Integrating Crops and Livestock by Ley Farming in the northern Great Plains

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Research Summary

Spring wheat (*Triticum* spp.) was grown on over 770 000 ha in southwestern North Dakota in 2004 (USDA NASS, 2005). The expected returns to labor and management in 2005 ranged from -$82 ha^{-1} for hard red spring wheat (*T. aestivum* L. emend. Thell.) grown after fallow to -$11 ha^{-1} for durum wheat (*T. turgidum* L.) grown after wheat (Swenson and Haugen, 2004). The negative returns that were projected suggest that diversification strategies are needed to enhance wheat production economics.

Alfalfa (*Medicago sativa* L.) was grown on over 80 000 ha in southwestern North Dakota in 2004. Alfalfa hay production returned an average of $41 ha^{-1} to labor and management in 58 fields within the region in that year (FinBin, 2005). Growing alfalfa for hay has returned an average of $65 ha^{-1} over the past 10 yr, making alfalfa hay production the most profitable crop enterprise in southwestern North Dakota. The returns generated by alfalfa suggest that legume forages can be grown successfully in the region. Alfalfa and other legume species offer benefits in addition to the high-value forage that is produced. Legumes are the symbiotic hosts of microorganisms that can fix atmospheric nitrogen (N_2) biologically, and this relatiionship can reduce if not eliminate N-fertilizer costs of subsequent crops in a rotation. Fertilizer expenses comprised around 20% and rising of the variable costs associated with wheat production in 2005 (Swenson and Haugen, 2004), so a reduction in N-fertilizer use could represent a substantial economic savings to wheat producers. The potential of incorporating legumes into rotations with wheat patterned after Australian ley farming, where wheat and legume pasture are rotated, was considered in a previous state project (ND 06251). Results of that project suggest that strategies must be developed so that the rotational benefits to wheat that occur in Australian ley farming can be duplicated in southwestern North Dakota. The goals of the proposed project are to develop management strategies for ley farming in southwestern North Dakota, and determine the economic returns and environmental stability of legume (pasture) - wheat systems. Attaining these goals will end any speculation on the suitability of ley farming in the northern Great Plains, which began when this farming system was considered in Montana in the 1980s (Koala, 1982).

Introduction

Wheat-fallow was the dominant cropping system in southwestern North Dakota during much of the 20th century. Environmental degradation and economic efficiency concerns largely explain why wheat no longer can be grown profitably using this system with or without government price supports. Still, preceding wheat with fallow remains a common practice, based on a survey of 370 fields in southwestern North Dakota in 2004 (M.M. McMullen, personal communication, 2004). A greater proportion of arable land was fallowed than seeded to barley, sunflower, or other field crops, except for wheat.

The development of ley farming was a response to the environmental and economic problems created by wheat-fallow in Australia. In Australian ley farming, wheat is rotated with legume pasture that both profitably and ecologically integrates cereal crop and livestock enterprises to form flexible and sustainable dryland agricultural systems. The legumes provide forage for sheep (*Ovies aries* L.) and cattle (*Bos taurus* L.) during the pasture phase, as well as fix N_2 biologically for subsequent use during the wheat phase.

The potential of 32 legume species and subspecies was evaluated as regenerating pasture crops in a 3-yr study in southwestern North Dakota (Carr et al., 2005a). Birdsfoot trefoil (*Lotus corniculatus* L.) showed the greatest potential as a regenerating pasture species in the study. Birdsfoot trefoil reseeded naturally following wheat and forage dry matter (DM) yield exceeded 3.5 Mg ha^{-1} in two of three field experiments (Carr et al., 2005b). Biennial sweetclover (*Melilotus* spp.) also showed potential as a regenerating forage legume species

in some yr. Other species like black medic (*Medicago lupulina* L.) regenerated from the soil seed bank following wheat, but failed to produce enough forage to support grazing.

Establishment success was poor for regenerating legume species when first seeded mechanically in previous research, and work is needed to determine if forage legume stands can be established consistently (Carr et al., 2005a). Research also is needed which determines the impact of small-grain companion crops when establishing forage legume species in southwestern North Dakota, since this is a common practice even though most research has been confined to subhumid regions.

Wheat yield was enhanced following the adoption of ley farming compared with wheat-fallow in Australia (Puckridge and French, 1983). In contrast, wheat yields generally were not elevated and sometimes were depressed in a 3-yr legume (2-yr)-wheat (1-yr) sequence following birdsfoot trefoil and many other regenerating pasture species in southwestern North Dakota (Carr et al., 2005b). Yield depression could have resulted from soil water deficits that developed during the legume phase, or because legume species were not fixing N_2 effectively. Research is needed to determine when legumes must be terminated so soil water recharge can occur prior to the wheat phase in a wheat-pasture rotation. Work also is needed to determine how much N_2 can be fixed by regenerating legume species in southwestern North Dakota, and in identifying management strategies that optimize biological N_2 fixation. The objectives of this project are to: (1) identify methods for the successful establishment, maintenance, and termination of regenerating legume pasture species, (2) determine the soil N and water use effects of legume forages on spring wheat in a legume-wheat sequence, and (3) identify the impact of pasture-based cropping systems on energy balance, economics, and pests compared with a grain-based cropping system.

Materials and Methods

Objective 1. Develop methods for the successful establishment, maintenance, and termination of regenerating legume pasture species.

Eight studies are included under Objective 1. Four of these studies focus on refining seeding methods for consistent establishment of legume stands in southwestern North Dakota. A fifth study will develop herbicide strategies for terminating legume plant stands effectively, while a sixth study will identify legume species offering advantages compared with alfalfa if grown for forage. A seventh study will determine if manipulating termination strategies enables some legume species to regenerate naturally following a 2-yr wheat-pea sequence, while an eighth study will identify legume species preferred for grazing by cattle.

Objective 2. Determine the soil N (nitrate, ammonium, and total) and water-use effects of legume forages on spring wheat in a wheat-pasture rotation.

Two studies are included under Objective 2. One study will determine the amount of N contained in plant parts (above-ground vegetation and roots) of legume species that can contribute to the soil-N pool. The impact that forage legumes have on performance of a subsequent wheat crop compared with applications of N-fertilizer will be determined in a second study. Soil water-use by legume forages is unknown in this region, so water-use by different species will be determined following a modification of the procedure described by Miller et al. (2002).

Objective 3. Identify the impact of pasture-based cropping systems on energy balance, economics, and pests compared with a grain-based cropping system.

A field experiment designed to determine if ley farming can be adopted in southwestern North Dakota was begun in 2000. This long-term project will be continued during this proposed project. A description of treatments, experimental

Results and Discussion

None at this time

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