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Large-Scale Dryland Cropping Systems

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Abstract

This study was conducted from 2008 to 2015 at the Kansas State University Southwest Research-Extension Center near Tribune, Kansas. The crop rotations evaluated were continuous grain sorghum (SS), wheat-fallow (WF), wheat-corn-fallow (WCF), wheat-sorghum-fallow (WSF), wheat-corn-sorghum-fallow (WCSF), and wheat-sorghum-corn-fallow (WSCF). All rotations were grown using no-till practices except for WF, which was grown using reduced-tillage. Precipitation capture efficiency was not greater with more intensive rotations. Wheat yields were not affected by length of rotation. Corn and grain sorghum yields were about 60% greater when following wheat than when following corn or grain sorghum. Grain sorghum yields were almost twice as great as corn in similar rotations. The most profitable cropping system was wheat-sorghum-fallow.

Keywords

large-scale dryland cropping systems, conventional tillage, no-till, wheat, fallow, corn, sorghum

Cover Page Footnote

This research project received support from the USDA-ARS Ogallala Aquifer Program.

Large-Scale Dryland Cropping Systems

A. Schlegel, L. Haag, and D. O'Brien

Summary

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Introduction

The change from conventional tillage to no-till cropping systems has allowed for greater intensification of cropping in semi-arid regions. In the central High Plains, wheat-fallow (1 crop in 2 years) has been a popular cropping system for many decades. This system is being replaced by more intensive wheat-summer crop-fallow rotations (2 crops in 3 years). There has also been increased interest in further intensifying the cropping systems by growing 3 crops in 4 years or continuous cropping. The objective of the study was to identify whether more intensive cropping systems can enhance and stabilize production in rainfed cropping systems to optimize economic crop production, more efficiently capture and utilize scarce precipitation, and maintain or enhance soil resources and environmental quality. This project evaluates several multi-crop rotations that are feasible for the region, along with alternative systems that are more intensive than 2- or 3-year rotations. The objectives are to (1) enhance and stabilize production of rainfed cropping systems through the use of multiple crops and rotations using best management practices to optimize capture and utilization of precipitation for economic crop production, and (2) enhance adoption of alternative rainfed cropping systems that provide optimal profitability.

Procedures

The crop rotations are 2-year (wheat-fallow [WF]); 3-year (wheat-grain sorghum-fallow [WSF] and wheat-corn-fallow [WCF]); 4-year rotations (wheat-corn-sorghum-fallow [WCSF] and wheat-sorghum-corn-fallow [WSCF]); and continuous sorghum [SS]). All rotations are grown using no-till (NT) practices except for WF, which is grown using reduced-tillage (RT). All phases of each rotation are present each year. Plot size is a minimum of 100 × 450 ft. In most instances, grain yields were determined by harvesting the center 60 ft (by entire length) of each plot with a commercial combine and determining grain weight with a weigh-wagon or combine yield monitor. Soil water was measured in 12-inch increments to 96 inches near planting and after harvest either gravimetrically (RT WF) or by neutron attenuation (NT plots). An economic analysis calculated net returns to land and management using custom rates for all machine operations, local costs of inputs, and average annual grain prices.

Results and Discussion

Precipitation averaged 96% of normal (17.90 in.) across the 8-yr study period and was near normal (+/- 15%) in 5 out of 8 years with two wet years (>20% above normal) and one exceptionally dry year (42% of normal) (Figure 1). Fallow accumulation, fallow efficiency, and profile available water at wheat planting was greater with WF than all other wheat rotations (Table 1). The fallow efficiencies of the 3- and 4-yr NT rotations were only 54-68% of WF under RT. With more water available, crop water use was also greater with WF than with wheat in other rotations. There were no differences in available water at wheat planting or crop water use among the 3- and 4-yr rotations.

Fallow accumulation prior to corn planting and profile available soil water at planting was greater following wheat (WCF or WCSF) than following grain sorghum (WSCF) (Table 1). However, the fallow period following wheat was longer, resulting in low fallow efficiencies (~15%) following wheat and only 22% following sorghum. Similar to wheat, corn water use was greater with greater available soil water at planting. Grain sorghum responded similarly to corn, with greater fallow accumulation and soil water at planting (and greater crop water use) when following wheat than following corn or sorghum. Again, fallow efficiencies prior to grain sorghum were very low, less than 17%.

Wheat yields varied greatly from less than 5 to almost 50 bu/a (Figure 2). The effect of cropping systems was not consistent across years with WF sometimes in the highest yielding group and sometimes in the lowest yielding group. Averaged across the 8 years, cropping system had little effect on wheat yields.

Grain sorghum yields varied greatly from year to year (ranging from less than 10 to more than 100 bu/a) but were consistently higher following wheat than either corn or sorghum (Figure 3). Average grain sorghum yields following wheat were about twice as great as following corn or sorghum.

Corn yields varied from less than 10 to greater than 80 bu/a (Figure 4). Corn yields following wheat in either the 3- or 4-yr rotations were always greater than corn yields following grain sorghum except in 2015 where corn yields following sorghum (wsCf) were great than wCf. On average, corn yields following wheat were about 60% greater than following grain sorghum.

When examining grain yields across crops, the greatest yields were produced by grain sorghum following wheat (either wSf or wScf) of about 65 bu/a (Figure 5). These yields were about twice that of corn following wheat (wCf or wCsf). Sorghum yields following wheat were also about twice that of sorghum following corn or sorghum (wcSf or

SS) while corn yields following wheat (wCf or wCsf) were more than 60% greater than following sorghum.

An economic analysis (excluding crop insurance and government payments) based on annual crop prices and input costs evaluated the average net returns to land and management from the six rotations. The only rotation that had a positive net return (although small at less than $6 per acre) was WSF (Figure 5). The next most profitable rotation was WF (negative $18 per acre) with all other rotations having negative returns of more than $35 per acre.

Acknowledgments

This research project received support from the USDA-ARS Ogallala Aquifer Program.

Table 1. Fallow accumulation, fallow efficiency, profile (8 ft) available soil water at planting, and crop water use by wheat, corn, and grain sorghum in several crop rotations, Tribune, Kansas, 2008-2015.

Crop	Rotation	Fallow accumulation	Fallow efficiency	Profile ASW at planting[2]	Crop water use
		inch	%	inch	inch
Wheat	Wf[1]	6.47a	28a	9.38a	16.70a
	Wsf	2.76bc	19b	6.11b	12.65b
	Wcf	2.26c	15c	5.77b	12.51b
	Wscf	2.92b	18b	6.11b	12.70b
	Wcsf	2.74bc	17bc	6.10b	12.65b
$LSD_{0.05}$		0.55	3	0.67	0.58
Corn	wCf	2.07a	16b	5.24a	13.28a
	wCsf	1.87a	15b	5.10a	13.17a
	wsCf	0.95b	22a	3.99b	12.47b
$LSD_{0.05}$		0.41	4	0.64	0.49
Grain sorghum	wSf	1.97b	14	5.33a	12.50a
	wScf	2.48a	17	5.51a	12.81a
	wcSf	1.01c	15	4.56b	11.80b
	SS	1.17c	17	4.40b	11.69b
$LSD_{0.05}$		0.42	4	0.66	0.43

[1] Wheat-fallow rotation is reduced-till; all other rotations are no-till. Means within a column with the same letter for the same crop are not statistically different at P=0.05. The capital letter in the rotation denotes the crop phase of the rotation.

[2] Available soil water in a 8 ft profile at planting.

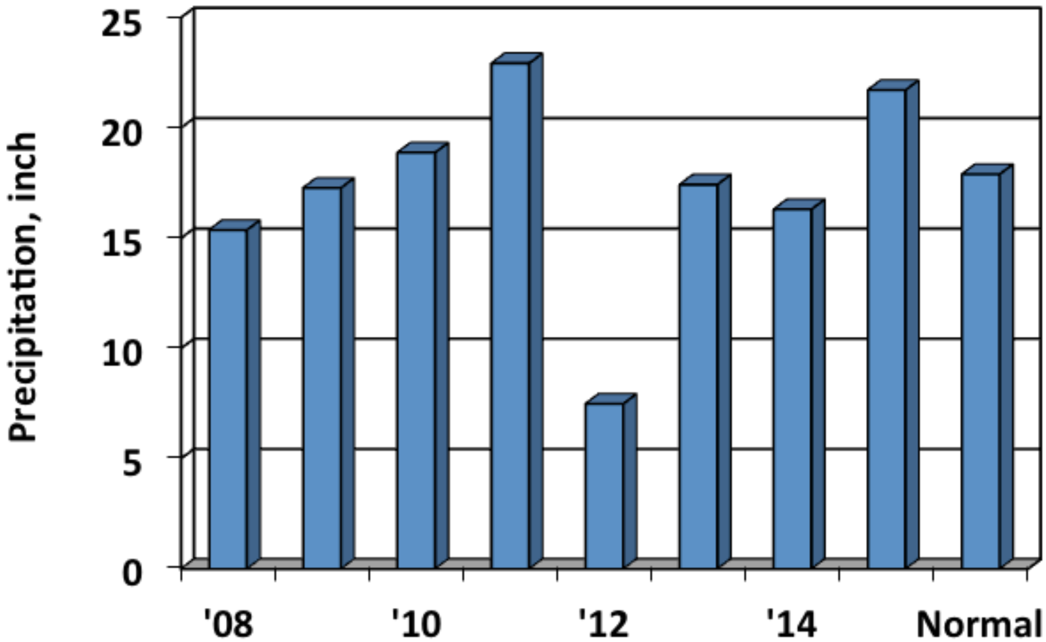

Figure 1. Annual (2008-2015) and normal precipitation (1981-2010), Tribune, Kansas.

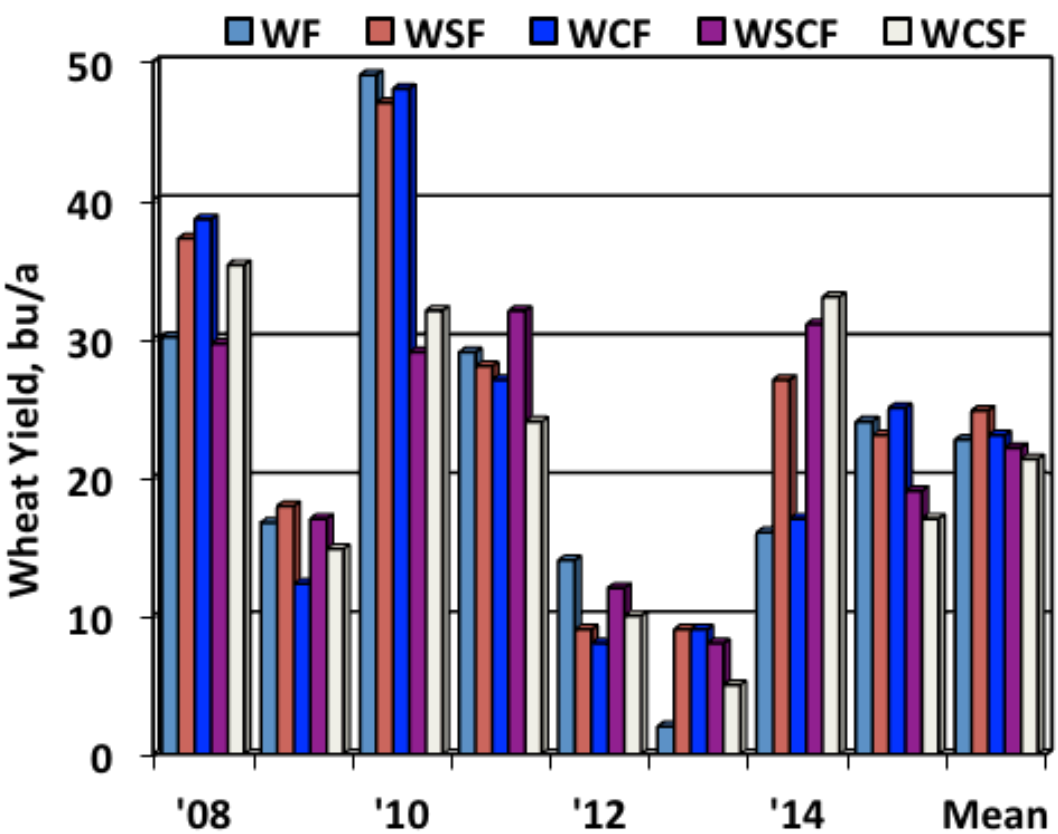

Figure 2. Wheat yields by cropping system, 2008-2015.

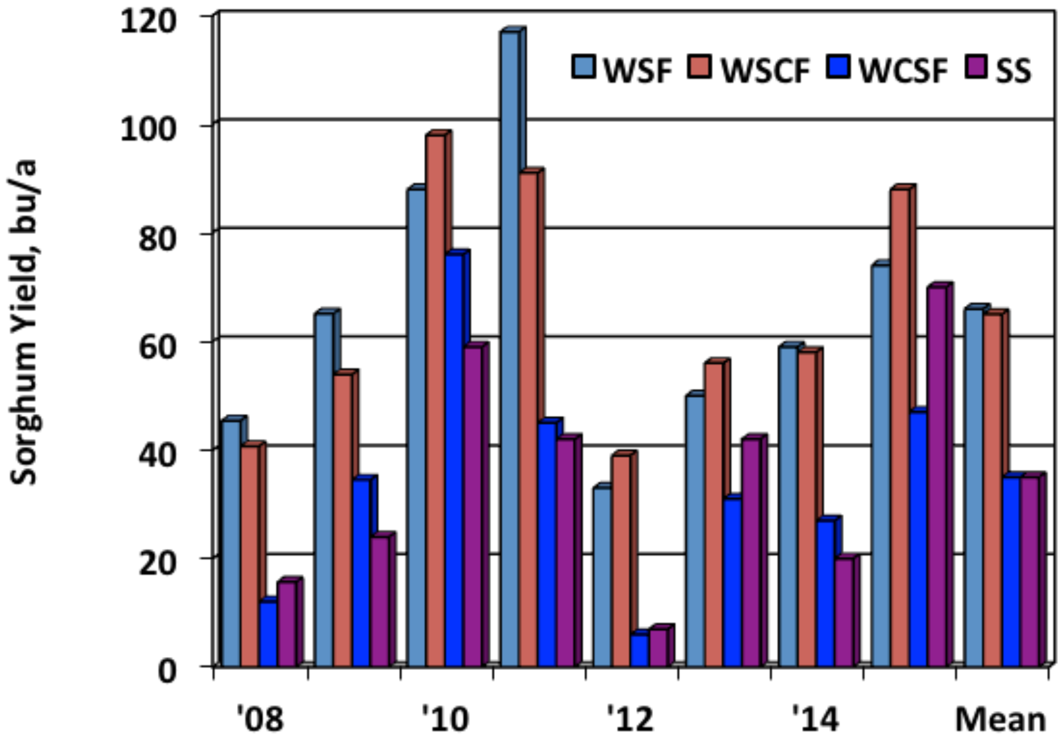

Figure 3. Grain sorghum yields by cropping system, 2008-2015.

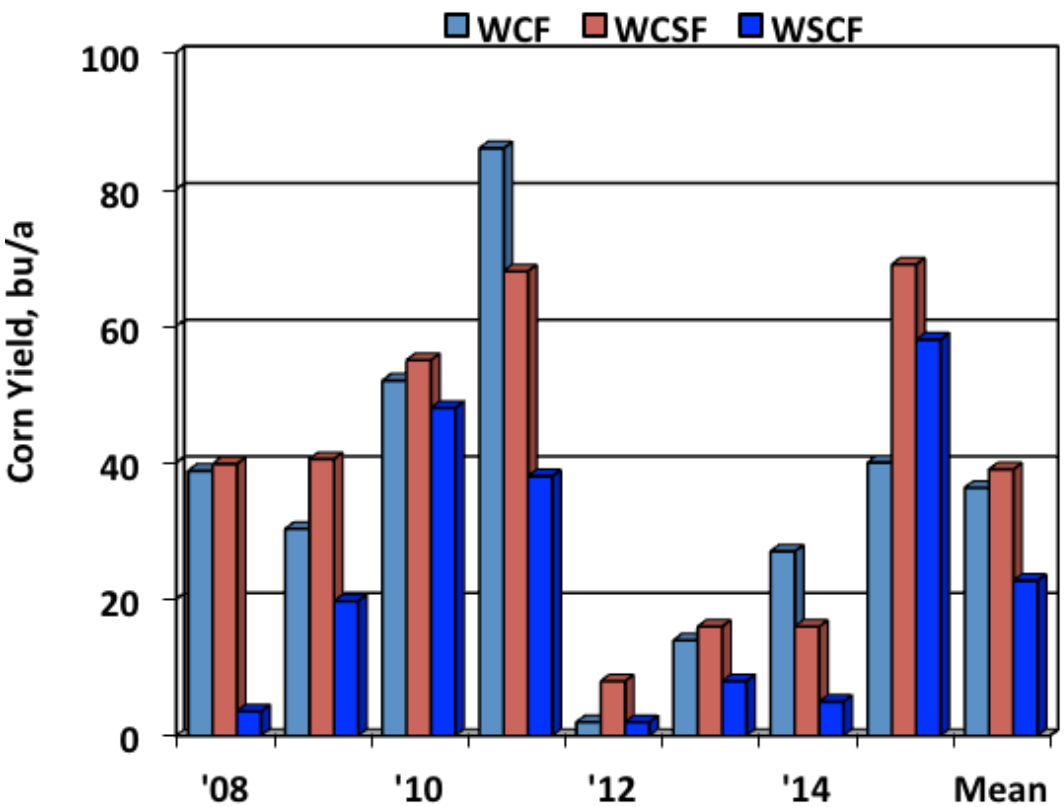

Figure 4. Corn yields by cropping system, 2008-2015.

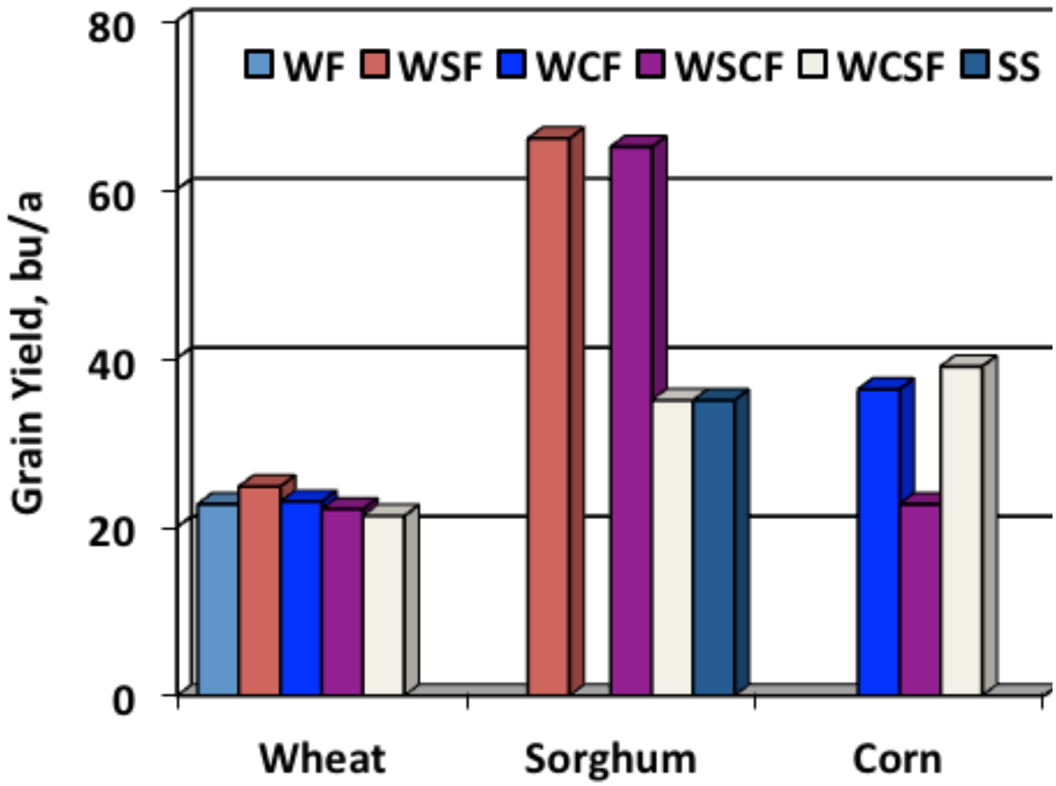

Figure 5. Average grain yields by cropping system, 2008-2015.

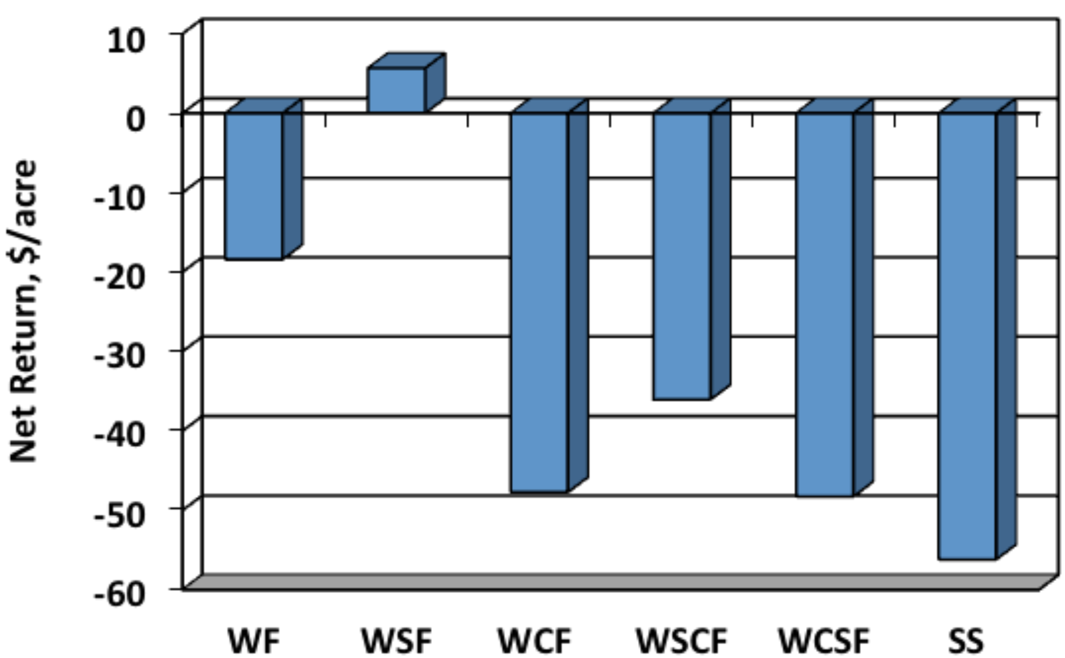

Figure 6. Average annual net returns to land and management, 2008-2015, Tribune, Kansas.