Long-Term No-Till in a Wheat-Sorghum-Fallow Rotation[1]

A. Schlegel and L. Stone[2]

Summary
Grain yields of wheat and grain sorghum increased with decreased tillage intensity in a wheat-sorghum-fallow (WSF) rotation. In 2014, available soil water at wheat planting was 2 inches greater for no-till (NT) than for reduced-tillage (RT) or conventional tillage (CT). For grain sorghum in 2014, available soil water at planting was greatest with RT and least with CT. Averaged across the 14-year study, available soil water at wheat and sorghum planting was similar for RT and NT and about 1 inch greater than CT. Averaged across the past 14 years, NT wheat yields were 5 bu/a greater than RT and 7 bu/a greater than CT. Grain sorghum yields in 2014 were 22 bu/a greater with long-term NT than short-term NT. Averaged across the past 14 years, sorghum yields with long-term NT have been nearly twice as great as short-term NT (61 vs. 33 bu/a).

Procedures
Research on different tillage intensities in a WSF rotation was initiated in 1991 at the Southwest Research-Extension Center near Tribune, Kansas. The three tillage intensities in this study are conventional (CT), reduced-tillage (RT), and no-till (NT). The CT system was tilled as needed to control weed growth during the fallow period. On average, this resulted in four to five tillage operations per year, usually with a blade plow or field cultivator. The RT system originally used a combination of herbicides (one to two spray operations) and tillage (two to three tillage operations) to control weed growth during the fallow period; however, in 2001, the RT system was changed to NT from wheat harvest through sorghum planting (short-term NT) and CT from sorghum harvest through wheat planting. The NT system exclusively used herbicides to control weed growth during the fallow period. All tillage systems used herbicides for in-crop weed control.

Results and Discussion
Soil water
The amount of available water in the soil profile (0 to 8 ft) at wheat planting varied greatly from year to year (Figure 1). In 2014, available soil water was 2 inches greater for NT than for RT or CT. Averaged across the 14-year study, available soil water at wheat planting was similar for RT and NT (about 7 inches) and 1 inch greater than CT.

[1] This research project was partially supported by the Ogallala Aquifer Initiative.
[2] Kansas State University Department of Agronomy.

Similar to the situation for wheat, the amount of available water in the soil profile at sorghum planting varied greatly from year to year (Figure 2). In 2014, available soil water at sorghum planting was greatest with RT and least with CT. On average, available soil water at sorghum planting was similar for RT and NT and about 1 inch more than CT.

Grain yields

Wheat yields have been severely depressed in 9 of 14 years since 2001, primarily because of lack of precipitation. Reduced-tillage and NT increased wheat yields (Table 1). On average, wheat yields were 7 bu/a higher for NT (21 bu/a) than CT (14 bu/a). Wheat yields for RT were 2 bu/a greater than CT, even though both systems had tillage prior to wheat. NT yields were significantly less than CT or RT in only 1 of the 13 years.

The yield benefit from RT was greater for grain sorghum than wheat. Grain sorghum yields for RT averaged 14 bu/a more than CT, whereas NT averaged 28 bu/a more than RT (Table 2). For sorghum, both RT and NT used herbicides for weed control during fallow, so the difference in yield could be attributed to short-term, compared with long-term, NT. In 2014, sorghum yields were 22 bu/a greater with long-term NT than short-term NT. This consistent yield benefit with long-term vs. short-term NT has been observed since the RT system was changed in 2001. Averaged across the past 14 years, sorghum yields with long-term NT have been nearly twice as great as with short-term NT (61 vs. 33 bu/a).

Table 1. Wheat response to tillage in a wheat-sorghum-fallow rotation, Tribune, Kansas, 2001–2014.

	Tillage				ANOVA ($P > F$)		
Year	Conventional	Reduced	No-till	LSD (0.05)	Tillage	Year	Tillage × year
	------------------- bu/a -------------------						
2001	17	40	31	8	0.002		
2002	0	0	0	- - -	- - -		
2003	22	15	30	7	0.007		
2004	1	2	4	2	0.001		
2005	32	32	39	12	0.360		
2006	0	2	16	6	0.001		
2007	26	36	51	15	0.017		
2008	21	19	9	14	0.142		
2009	8	10	22	9	0.018		
2010	29	35	50	8	0.002		
2011	22	20	20	7	0.649		
2012	0	1	5	1	0.001		
2013	0	0	0	- - -	- - -		
2014	10	11	18	12	0.336		
Mean	14c	16b	21a	2	0.001	0.001	0.001

Table 2. Grain sorghum response to tillage in a wheat-sorghum-fallow rotation, Tribune, Kansas, 2001–2014.

Year	Tillage: Conventional	Tillage: Reduced	Tillage: No-till	LSD (0.05)	ANOVA ($P > F$): Tillage	ANOVA ($P > F$): Year	ANOVA ($P > F$): Tillage × year
	-------------------	bu/a	-------------------				
2001	6	43	64	7	0.001		
2002	0	0	0	- - -	- - -		
2003	7	7	37	8	0.001		
2004	44	67	118	14	0.001		
2005	28	38	61	35	0.130		
2006	4	3	29	10	0.001		
2007	26	43	62	42	0.196		
2008	16	25	40	20	0.071		
2009	19	5	72	31	0.004		
2010	10	26	84	9	0.001		
2011	37	78	113	10	0.001		
2012	0	0	0	- - -	- - -		
2013	37	51	78	32	0.053		
2014	38	72	94	28	0.008		
Mean	19c	33b	61a	5	0.001	0.001	0.001

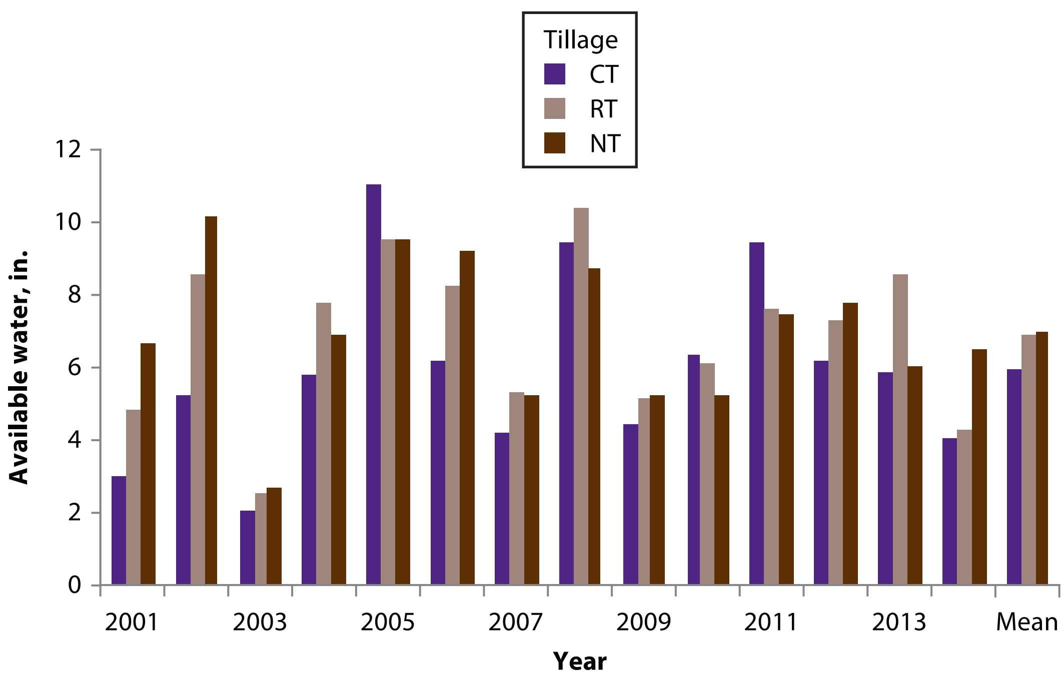

Figure 1. Available soil water in 8-ft profile at wheat planting in a WSF rotation as affected by tillage intensity, Tribune, Kansas, 2001–2014.
The last set of bars (Mean) is the average across years.

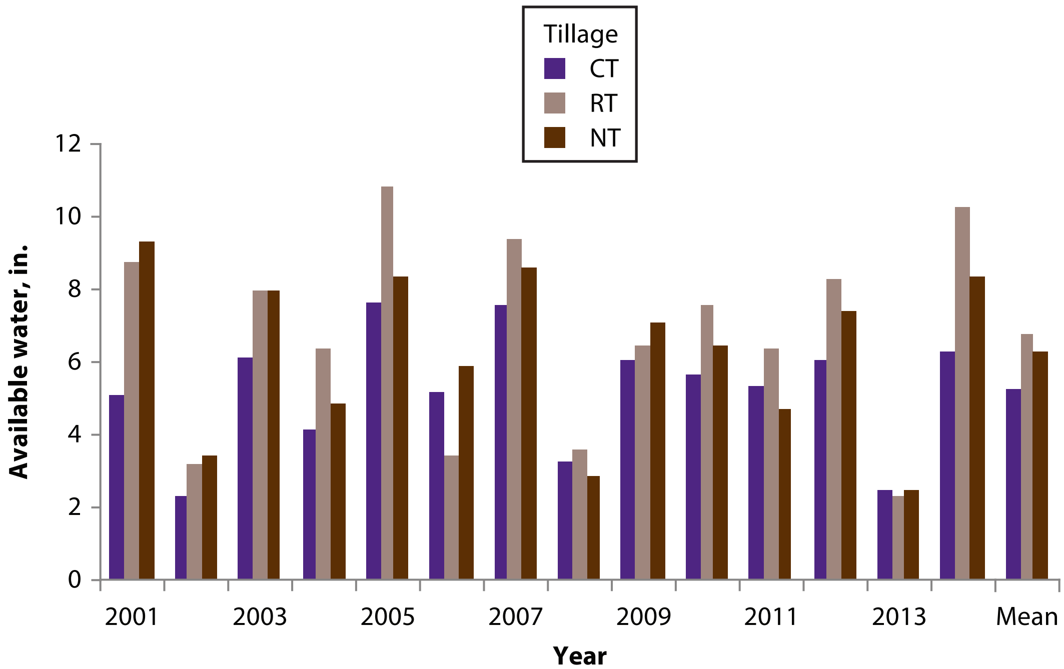

Figure 2. Available soil water in 8-ft profile at grain sorghum planting in a WSF rotation as affected by tillage intensity, Tribune, Kansas, 2001–2014.
The last set of bars (Mean) is the average across years.