Legume Cover Crops
(Legume Green Manures)

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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.
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  ×  4 Tillage Treatments
- Spring Pea
- Spring Lentil
- Non-nodulating Pea
- Fallow

- Green manures terminated at first flower
- Spring wheat planted at 4 N rates following year
- No-Till (NT)
- Chem – Till (NTT)
- Till (T)
- Till – Chem (TNT)
Study 1 (3-year plot scale) Results

![Graph showing the relationship between fertilizer and yield/protein for different crop types.](image-url)
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

![Bar chart showing biomass percentages for Pea, Turnip, Sudan Grass, Sunflower, and Weeds.]

- Pea: 40%
- Turnip: 42%
- Sudan Grass: 13%
- Sunflower: 5%
- Weeds: 0%
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 2\textsuperscript{nd} 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
- 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 8\textsuperscript{th} year

@ 12\% moist
Study 4: 8 year plot study, Grain protein in 8th year

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.
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Questions?

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