Greening Summerfallow:
On-Farm Evaluation of Legume Green Fallow Rotations.

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Materials & Methods

Producer Involvement:

- Six no-till producers voluntarily agreed to participate in this study. (see fig. 1)
- Producers agreed to:
  - Plant a legume green fallow crop (LGF), maintain adjacent Fallow control
  - Communicate field operations and management decisions
  - Manage as they saw fit (see fig.1a)

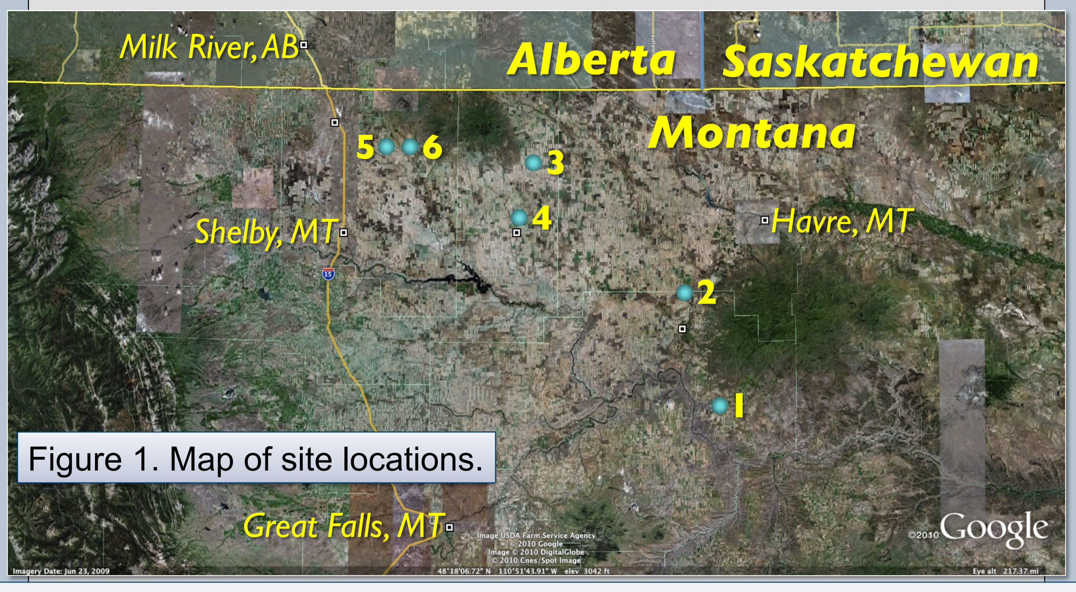


Figure 1. Map of site locations.

Site	1	2	3	4	5	6
LGF crop	Spring Pea	Spring Pea	Spring Pea	Spring Pea	Spring Pea	Spring Lentil
Precip 09' (est., mm)	89	33	152	140	61	64
Wheat type	Winter	Winter	Winter	Spring Durum	Spring	Spring
Precip. 10' (est., mm)	175	175	175	175	175	175
Wheat N fertilizer (kg/ha)	0	30	14	16	14	0

Figure 1a.Basic site management, growing season precipitation.

Study Design:

- Replicated measurement t-test design
- Green fallow vs. Summerfallow
- 550-1300 m field site transects, 6-12 paired measurements (See fig. 2)

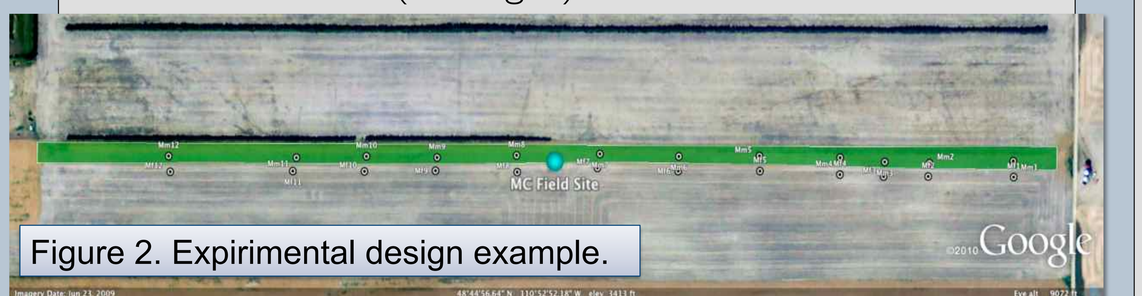


Figure 2. Expirimental design example.

Explanatory Variables:

- LGF biomass and N content
- Soil water status
- Soil nitrate status
- Soil potentially mineralizeable nitrogen (PMN)

Primary Response Variables:

- Wheat yield parameters
  - Grain yield
  - Grain protein content

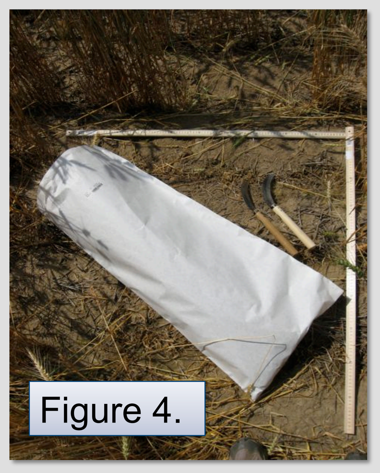
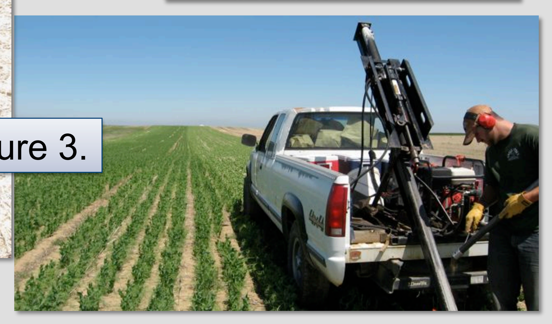


Figure 4.

Figure 3.



Sampling:

- Soil Water, Nitrate status
  - 0 - 90 cm, 30 cm increment samples (See fig. 3)
  - Taken after LGF termination, before wheat seeding
- Soil PMN
  - 0 - 30 cm samples
  - Taken before wheat seeding
- LGF and wheat biomass (see fig. 4)
  - 1 m^2 samples
    - LGF: 3-7 days from termination date
    - Wheat:1-7 days before producer harvested

Introduction/Rationale, Hypotheses, Objectives

Introduction/Rationale:

- Growing legume green fallow crops (LGF) may increase cropping systems sustainability in regions still using conventional summerfallow (fallow) in the northern Great Plains (NGP).
- Excessive LGF soil water use and cheap nitrogen fertilizer costs have historically discouraged LGF practices (Crews and Peoples, 2004; Power, 1990).
- Volatile N fertilizer costs and soil water conservation advances via no-tillage and better LGF management have reinvigorated interest in LGF's (Miller et al., 2006).
- Regional LGF adoption is negligible, and participatory field-scale research may be necessary to better understand this trend.

Hypotheses:

- Plot-scale studies suggest that small soil water deficits from LGF's are unlikely to affect wheat yields negatively.
- With proper soil water management, N fixed by green fallow crops should benefit subsequent wheat yields and quality.
- Participatory on-farm research with farmers using a LGF will illustrate adoption potential and inform regionally appropriate adoption strategies.

Objectives:

- Assess farmer-managed no-till LGF-wheat vs. fallow-wheat rotations on field-scale sites in a region still widely using fallow practices.
- Elucidate management and paradigm challenges to regional viability and adoption of LGF practices.

Results

Figure 5. *LGF biomass by site.*

Figure 6. *Biomass N by site.*

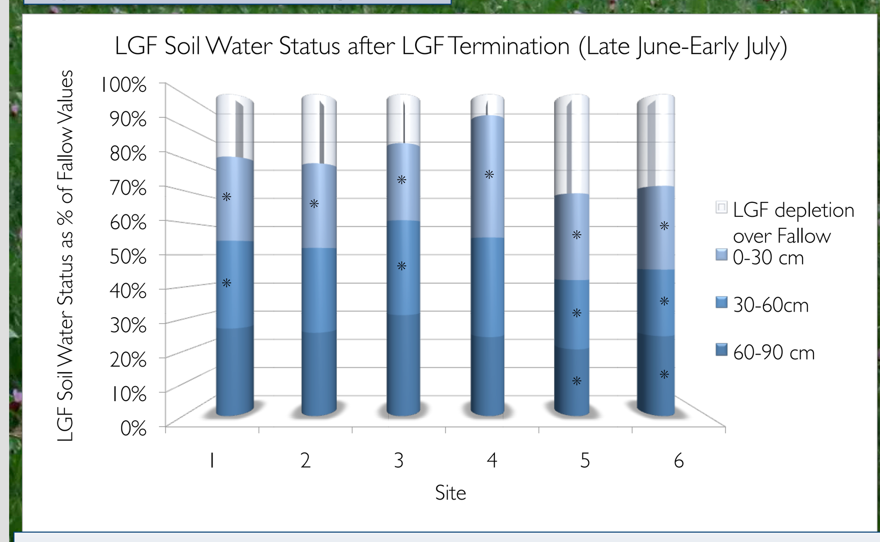


Figure 7. *LGF soil water status at termination in late June-early July.* Values with a * were significantly lower (p- ≤ 0.1) than fallow values.

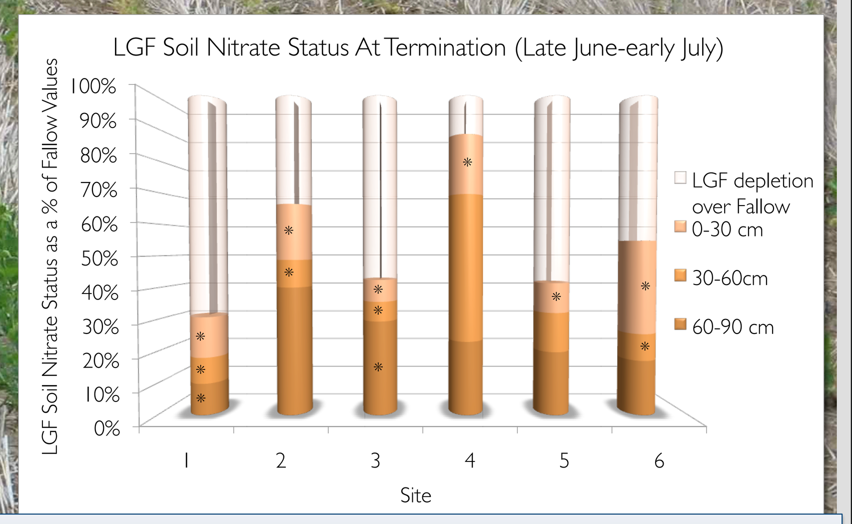


Figure 8. *LGF Soil NO_3^- status at termination in late June-early July.* Values with a * were significantly lower (p- ≤ 0.1) than fallow values.

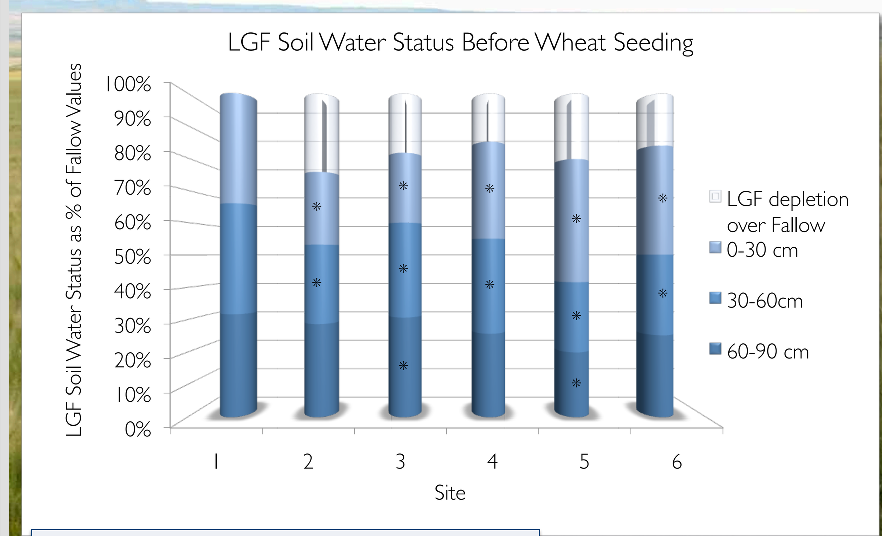


Figure 9. *LGF soil water status before seeding.* Timing of measurement was dictated by producer's decisions to plant winter or spring wheat.

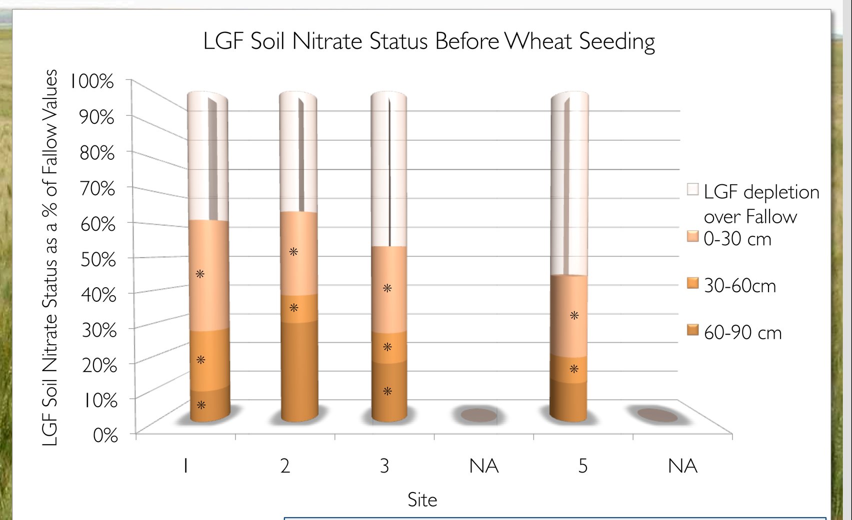


Figure 10. *LGF soil NO_3^- status before wheat seeding (incomplete).* Timing of measurement was dictated by the producer's decision to plant winter or spring wheat.

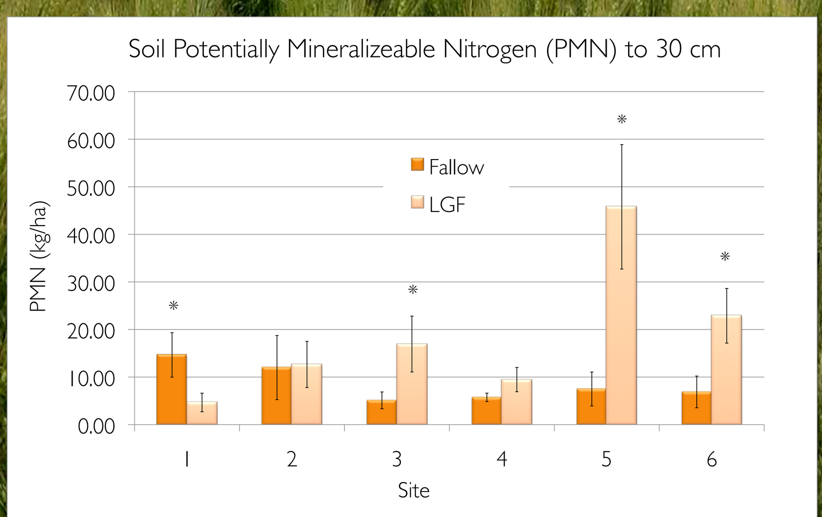


Figure 11. *LGF soil PMN values to 30 cm.* PMN determined by ammonium evolved from soil subsamples (10 g) during a lab incubation (7d,40° C). Significantly higher PMN values (p- ≤ 0.1) are indicated with a *, error bars are one standard error of the mean.

Preliminary Response, Conclusions

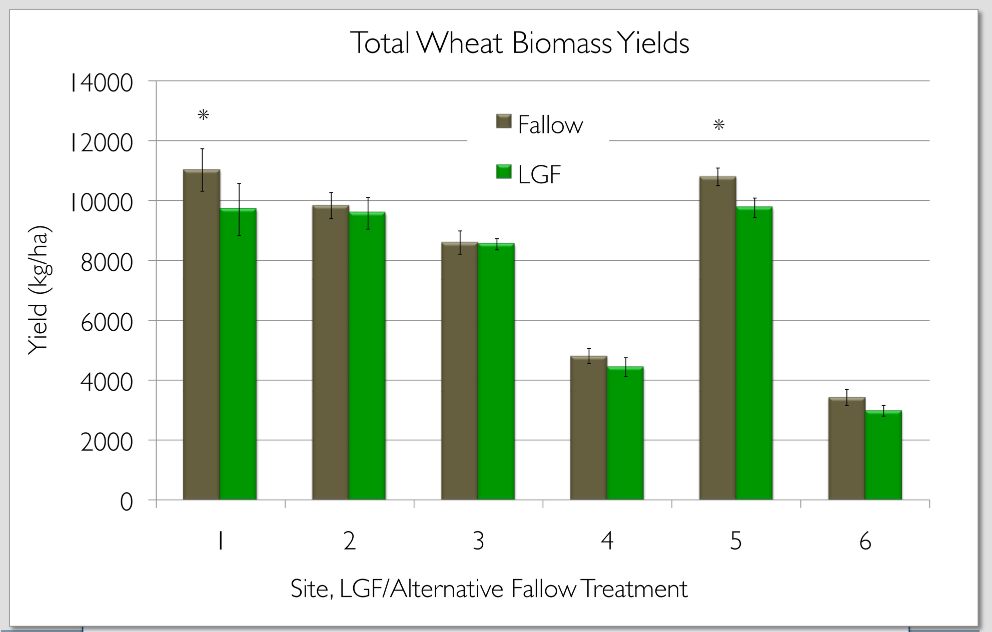


Figure 12. *Total wheat biomass yields.* Significantly higher yield values (p- ≤ 0.1) are indicated with a *, error bars are one standard error of the mean.

- Full soil water recharge of LGF soils to fallow values by wheat seeding was illustrated. (see fig. 9).
- Small water deficits at seeding (see fig. 9), high growing season rainfall at all sites (est. 150-200 mm) and high yields overall suggest water was not a primary limiting factor of yield potential
- Values reflecting soil N before seeding (see figs. 10,11) suggest biomass N may not be substantial enough (see fig. 5)(Tonitto et al., 2006) to have mineralized sufficiently (see figs. 8,10) for wheat uptake of N to equal fallow values (Janzen et al., 1990) and produce equal yields (see fig 12.)
- Early season N limitation may have occurred (see fig.10), suggesting that substantial N benefits may not be immediately realized after one rotation, (Drinkwater et al., 1998; Zentner et al., 2004).
- Expected late season N mineralization of LGF residues (see fig. 11) may still benefit wheat during grain fill (Miller et al., 2002).
- Assessments to date suggest that seed costs for LGF's, conflicting spring wheat and LGF crop seeding windows, adherence to first-flower termination timing, herbicide choice for LGF termination, and lack of substantial immediate LGF yield benefits may be barriers to adoption.

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