Conservation Tillage Effects on Productivity in the Blackland Prairie

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Introduction

The 1985 and 1990 Food Security Act resulted in a renewed interest in conservation tillage, especially in the Blackland Prairie. The soils of this region are predominantly heavy, expanding clays and are highly erodible when tilled. They are underlined by soft limestone or chalk as the main soil-forming material. This formation, coupled with a relatively high cropping intensity, causes the land resource region to be one of the nation's most susceptible to productivity losses from soil erosion (USDA, 1989; U.S. Army Corps of Engineers, USDA-SCS, 1990). Research (Hairston et al., 1984; Hairston et al., 1987) in the Blackland Prairie has shown that a positive correlation existed for higher yields on soils with a greater soil depth. Continued loss of topsoil to erosion will eventually expose the unproductive chalk subsoil and render this region unsuitable for row crops.

Appropriate use of conservation tillage, including stale seedbed systems (ridge-tillage and no-tillage) and rotation systems, have the potential to be effective practices in minimizing production costs, enhancing productivity, and meeting conservation co mpliance. The objectives of this study were to evaluate crop yield response to selected tillage and crop rotation/tillage systems in the Blackland Prairie Region.

Materials and Methods

Studies were initiated in the fall of 1991 at the Mississippi Agricultural and Forestry Experiment Station Prairie Research Unit, Prairie, MS, and the Northeast Mississippi Branch Experiment Station, Verona. The Prairie site was a Vaiden silty clay (very-fine, montmorillonitic, thermic, Vertic Hapladalfs) generally acidic topsoil and with a 1 to 2% slope. The Verona site was a Leeper silty clay (fine, montmorillonitic, nonacid, thermic, Vertic Haplaquepts) with alkaline top-soil and 0 to 0.5% slope. The experimental design was a randomized complete block design with four replications. Plot sizes were 20 feet x 60 feet. Annual surface broadcast fertilizer applications of P20, and K 2 0 and nitrogen for corn and wheat were made according to soil test recommendations.

The following continuous cropping tillage treatments were evaluated on both sites: (1) no-tillage (NT) corn; (2) ridge-tillage (RT1) corn, planted no-till and cultivated once with a high-clearance cultivator equipped with ridgers; (3) turf aerator (TA) corn, with turf aerator knives operated one month prior to planting at 10" angle from vertical and at a 4- to 6-inch depth on the Prairie site; (4) conventional raised-bed tillage (CTB) corn chiseled, disked, bedded, do-alled before planting, and cultivated once; (5) NT soybean; (6) ridge-tillage (RT2) soybeans planted no-till and cultivated twice with a high-clearance cultivator equipped with ridgers; (7) TA soybeans; and (8) conventional smooth seedbed tillage (CT) soybeans chiseled, disked, do-alled before planting, and cultivated twice during the growing season.

The following tillage/crop rotation treatments were evaluated on both sites: (1) RT1 corn followed by RT2 soybeans; (2) RT2 soybeans followed by RT1 corn; (3) NT corn followed by minimum tillage MT wheat (disked twice after corn harvest and do-alled before planting wheat) with NT doublecrop soybeans; (4) MT wheat followed by NT doublecropped soybeans followed by NT corn; (5) NT corn followed by MT bed wheat and NT doublecrop soybeans (Verona site); (6) MT bed wheat with NT doublecrop soybeans followed by NT corn (Verona site); (7) fall paratill bed (FPTB) soybeans followed by FPTB corn; and (8) FPTB corn followed by FPTB soybeans.

Corn plots were planted in 30-inch rows with 1.5 seeds/foot of row. Burndown and preemergence herbicides were applied to RT1, TA, and NT corn. Preemergence herbicides were applied to CTB corn plots. A post-directed herbicide was applied broadcast to N T and TA, and in a 15-inch band to RT1 corn. Nitrogen (N) as ammonium nitrate was applied broadcast over the top of all corn plots at 160 lb N/A (split application).

The herbicide 2,4-D was applied as an early (mid-February to mid-March) spring broadleaf weed control method on all monocrop soybean stale seedbed and wheat-doublecrop soybean treatments. Two weeks prior to planting soybeans, a burndown herbicide was applied to NT, TA, and RT2 soybean plots. Soybeans were planted in 30-inch rows with 9

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seedslft of row in May-June on monocrop treatments and in June on doublecrop treatments. A preemergence herbicide was applied to all monocrop soybean plots. Soybean weed control during the cropping season involved the use of broadcast over-the-top postemergence herbicides and/or post-directed herbicides applied on TA and NT treatments. Postemergence over the top and/or post-directed herbicides in 15-inch band with two cultivations were applied to RT2 and CT soybean treatments.

The center 6-foot wide swath of wheat was harvested for grain yield in both studies. The center two rows of corn and soybean plots, in both studies, were harvested for grain yield. Soybean and corn yield were adjusted to bushels per acre at 13.5 and 15.5% seed moisture, respectively. Data were subjected to statistical analysis (SAS, Cary, NC, 1991) and means were separated by Least Significant Differences (LSD) at the 0.05 probability level.

Results and Discussion

The first year (1992) was the establishment year; therefore, the data being reported for both locations are for 1993 and 1994. Rainfall for the 1993-1994 growing season of May-October ranged from 19 to 40 inches (Table 1). Rainfall for 1993 growing season ranged from normal for Prairie to above normal for Verona. The 1994 growing season rainfall was above normal at both sites, ranging from 150% to 170% of normal. Ample rainfall resulted in good corn and soybean yield at both locations.

Wheat

Wheat yields for 1993-1994 are presented in Table 2. A late spring freeze in 1993 resulted in cold injury to seed heads and low yields on both sites. Yields for 1994 were higher on the Vaiden soil than the Leeper soil, possibly because of less surface drainage on the Leeper than Vaiden site.

Corn

Both Leeper and Vaiden silty clay corn yields for 1993-1994 are presented in Table 3. The Vaiden soil in 1993 for raised-bed systems of continuous CTB and RTl corn, and rotation of RT2 soybeans followed by RTl corn showed no yield difference. The flat systems of continuous TA and NT corn and a rotation of MT wheat NT doublecropped soybeans followed by NT corn, however, produced lower yield than the raised-bed systems. The higher yields for the raised-bed treatments are attributed to better surface drainage than the smooth surface tillage systems NT and TA. Crop rotation had no effect on yield. The 1994 yield on the Vaiden soil were lower than 1993, and neither tillage nor crop rotation had any effect on yield. The lack of yield difference and the lower yield may have been due to stunting from post emergence herbicide injury.

On the Leeper soil for 1993, there was no corn yield difference between tillage and crop rotation systems. The 1994 Leeper site indicated an interaction between raised-bed systems and smooth tillage systems. The raised-bed treatments RT1 corn following RT2 soybeans, FPTB soybeans followed by FPTB corn and MT bed wheat-doublecrop NT soybeans followed by NT corn produced higher yield than smooth tillage systems (NT corn and MT wheat-doublecrop NT soybeans followed by NT corn), but were not different from CTB and RT1 corn. Continuous RT1 and CTB corn yields, however, were not different from MT wheat-doublecrop NT soybeans followed by NT corn. These results were similar to Vaiden soil in 1993, which showed higher yield for raised-bed systems. However, crop rotation had no effect on corn yield.

Table 1. 1993-1994 rainfall at Prairie Research Unit, Prairie, MS and Northeast Mississippi Branch Station, Verona, MS.

	Prairie[1]		Verona[2]	
Month	1993	1994	1993	1994
	in.	in.	in.	in.
May	4.40	3.27	5.54	4.39
June	2.92	12.92	4.36	7.57
July	4.60	11.10	2.04	9.57
August	5.03	1.14	5.51	2.91
September	4.80	5.56	6.83	5.09
October	2.45	5.72	2.70	6.22
Six-month Total	24.20	39.71	26.98	35.75

[1]Prairie rainfall totals for May, June, July, August, September, and October were: 4.72, 5.04, 3.78, 2.58, 3.44, and 3.08, with a 6-month total of 25.97 inches.

[2]Verona rainfall totals for May, June, July, August, September, and October were: 4.04, 3.50, 4.49, 3.08, 3.39, and 2.61, with a 6-month total of 21.11 inches.

Table 2. Effect of tillage and rotation on wheat yield in a soybean-wheat doublecropping system in 1993-1994, at the Northeast Branch Station, Verona, MS, and at the Prairie Research Unit, Prairie, MS

	Wheat		
	1993	1994	Avg.
	---- bu/acre ----		
1. Corn-Wheat/Soybean Rotation			
A. Leeper silty clay - Verona[1]			
1. NT Corn; fb[2] MT - Wheat NT Drill Beans	17.1	37.0	27.1
2. NT Corn; fb MTBd - Wheat NT Beans	16.4	38.2	27.3
B. Vaiden silty clay - Prairie[3]			
1. NT Corn; fb MT - Wheat NT Bean	26.2	70.0	56.3

[1] Previous crop (1991) was conventional tillage soybeans.

[2] fb=followed by.

[3] Previous crop (1982-91) was native grasses cut for hay. Since 1992 was first year of the study, data for rotation effects were not available.

Soybeans

The 1993-94 Leeper and Vaiden soils produced similar soybean yields (Table 4). The 1993 soybean grain yield on the

Table 3. Tillage and crop rotation effect on corn yield on Vaiden silty clay and Leeper silty clay soils, Prairie and Verona, MS 1993-1994.

Crop Rotation/ Tillage System	Vaiden Silty Clay[1]			Leeper Silty Clay[2]		
	1993	1994	Mean	1993	1994	Mean
	bu/acre			bu/acre		
I. CONVENTIONAL TILLAGE						
Continuous Corn (CTB)	92.7	89.3	91.0	88.7	126.9	107.8
II. STALE SEEDBED SYSTEMS						
A. **Continuous Corn**						
1. No Tillage (NT)	72.0	76.8	74.4	84.31	13.4	98.8
2. Ridge Tillage (RT1)	100.4	76.3	88.3	100.4	121.9	111.2
3. Turf Aerator-Renovator (TA)	62.1	84.4	73.2	—	—	—
B. Corn-Soybean(Bn) Rotation (2-year)						
4. RT2 Bn; fb[3] RT1 Corn	109.2	82.4	95.4	93.81	36.61	15.2
5. FPTB Bn; fb FPTB Corn	—	—	—	—	—	—
C. Corn-Wheat/Soybean Doublecrop Rotation (2 year)						
6. MT Wheat NT Bn; fb NT Corn	56.2	76.8	66.5	—	—	—
7. NT Corn; fb MT Wheat NT Bn	—	—	—	92.3	109.6	100.9
8. NT Corn; fb MT Bed Wheat NT Bn	—	—	—	100.0	138.1	119.7
LSD 0.05	17.7	NS		NS	20.2	
CV%	14.4	26.8		16.9	11.4	

[1] Previous crop was native grasses for hay production from 1982-91. Prior to initiation of the study, the site was disked twice and harrowed.
[2] Previous crop (1991) was conventionally tilled soybeans.
[3] fb=followed by.

Table 4. Tillage and crop rotation effect on soybean yield on Vaiden silty clay and Leeper silty clay soils, Prairie and Verona, MS, 1993-1994.

Crop Rotation/ Tillage System	Vaiden Silty Clay			Leeper Silty Clay		
	1993	1994	Mean	1993	1994	Mean
	bu/acre			bu/acre		
I. CONVENTIONAL TILLAGE						
Continuous Soybean (CT)	41.5	34.5	44.2	31.2	41.7	37.2
II. STALE SEEDBED SYSTEMS						
A. **Continuous Soybean (Bn)**						
1. No Tillage (NT)	40.7	33.7	35.5	38.6	41.7	34.3
2. Ridge Tillage (RT2)	29.2[1]	37.4	42.3	21.5[1]	40.5	32.8
3. Turf Aerator-Renovator (TA)	40.7	37.8	41.5	—	—	—
B.. Corn-Soybean Rotation (2-year)						
4. **RT1** Corn; fb[3] RT2 Bn	41.2	36.4	43.6	37.7	41.5	39.6
5. FPTB Corn; fb FPTB Bn	—	35.5	35.5	—	49.7	—
C. Corn-Wheat/Soybean Doublecrop Rotation (2-year)						
6. NT Corn; fb MT Wheat NT Bn	42.7	-[2]	—	35.5[3]	23.93	29.7
7. NT Corn; fb MT Bd Wheat NT Bn	—	—	—	28.1	26.0	27.1
LSD 0.05	6.8	NS		7.5	5.7	
CV%	11.9	13.4		18.4	11.1	

[1] Low yield is due to death caused by stem canker.
[2] No yield data due to stand failure and an extremely late replanting date.
[3] Drilled soybeans.
fb=followed by; NS=not significant.

Vaiden soil showed no difference between continuous CT, NT, and TA and rotations of RT1 corn followed by RT2 soybean, and NT drilled doublecropped soybeans, but all produced higher yield than continuous RT2 soybeans. The lower continuous RT2 soybean yield in 1993 is attributed to a severe infestation of stem canker, which caused plant death in this treatment but did not effect other treatments. In 1994, all tillage and crop rotation, except NT soybeans doublecrop following MT wheat produced similar yields. NT doublecrop soybeans replanted July 5, 1994, because poor stands from excessive rainfall in June, followed by a dry August, resulted in no harvestable yield.

Soybean yield on the Leeper soil for 1993 varied with tillage and crop rotation. Continuous NT and CT soybeans, and rotations of E 1 corn followed by RT2 soybeans and NT corn followed by NT doublecropped soybeans drilled into wheat stubble were not different in yield, but all produced higher yields than RT2 continuous soybeans. Lower yields on RT2 continuous soybeans were due to stem canker disease, which caused plant death but had no effect on other treatments. In 1994, stem canker had no effect on any treatments. Continuous CT, NT, RT and RTI corn followed by RT2 soybeans produced similar yields, which were higher than 30-inch and drilled no-till doublecrop soybeans. FPTB corn followed FPTB soybeans, however, produced the highest yield (49.7 bu/ac re) of all treatments. Lack of yield differences between CT and NT soybeans on both sites in 1993 and 1994 is in contrast to previous tillage research on Prairie soils (Buehring et al., 1981, Buehring et al., 1988; Hairston et al., 1984; and Hairston et al., 1990), who reported that NT soybeans with the burndown herbicide applied at planting produced lower yield than CT. The contrasting results may possibly be because of normal or above normal rainfall during the 1993 and 1994 growing season and/or earlier burndown herbicide applications (2 to 3 weeks before planting) in 1993 and 1994.

Summary

Preliminary data indicated that both corn and soybean tillage systems showed difference in response. Soybean stale seedbed systems (TA, NT, RT, and FPTB) yields were equal to or above CT on both soils. However, corn yields were generally higher on raised beds (RT1, CTB) than on nonraised-bed treatments (TA, NT and MT wheat-NT Bn followed by NT corn), especially when above-normal rainfall occurred. Neither corn nor soybeans in a 2-year crop rotation showed improved yield response due to rotation. MT wheat and NT doublecrop soybeans in 30-inch rows on Leeper soil produced lower yield than monocrop soybean tillage and rotation treatments in 1993 and 1994. The doublerop drill beans on the Leeper site produced yield equal to NT monocrop beans in 1993, but yields were lower in 1994. Yield of doublecrop soybeans (30-inch row) on the Vaiden site were equal to monocrop CT and NT soybeans in 1993, but lower in 1994. Excessive rainfall in June and July, 1994, followed by a dry August, resulted in no yield from doublecrop NT soybean treatment. These studies will be continued in order to determine the long-term effects of tillage and rotation systems on both corn and soybean yield.

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