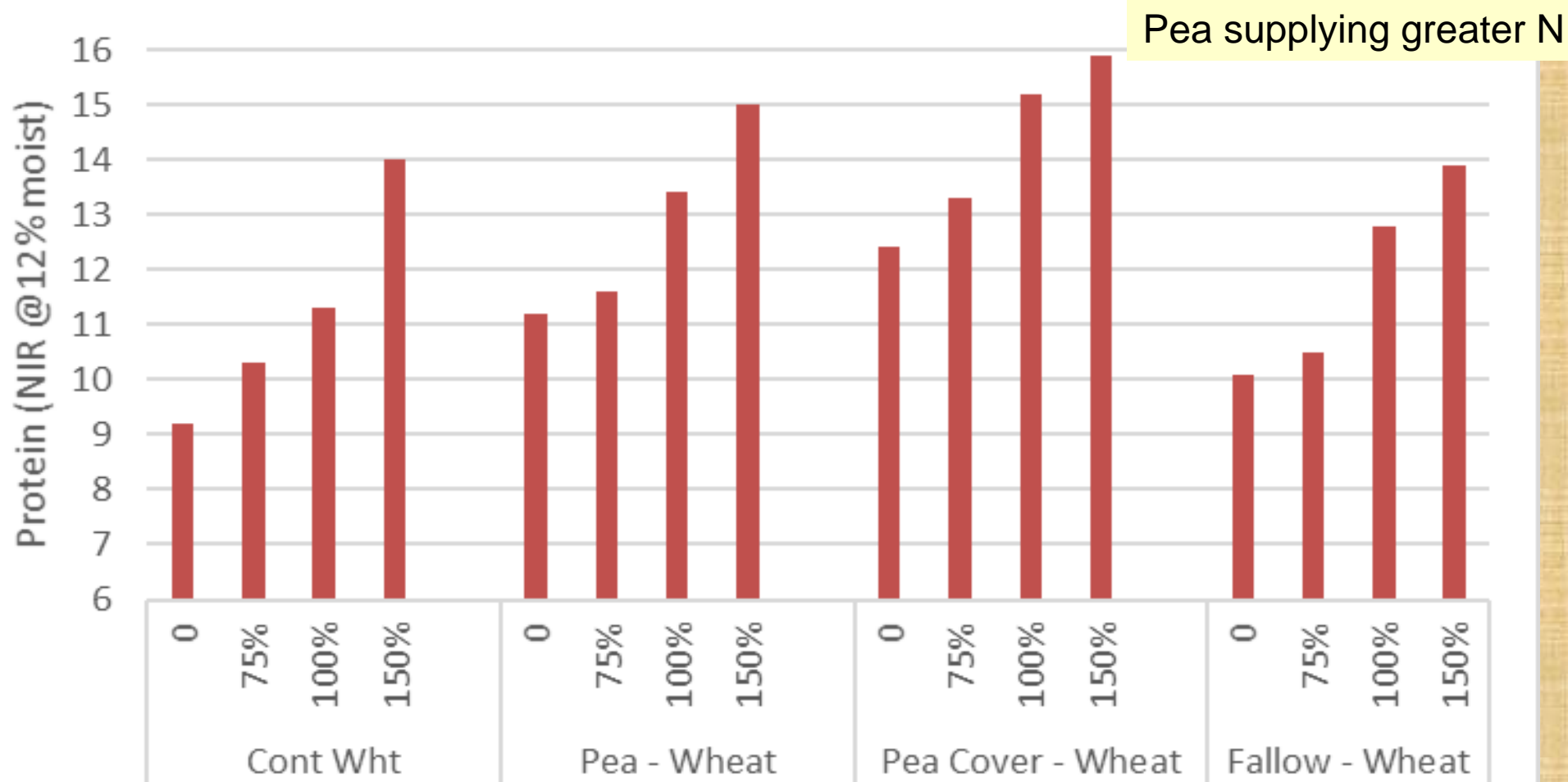


Fallow - Wht



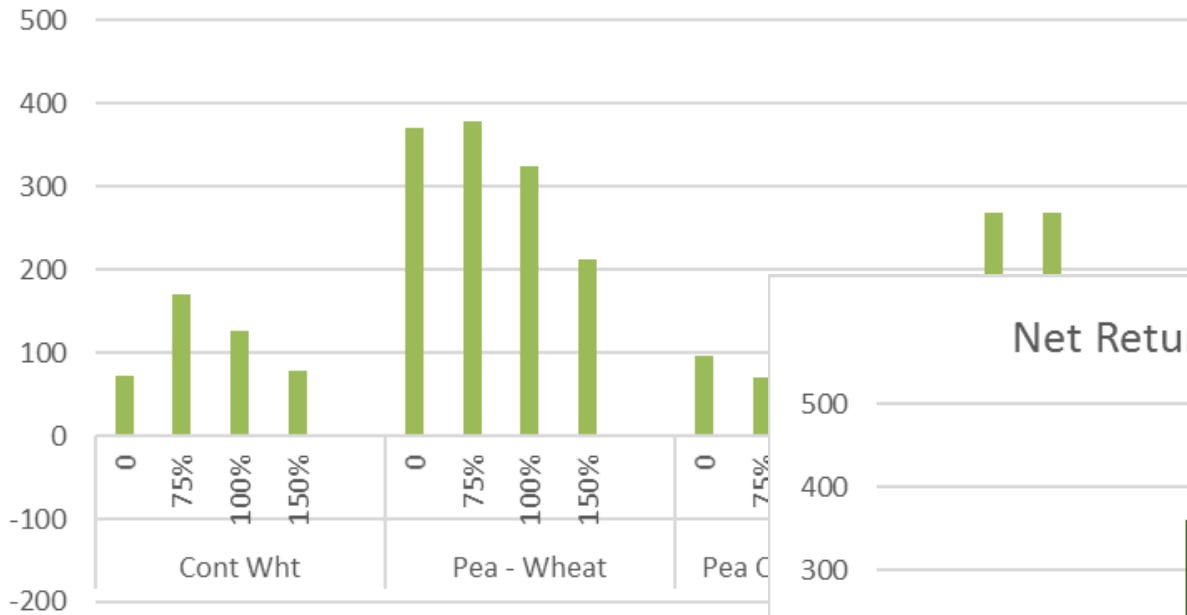
2016 Results - Dutton

Winter wheat Protein - Dutton 2016



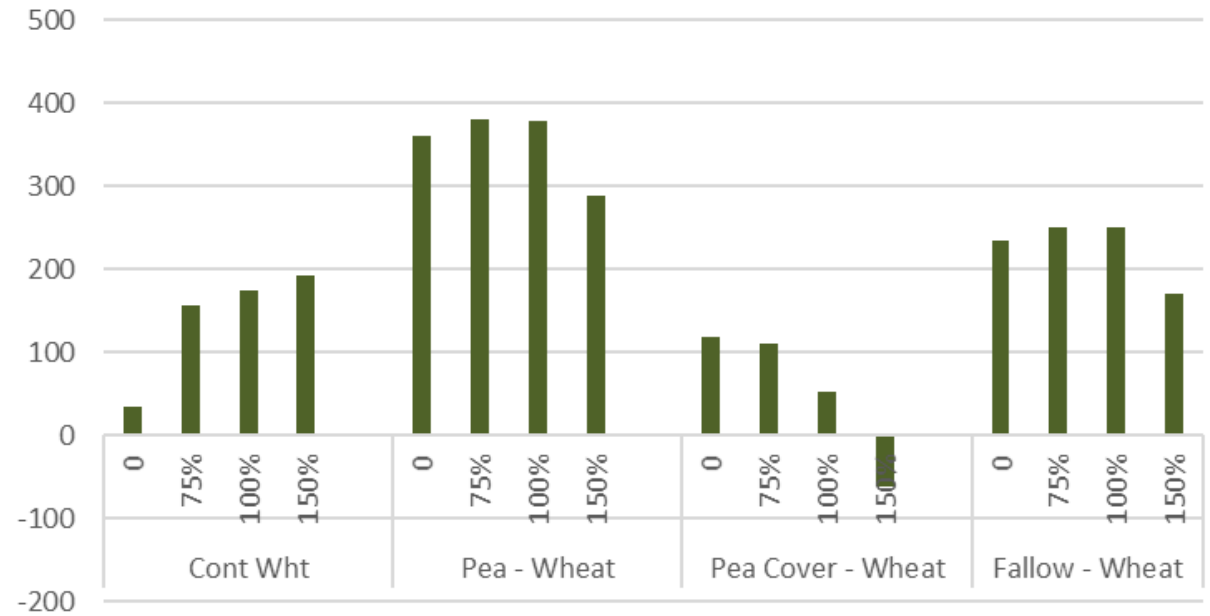
6-yr Summed Net Returns per Acre

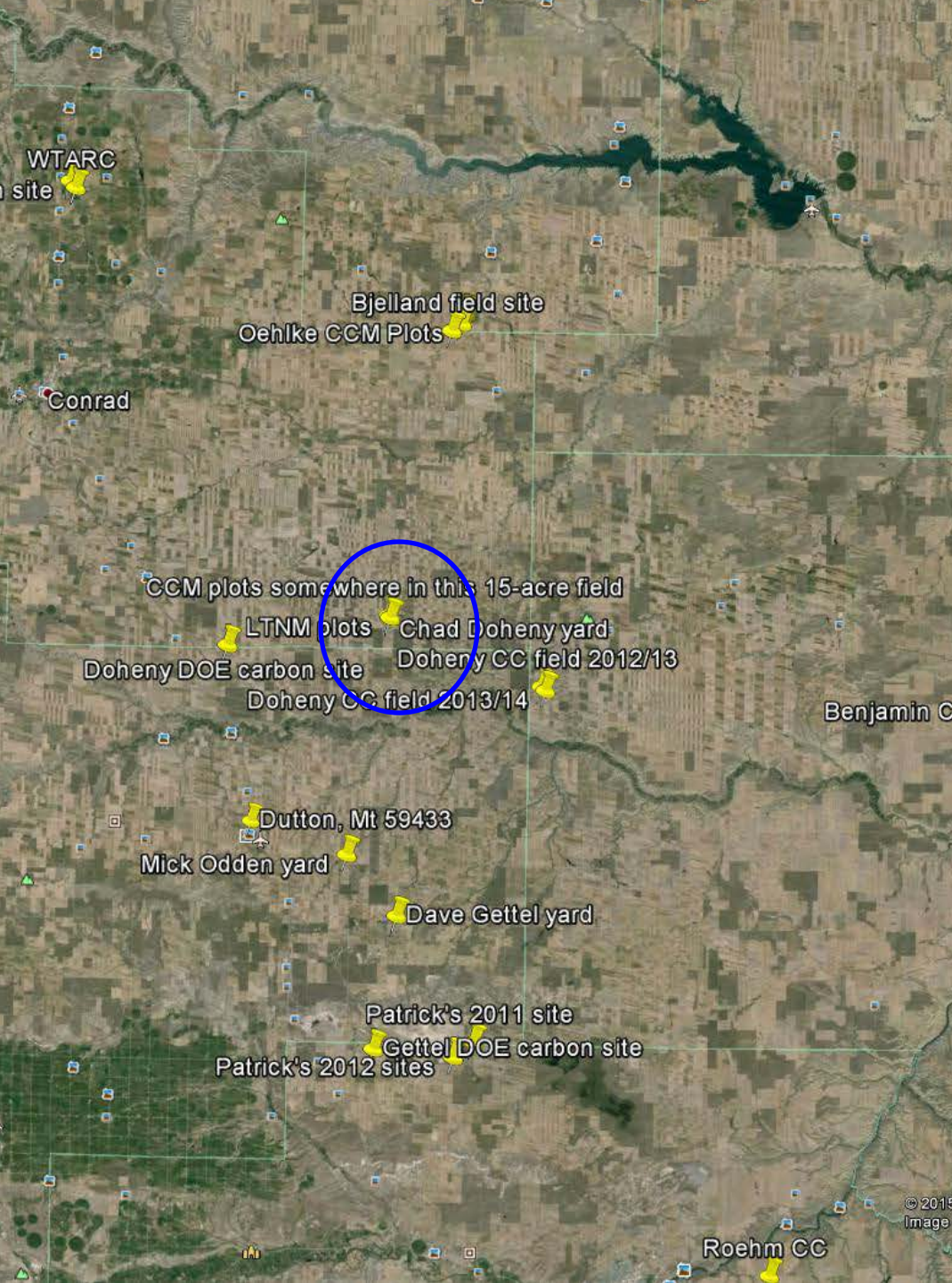
Net Returns Summed for 6 yr - Flat Pro

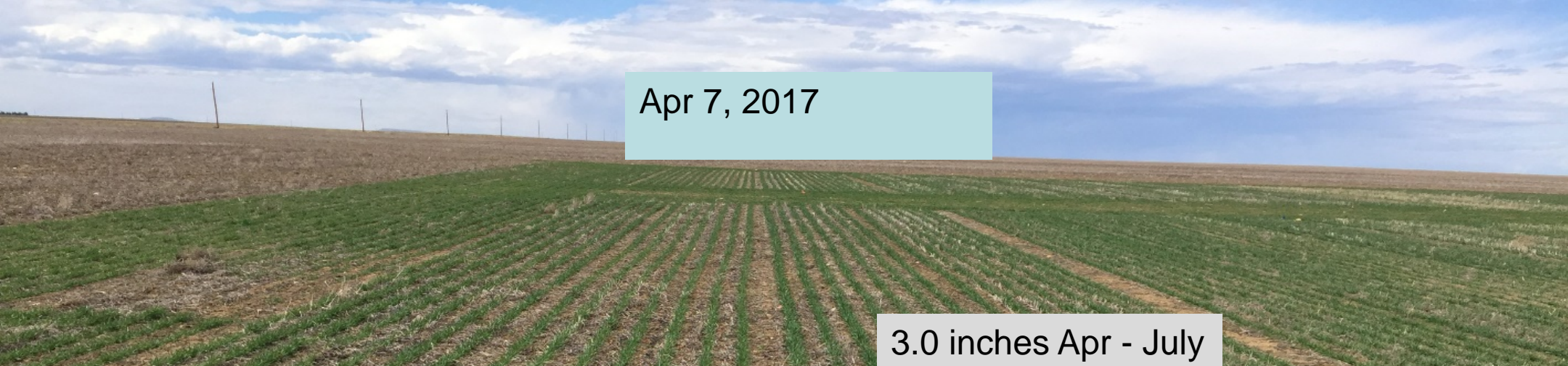


Pea – Wheat system best returns
Pea manure – not so much

Net Returns Summed for 6 yr - Steep Pro

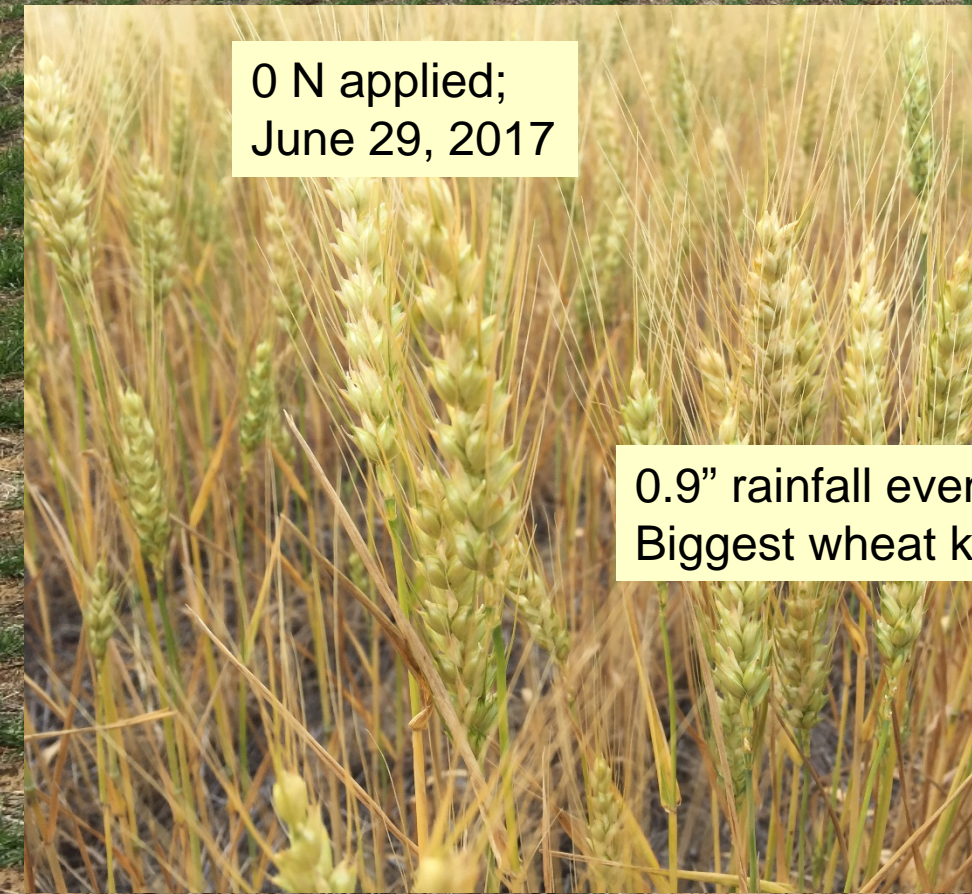







Apr 7, 2017

3.0 inches Apr - July



0 N applied;
June 29, 2017

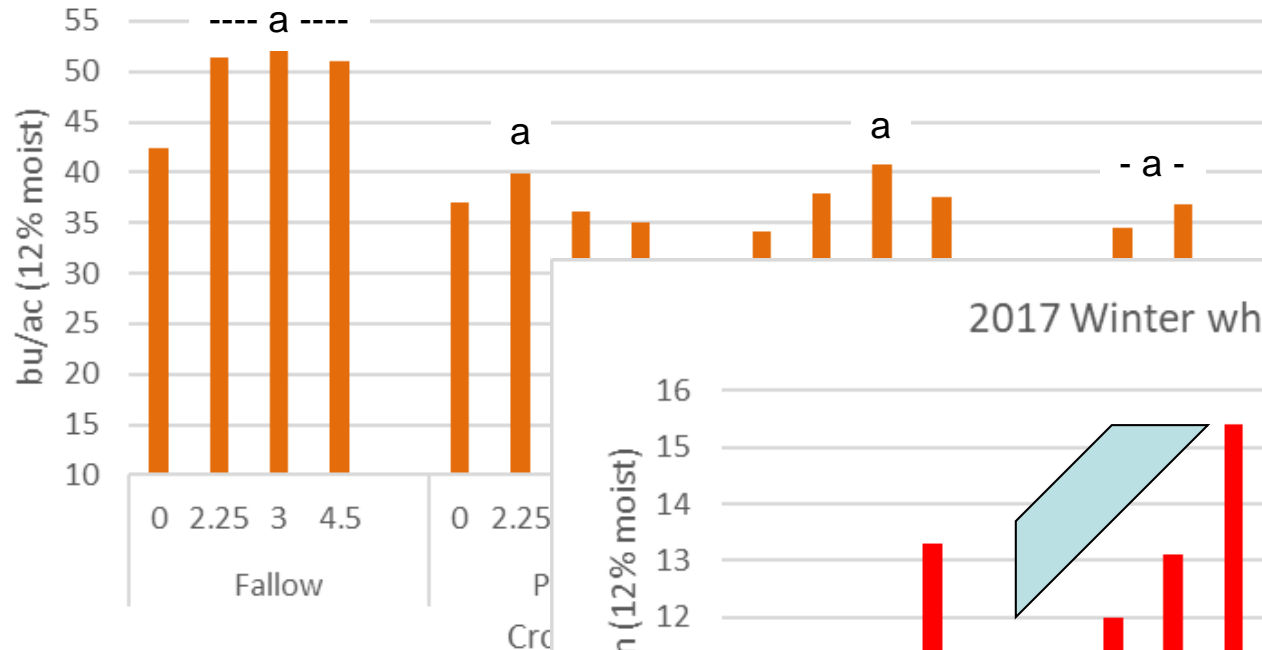


Full N rate;
June 29, 2017

0.9" rainfall event June 12-14 Rescued this crop;
Biggest wheat kernels we've ever harvested

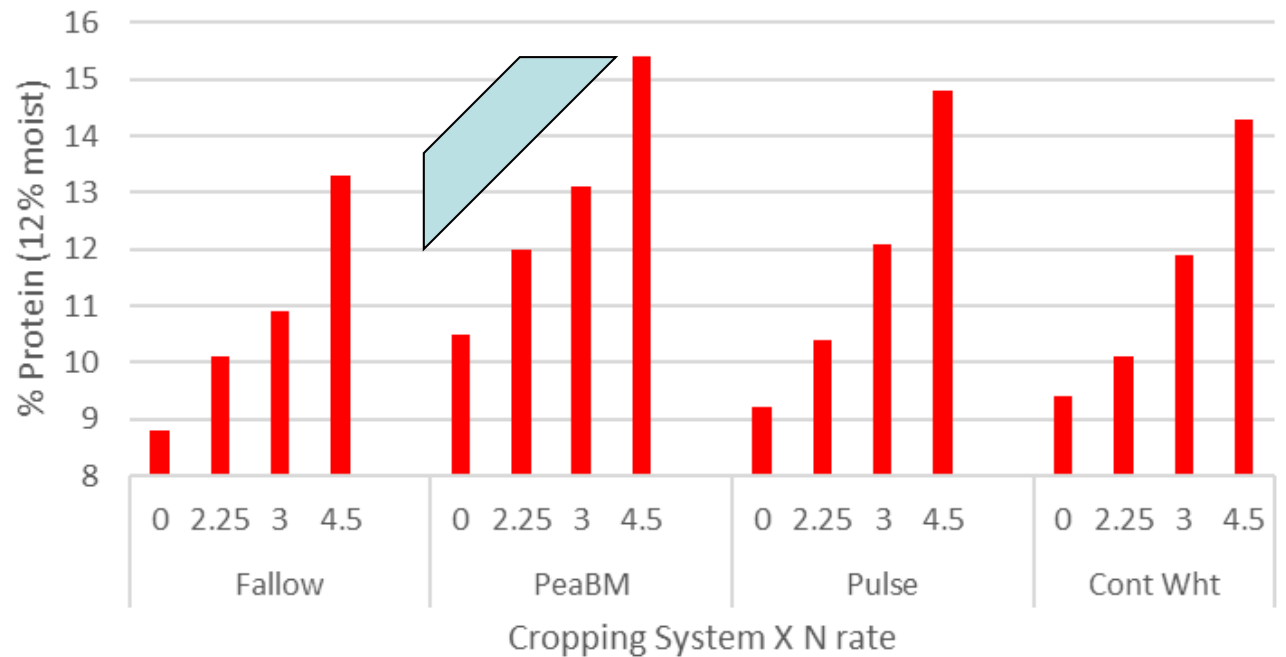
2017 Winter wheat results – Big Sandy

2017 Winter wheat - Yield

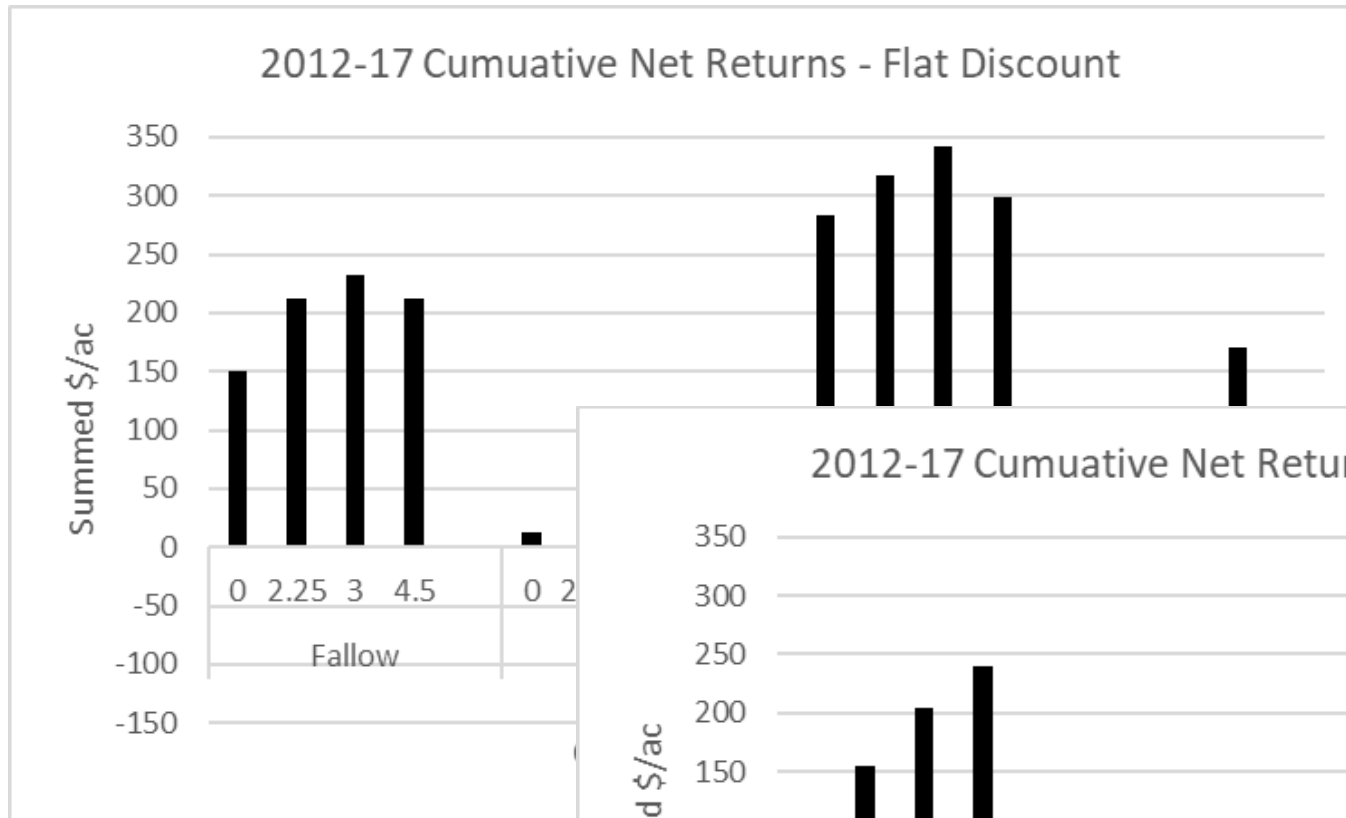


1. Amazing yields for 3.0" of rain!!!
2. Pea brown manure similar to Pulse for grain; less N responsive

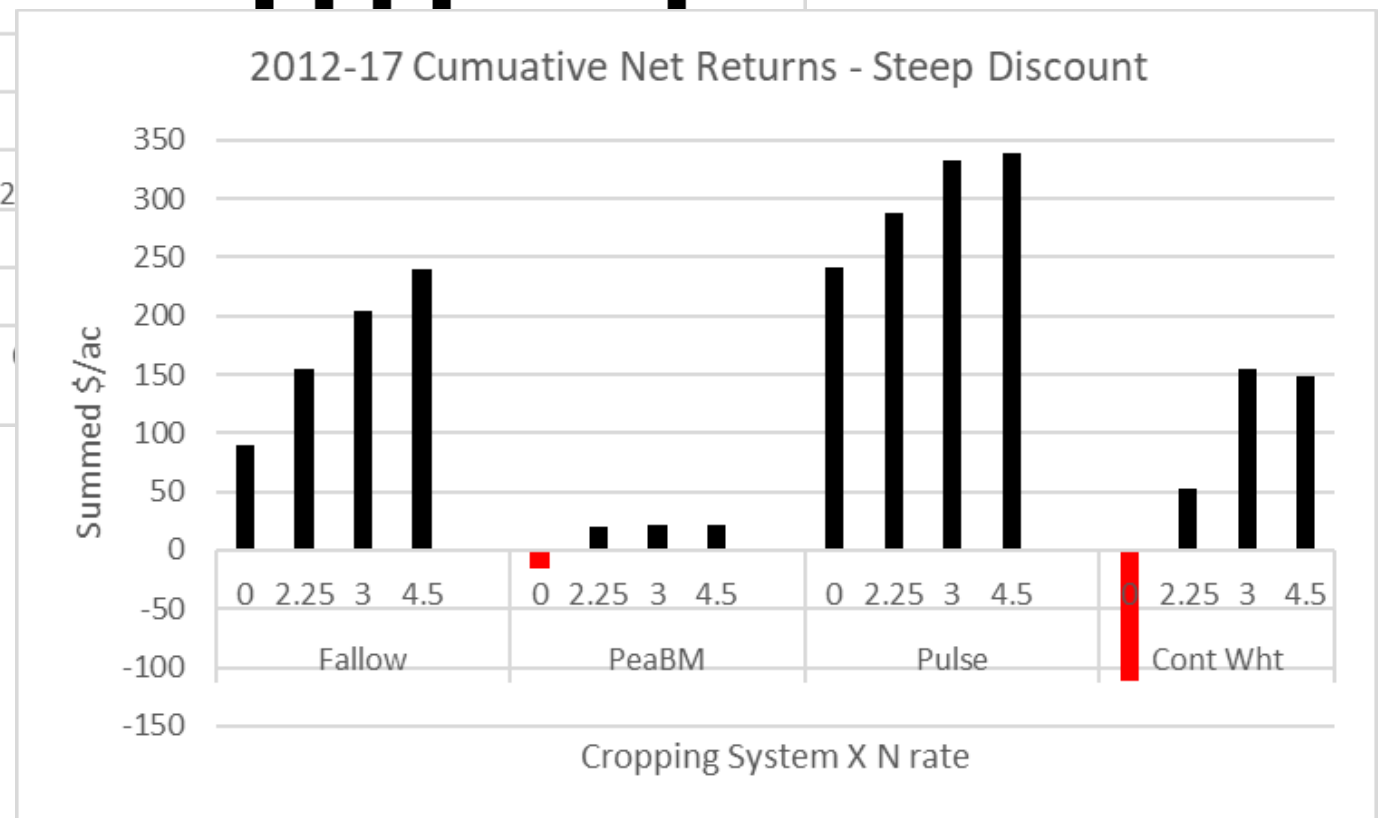
2017 Winter wheat - Protein



Cumulative Net Returns 2012-17

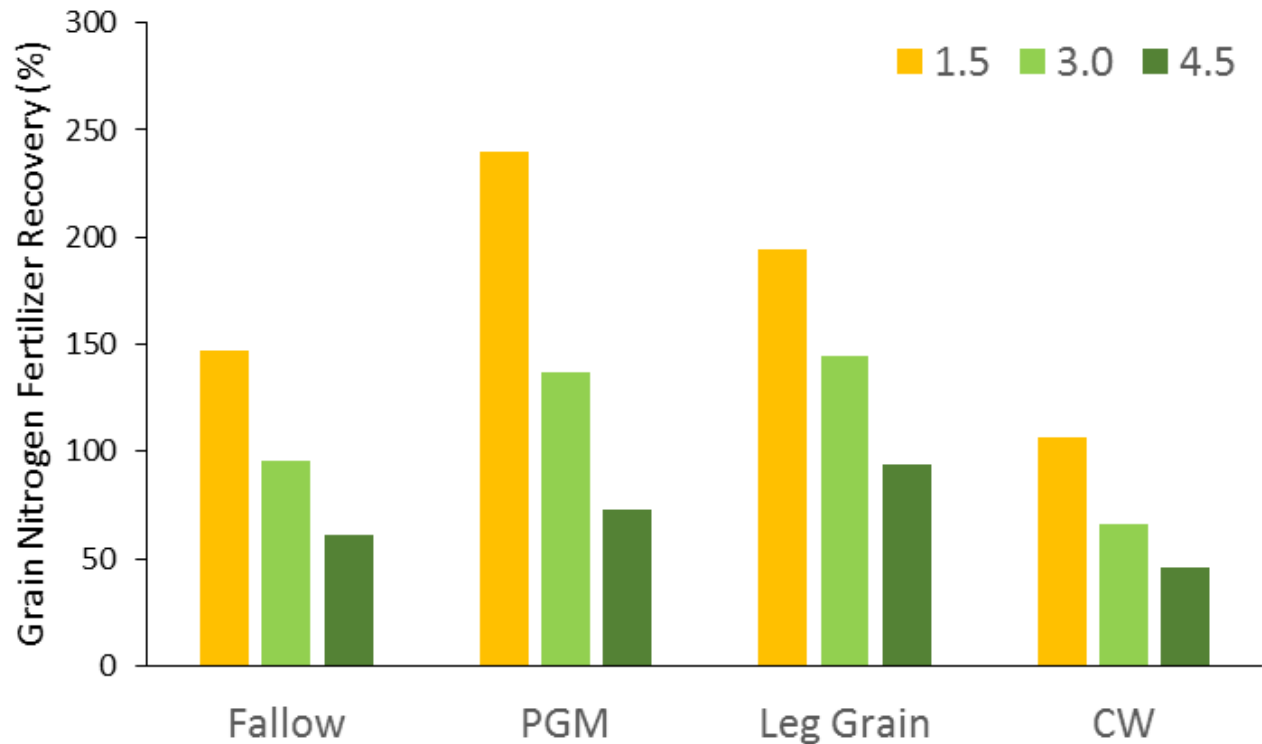


Pulse-wheat system
most profitable;
Pea brown manure least



With steep protein discounts,
it pays to fertilize aggressively

Apparent Nitrogen Fertilizer Recovery – 6 yr (Clain Jones)



Notable:

NFR much higher than reported nationwide and globally in literature (33 – 50%). Precip.

Leg Grain consistently produced higher profits, higher NFR, and lower leaching than Fallow. Win – win - win

Discussion about long-term
aspects?

Future challenges – role of pulses?

1. Glyphosate-resistant kochia
2. Soil acidification

Things that weren't even on our minds when study begun.

Agronomics:

CRP hangover. Organic hangover.

Soils:

Biology, other measures of soil Q

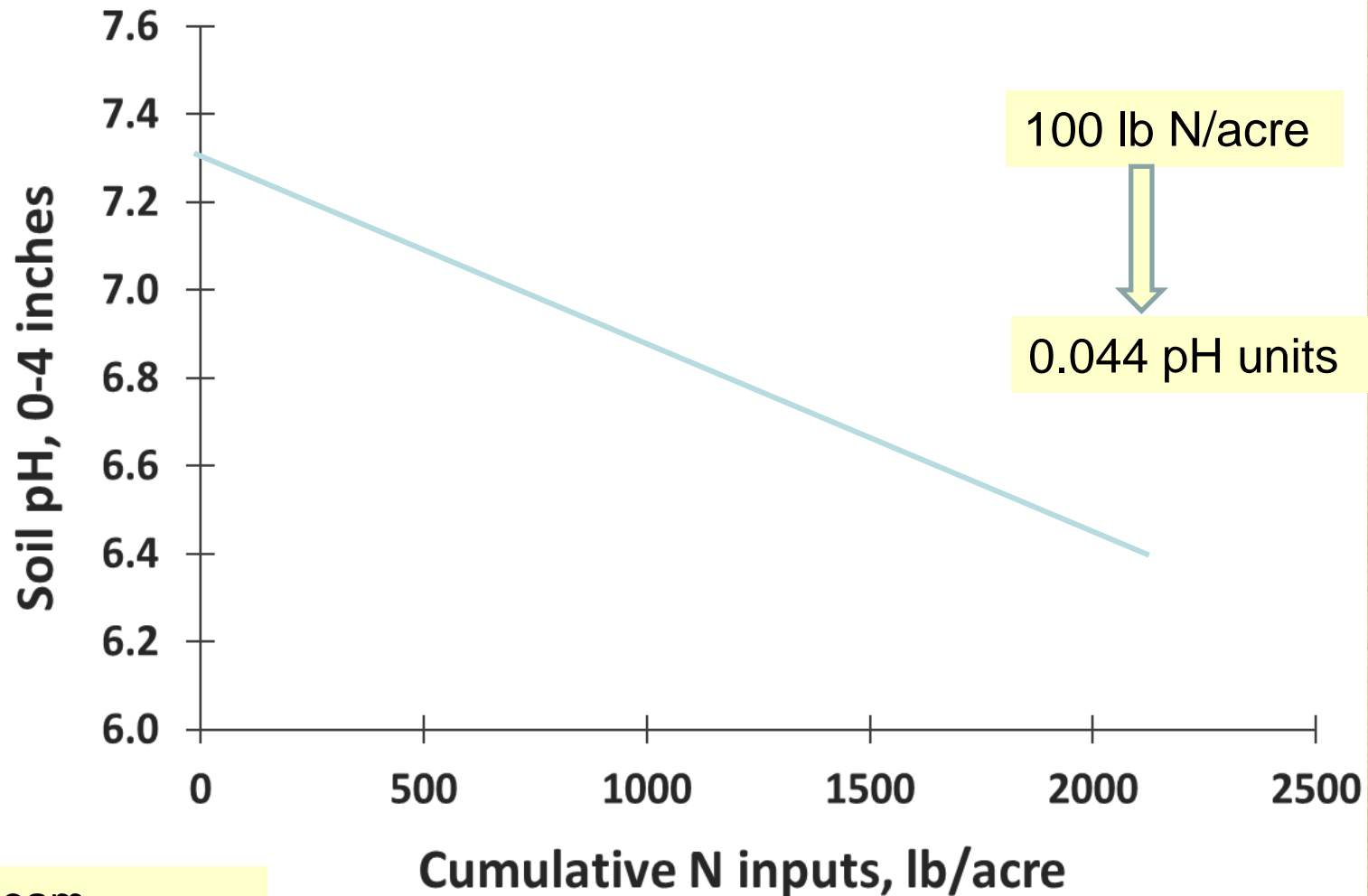
Seed zone acidity!



Aug 14, 2018

Pulses likely to be a help or a hindrance?
What do you think?

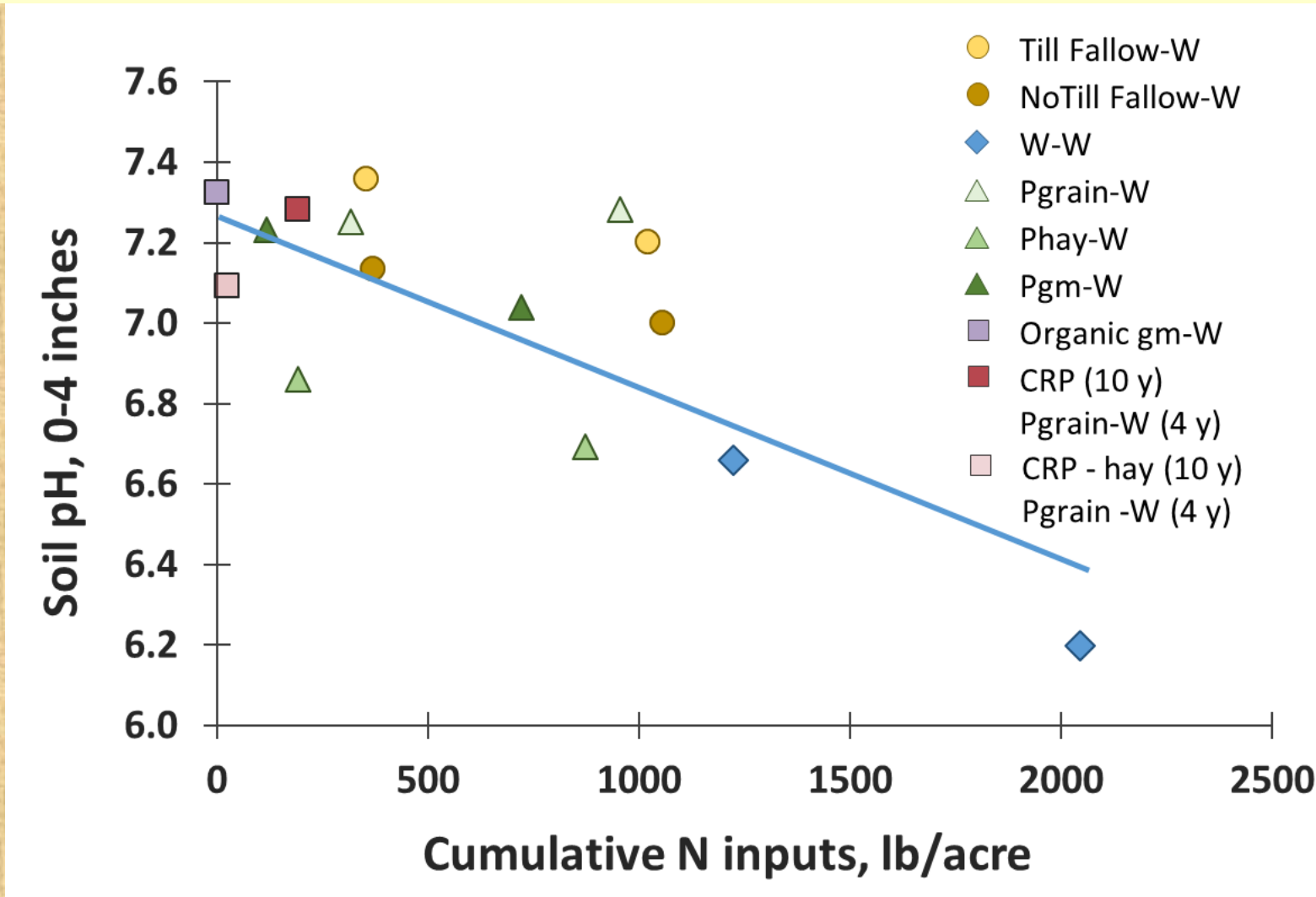
14-yr of N fertilization reduced top 4" pH on dryland cropping west of Bozeman



Silt loam

Engel, Ewing, Miller, unpub data

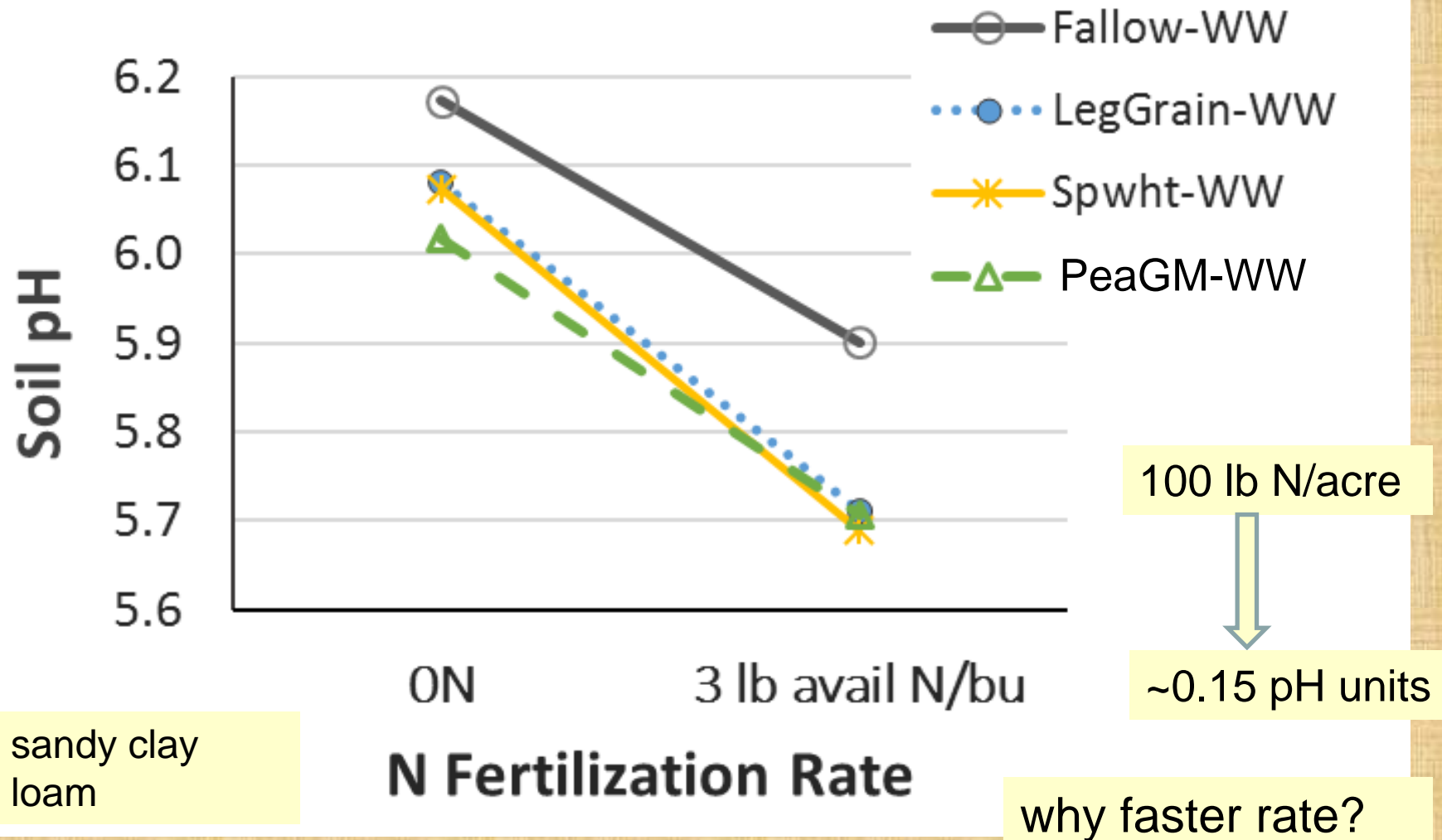
Some dryland crop rotations reduced top 4" soil pH more than others



Silt loam

Engel, Ewing, Miller, unpub data

6-yr N fertilization reduce soil pH (0-3") west of Big Sandy



Alternate year was always winter wheat; Jones and Miller unpub data

No Discussion please!



4. Fun with Pulses!

Chickpea-flax Intercrop

- Increased weed competition/over-yielding
- Ascochyta blight help
- Seeding/harvesting challenges

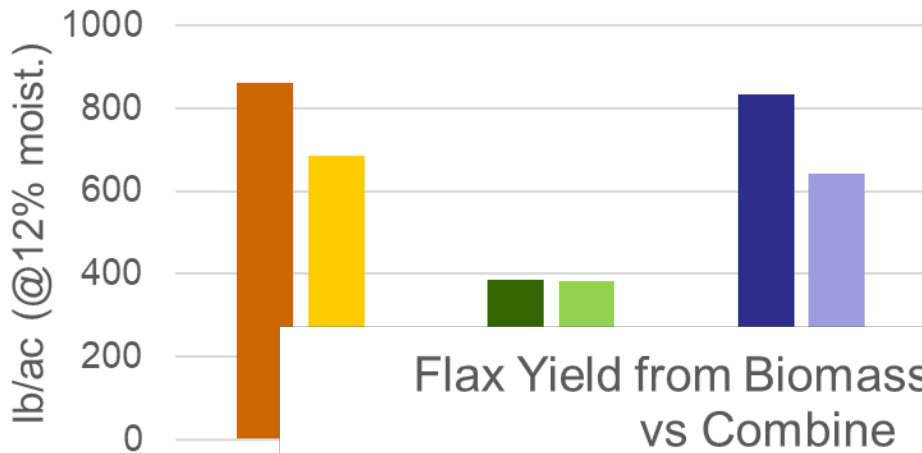
meh

Ooh, interesting!

Fun with Pulses: Chickpea-Flax Intercrop . . .

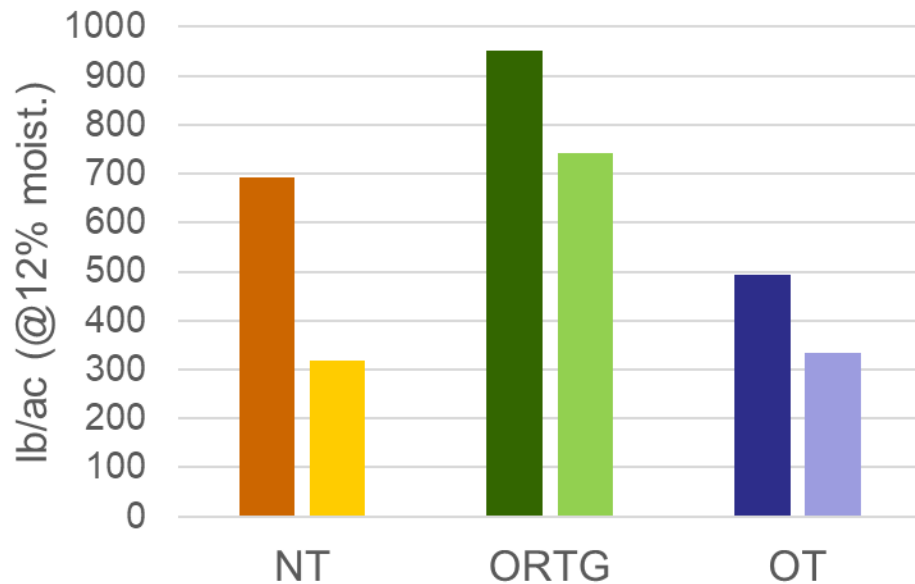


Chickpea Yield from Biomass samples vs Combine

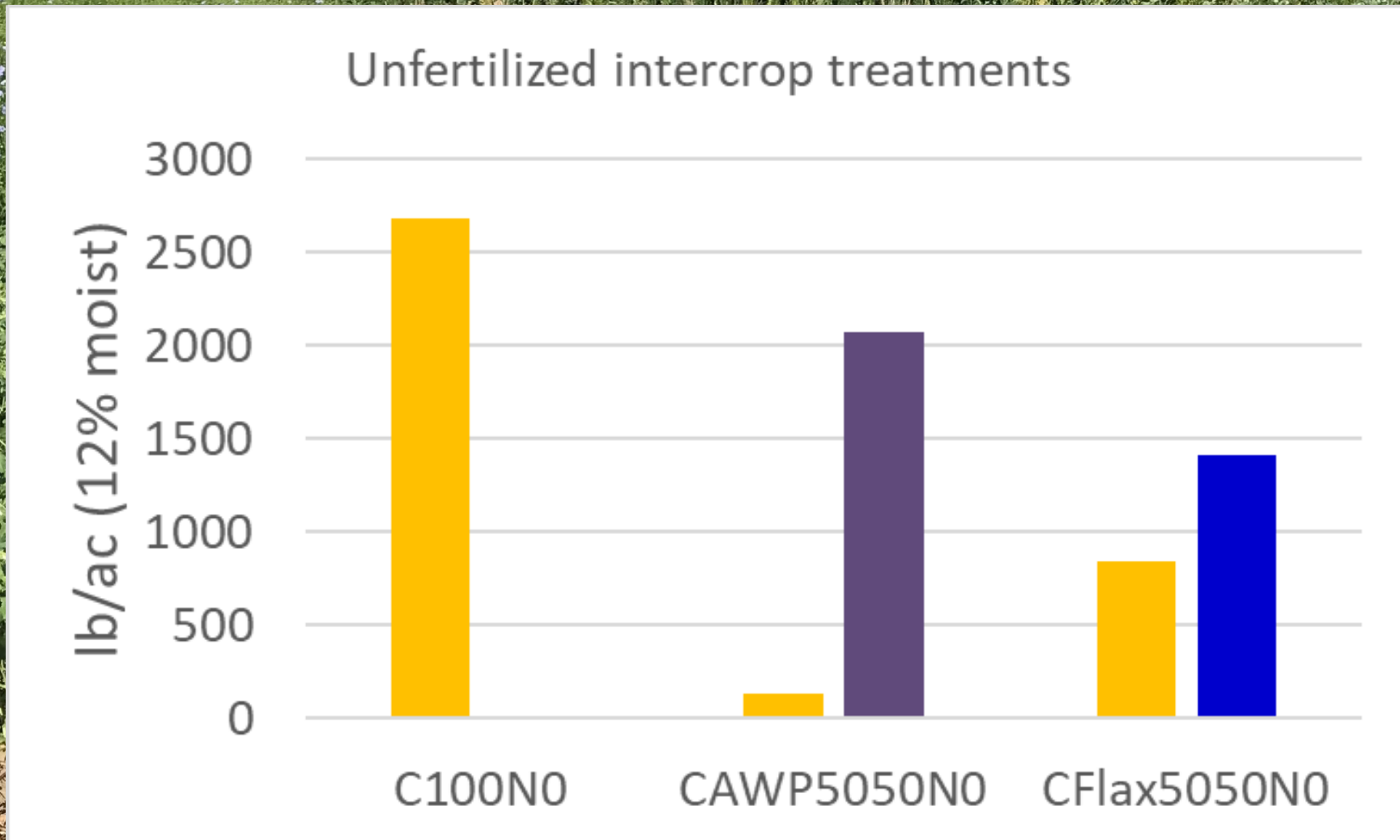


No-till sown 22 d earlier but had lots of prick lettuce
 OGRT was seeded as planned
 OT flax component was sown too deep
 Lost ~ 150 lb/ac chickpea in two of three
 (probably harvest losses in swath)

Flax Yield from Biomass samples vs Combine



But we lost 160 – 470 lb/ac flax due to insufficient threshing!



Discussion?

