Legume Cover Crops (Legume Green Manures)

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MONTANA STATE UNIVERSITY EXTENSION

What we think we know about cover crops in Montana

- Replacing fallow with cover crops should reduce nitrate leaching, saline seeps, O.M. loss, and soil erosion, while improving soil health.
- Legumes as forage or green manure crops are promising fallow replacements because of their N fixing capability.
- Water and nitrogen use by cover crop may reduce yield of following crop in some years.

Additional Background

- Current large interest in MIXED cover crops ("cover crop cocktails"), which generally contain legumes
- Four MT studies shed some light on effects of LGMs and mixed cover crops *on subsequent crop*

Study 1: Three 2-year cycles, no-till and till, plot scale

- Objective: Determine effects of legume species and tillage on subsequent winter wheat.
- ~14 inch annual precip. (Amsterdam)
- Field had been no-till for several years

Study 1 Design

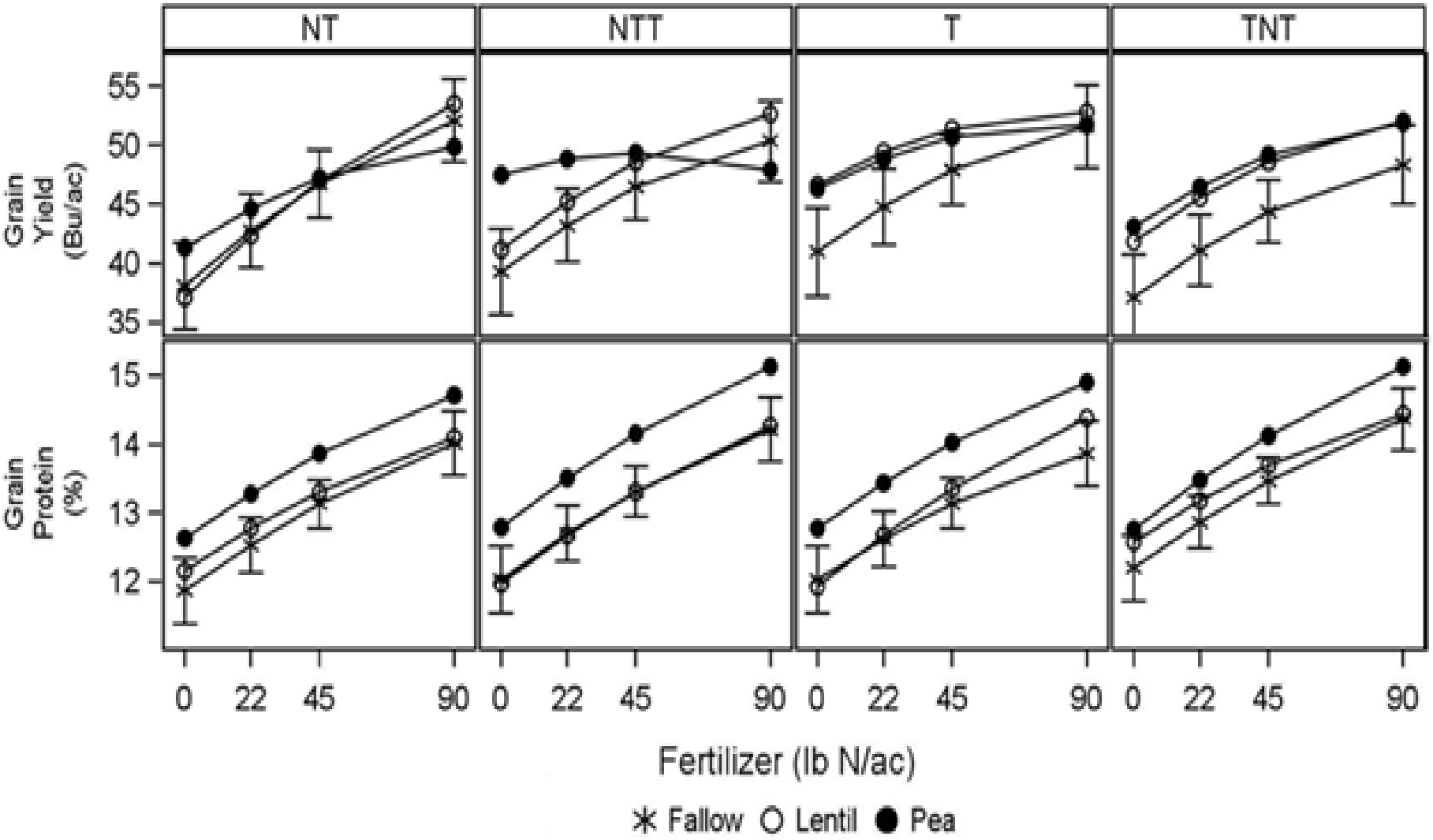
4 green manures X **4 Tillage Treatments**

- Spring Pea
- Spring Lentil
- Non-nodulating Pea
- Fallow

- No-Till (NT)
- Chem – Till (NTT)
- Till (T)
- Till – Chem (TNT)

- Green manures terminated at first flower
- Spring wheat planted at 4 N rates following year

Study 1 (3-year plot scale) Results



Study 1: Take home messages

- If any tillage in system, wheat grain yield following pea manure was higher than yield following lentil or fallow at low N rates.
- In no-till systems, grain yields were not different among treatments regardless of N rate.
- Grain protein was higher following pea manure than following lentil manure or fallow regardless of tillage system at most N rates.
- Legume N was either not being mineralized fast enough or was lost in no-till (volatilized?)
- Question: Are no-till results reproducible at field scale?

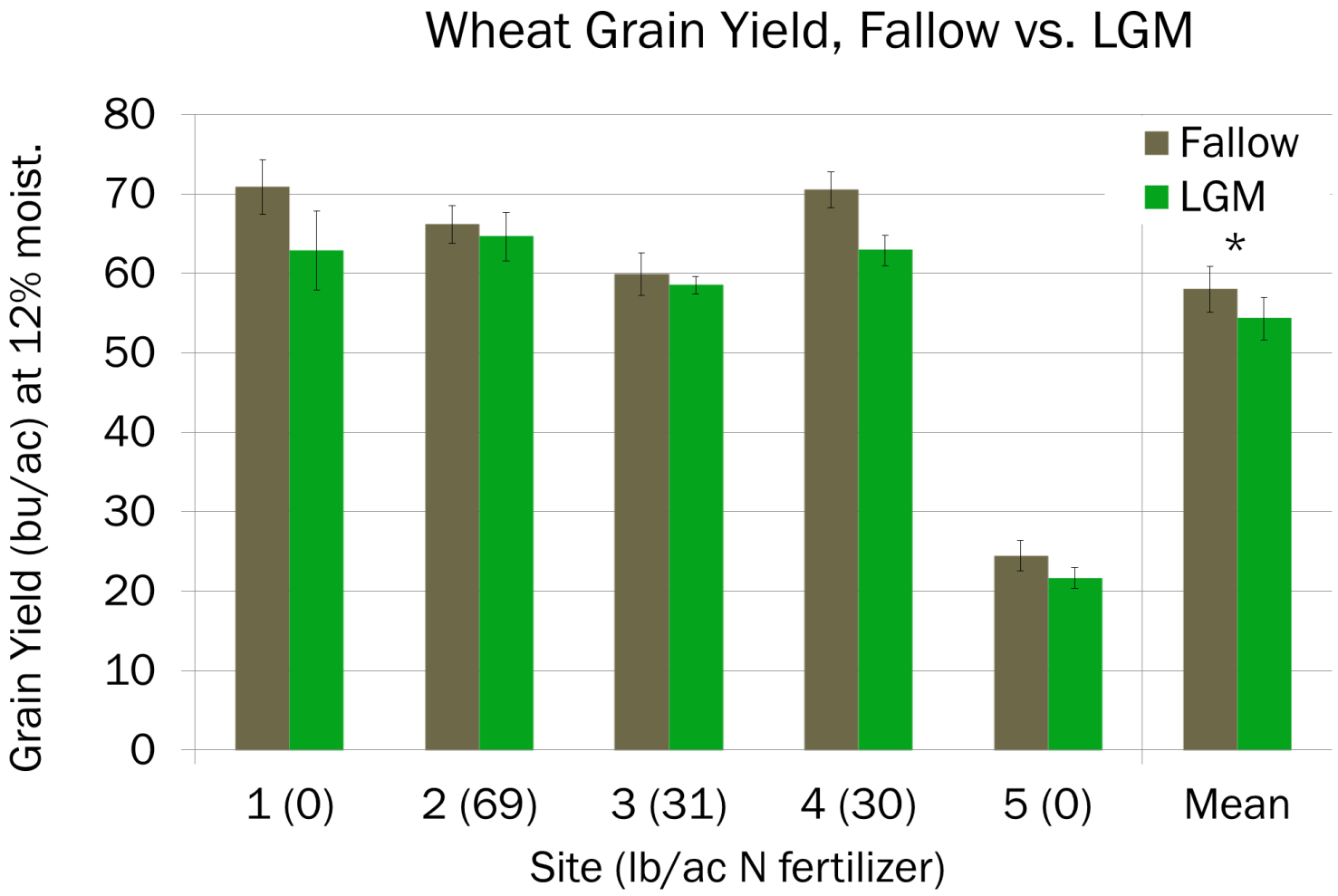
Study 2: One 2-year cycle, five farmer fields

- Objective: Determine effects of LGM on subsequent wheat at field scale in no-till operations.
- 12-14 inch annual precip. (Golden Triangle), though drier than normal 2009 (LGM year) and near-record wet 2010 (wheat year)

Study 2 Design

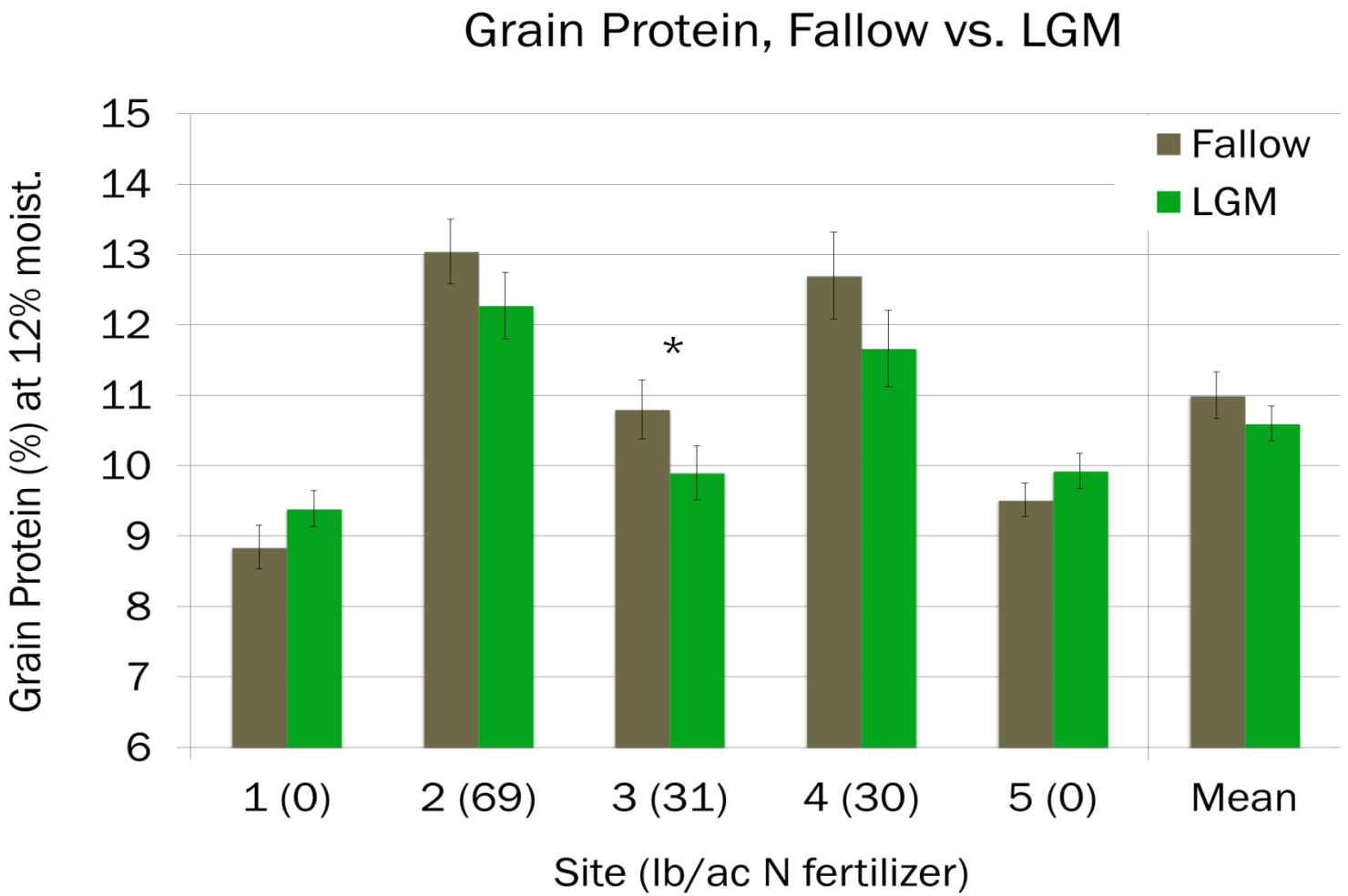
- *LGM (mainly pea) vs. summer fallow*
- LGM grown in 2009 and sprayed out at first flower
- Wheat grown in 2010

Study 2: Grain Yield Results



Wheat grain yield was about 4 bu/ac higher after fallow than after LGM

Study 2: Grain protein results



Grain protein was not different between LGM and fallow when averaged across sites

Study 2: Take home messages

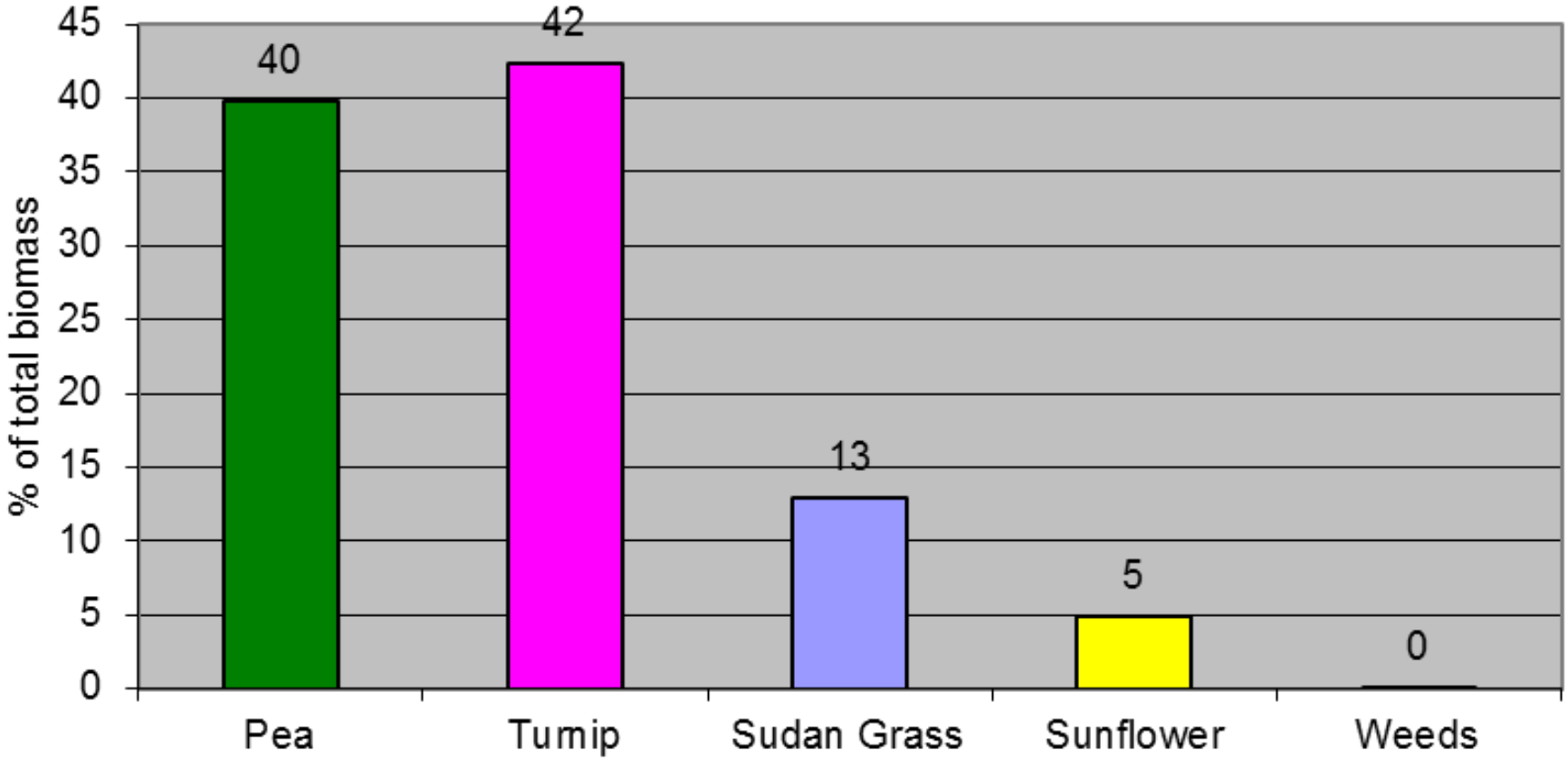
- Grain yield following LGM was 4 bu/ac lower than following fallow.
- Grain protein was not different between LGM and fallow.
- Water use was likely not reason for differences in grain yield: 2010 had near record high precip.
- Nitrate use by LGM (!) was likely cause for yield differences.

  LGM soil had ~18 lb N/ac less nitrate than after fallow at wheat seeding

Study 3: Mixed cover crops, grower's field

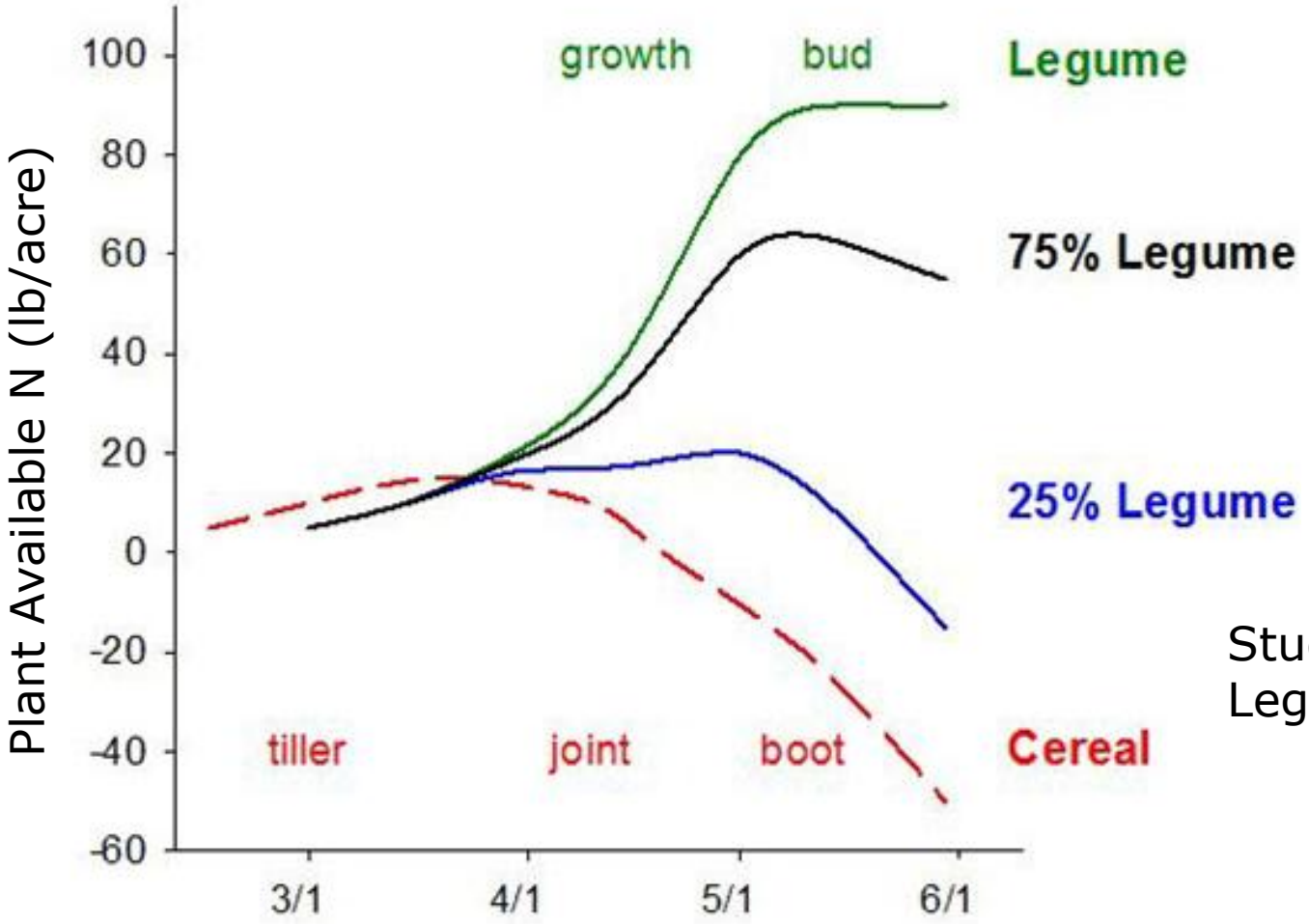
- Amsterdam
- Pea, turnip, sudan grass, and sunflower
  (mix picked by grower)
- Seeded mid-June
- Sprayed out mid-Sept
- Dry Biomass at spraying: 2,600 lb/ac

Study 3: Cover Crop Results



Study 3: Wheat Results (after cover crop)

Percent legume and termination timing affects available N



Study 3: 40% Legume.

Willamette Valley, Oregon
Andrews and Sullivan, 2012

Study 3: Take home messages

- Pea and turnip dominated cover crop stand.
- Winter wheat grain yield was not different after cover crop than after fallow.
- Winter wheat grain protein was lower after cover crop than after fallow.
- Nitrate use by cover crop was likely cause of protein difference.
- *Stay tuned*: we're in 2nd year of 3 year study on mixed cover crops (plot and field scale)

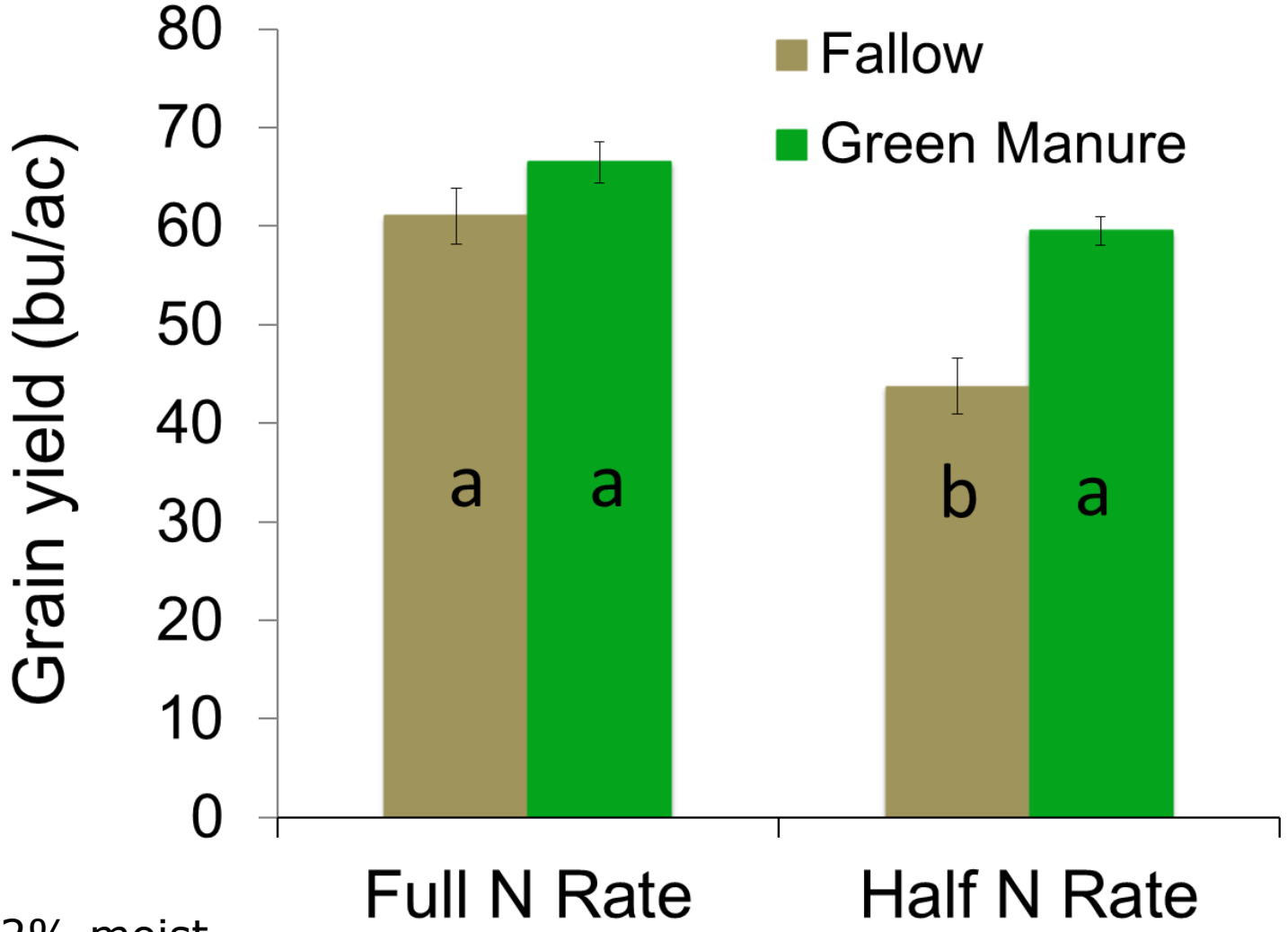
Study 4: Eight-year, plot study

- Objective: Determine long-term effects of legume-containing rotations vs. fallow on subsequent wheat mainly in no-till.
- ~17 inch annual precip. (4 miles w. of Bzn)

Study 4. Experimental Design

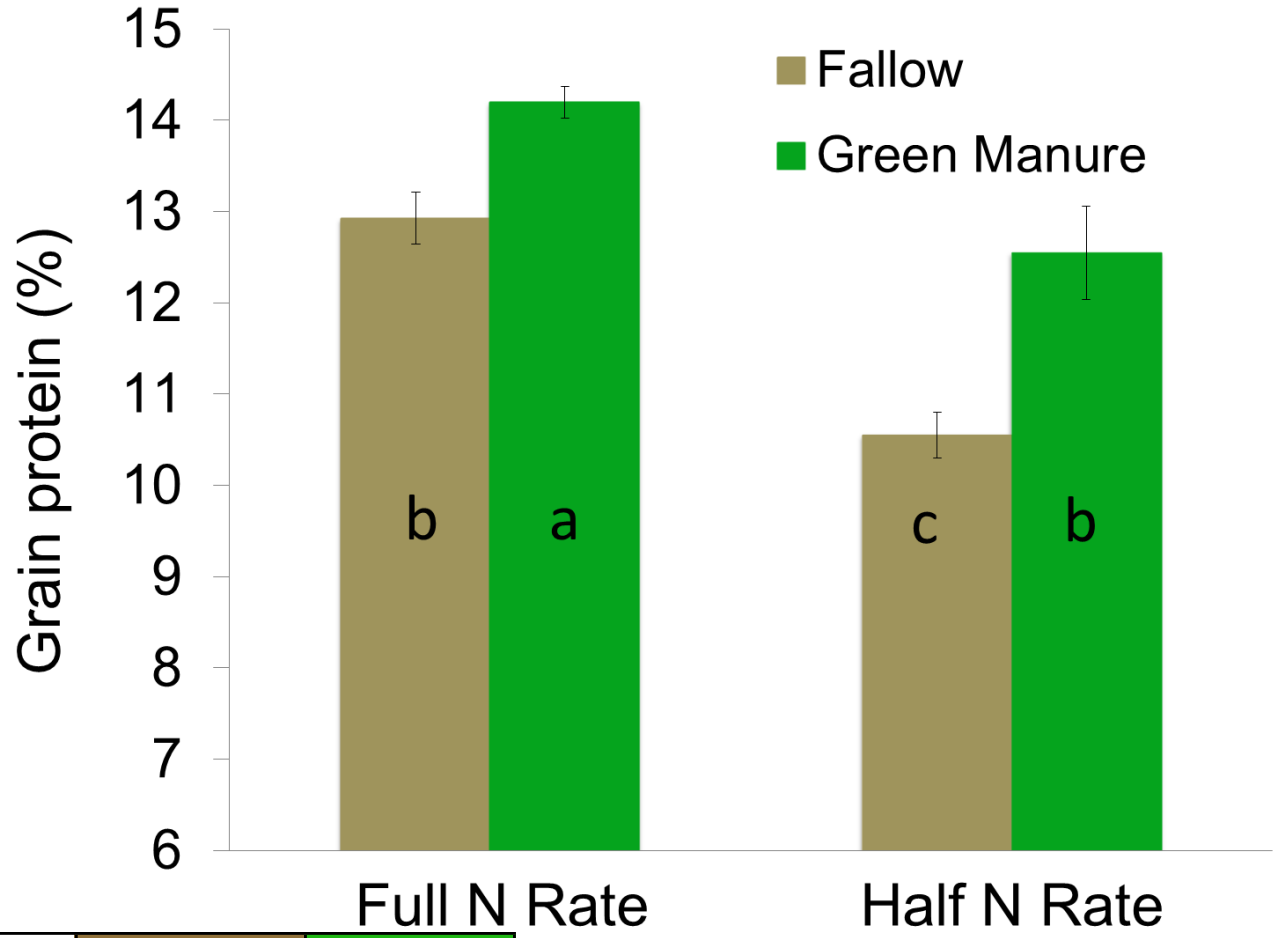
- Focus here on no-till pea forage/legume green manure-wheat vs. fallow-wheat
- Pea forage grown in 2003, 2005, 2007 and pea green manure grown in 2009, terminated at full pod
- Spring or winter wheat planted in even years. 2010 was wettest of wheat years.
- 2 N rates: Full (3 lb available N/bu) and ½

Study 4: 8 year plot study, Grain yield in 8th year



@ 12% moist

Study 4: 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 green manure after 4 LGM-wheat rotations saved **124 lb N/ac** compared to fallow.

Study 4: Take home messages

- After 4 two-year cycles, wheat grain yield and protein were higher after LGM than after fallow.
- In the first 3 cycles, wheat grain yield was not higher after legume 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 (not water) limiting to growth.
- Over 100 lb N/ac was saved in 2010 following LGM compared to fallow.

Conclusions

- In a 3-year study, wheat grain protein was consistently higher after pea green manure than after fallow or lentil green manure.
- Wheat grain yield was only higher after pea green manure than fallow or lentil in tilled systems.
- In no-till systems, there was no benefit of cover crop (legume or mixed) over fallow systems following one LGM cycle.
- After four LGM-wheat cycles, there was a substantial increase in both grain yield and protein compared to after fallow at lower N rates.
- Cover crop value to soil health and subsequent crops is expected to increase over time.

Acknowledgements

- USDA – AFRI
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Questions?

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