Flexible Summer Fallow: A Dynamic Cropping Systems Concept for the Central Great Plains

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Abstract

Summer fallow has played a significant role in dryland cropping systems in the Central Great Plains for many years. Although it helps to stabilize crop yields, summer fallow jeopardizes the long-term sustainability of dryland systems by degrading the soil resource and limiting profitability. We argue that a dynamic system involving flexible fallow, whereby a grower's decision to transition from a summer crop to winter wheat with a short-duration spring crop or summer fallow is based on several dynamic factors including soil water and economics, would be preferable to a static system incapable of responding to the highly variable climatic and economic scenarios indicative of the region.

Introduction

Summer fallow, the practice of controlling all weed growth during the non-crop season, is commonly used to stabilize winter wheat production in the Great Plains. Wheat-fallow is the predominate cropping system in the Great Plains, but water storage efficiency during fallow is frequently less than 25% with conventional tillage (McGee et al., 1997). The advent of reduced- and no-till systems have generally enhanced the ability to capture and retain precipitation in the soil during non-crop periods of the cropping cycle, making it more feasible to reduce the frequency of fallow and intensify cropping systems relative to wheat-fallow (Peterson et al., 1996). Data from 1993-2001 at Akron, CO (Nielsen et al., 2002) indicated that winter wheat yields were strongly influenced by amount of soil water available at wheat planting. They also showed that 2- and 3-yr cropping systems that included no-till summer fallow before wheat planting nearly always had enough soil water at planting to ensure at least 2500 kg ha^{-1} wheat grain yield. On the other hand, a 3-yr no-till system without summer fallow had enough soil water at planting to ensure at least 2500 kg ha^{-1} in only 28% of the years.

In the Great Plains, annual precipitation is concentrated during the warm season from April to September. Hence, inclusion of a summer crop, e.g., corn or grain sorghum, in a 3-yr system of wheat-summer crop-fallow increased the efficient use of precipitation by reducing the frequency of summer fallow and using more water for crop transpiration (Farahani et al., 1998). In addition to increased precipitation use efficiency and grain yield, more intensified dryland cropping systems increase potentially active surface soil organic C and N (Peterson et al., 1998) and effectively control winter annual grass weeds in winter wheat (Daugovish et al., 1999).

In the 1970s, Montana and North Dakota initiated "Flexible Cropping" to use precipitation more effectively, to increase spring small grain yields, and to help prevent and control saline seeps (Brown et al., 1981). A dynamic programming approach determined that using soil water at wheat planting time would increase expected annualized returns by about \$7.50 ha^{-1} compared to continuous wheat and about \$15.00 ha^{-1} compared to winter wheat-fallow (Burt and Allison, 1963).

Table 1. Annualized net return for the spring crop and subsequent winter wheat crop at Sidney, NE.

Preceding spring crop	1999-2000	2000-2001	2001-2002	3-yr mean
		$ ha^{-1}		
Summer fallow	-6.33	41.56	-57.88	-7.55
Oat/pea forage	91.05	-22.43	-56.03	4.20
Spring canola	-50.29	-106.49	-127.85	-94.88
Proso millet	6.21	-25.45	-1.50	-6.91
Dry bean	101.63	-127.60	-63.01	-29.66
Corn	-34.15	-115.56	-93.78	-81.17
LSD (0.05)	16.90	13.56	14.19	8.58

Discerning When to Use Summer Fallow

In a previous study (Lyon et al., 1995) conducted near Sidney, NE, the grain yields of two short duration crops (pinto bean and proso millet) consistently responded positively to increasing soil water at planting (Table 2). In contrast, grain yields of long-duration crops (corn, grain sorghum, and sunflower) did not consistently respond to increasing soil water at planting, although there was a significant positive correlation between soil water at planting and dry weight of the crop at 12 wk after planting. The correlation of grain yield to soil water at planting appeared to decrease as the days from planting to harvest increased. There might be a substantial amount of initial soil water available at flowering for short-duration crops, but not for long-duration crops, because they use this initial water for vegetative production, leaving little for grain development.

Table 2. Correlation coefficients (r) showing the relationship between soil water at planting and dry weight accumulation 12 wk after planting, grain yield, and water use.

Crop	Dry weight	Grain yield	Water use
		r	
Proso millet	0.87***	0.89**	0.55*
Pinto bean (1992)	0.72*	0.81*	0.77**
Pinto bean (1993)	0.93***	0.87**	0.89**
Sunflower	–	0.65**	0.85**
Corn	0.93***	-0.64**	0.85**
Grain sorghum	0.80***	-0.51*	0.81**

*, **, *** Indicates significance at 0.05, 0.01, and 0.001 levels, respectively.