Conservation Tillage Cropping Systems for the Texas Southern High Plains

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Introduction

The Southern High Plains of Texas are a major cotton producing area with annual plantings of 3.2 million acres. Over the last 20 years, a cotton monoculture system has evolved. Due to rising production costs, declining yields, and increased concern about soil erosion, interest in conservation tillage/crop rotation production systems has increased.

In conventional tillage cotton production, dinitroaniline herbicides incorporated prior to planting are utilized to control annual broadleaf weeds and grasses while perennial weeds and grasses are controlled by various spot applications and cultivation (5). However, continuous cotton production does not produce sufficient residue cover to prevent soil erosion during high spring winds. Crops such as sorghum *(Sorghum bicolor* (L.) Moench) or wheat *(Triticum aestivum* L.) provide sufficient residue to protect the soil from erosion, but conventional land preparation and preplant herbicide incorporation bury most of this residue, significantly reducing the amount of soil cover.

Several conservation tillage systems for cotton production have been reported for various regions (1, 2, 4). Conservation tillage has shown potential for reducing production costs (6) and increasing yields for cotton (3). Conservation tillage cropping studies were initiated in 1985 at three Texas locations: Lubbock, Halfway, and Wellman, all of which are typical of the hard; mixed- and sandy-land areas, respectively, of the Southern High Plains. Various conservation tillage/crop rotation systems were compared to conventional cotton production in terms of crop growth and development, yield, quality, and profitability under irrigated and dryland conditions.

Materials and Methods

Cropping systems evaluated at the three locations included continuous cotton using conventional, reduced and no-tillage systems, conservation tillage/crop rotations including sorghum-cotton, wheat-cotton, terminated wheat-cotton, forage sorghum-cotton, and fallow-cotton.

Tillage operations for the conventional production systems included stalk shredding, disking, chiseling, listing to form beds, rod weeding, rotary hoe, and three cultivations. For continuous minimum tillage cotton, listing to incorporate preplant herbicides, rod weeding, rotary hoe, and one cultivation were performed. For no-till cotton and conservation tillage-rotations, one cultivation to make water furrows for irrigation was the only tillage operation performed. Combination of early preplant, preemergence, and postemergence herbicide treatments replaced tillage operations to control weeds in all conservation tillage systems.

These herbicide treatments included 2,4-D amine for winter annual weed control, Roundup® and Caparol® or Sancap® at planting, and Fusilade® for volunteer sorghum control. Treflan® was applied preplant incorporated in conventional and minimum-till cotton. Cotton (Paymaster HS 26) was planted in mid-May at each location and Temik® was applied at 2 Ib/acre for thrip control. Fertilizer applications were based on soil tests recommendation for each cropping system. Furrow irrigation was applied preplant (3 inches) and at peak bloom (3 inches). Plots were harvested and ginned to determine cotton yields and lint quality.

Results and Discussion

The growing season in 1987 was characterized by a dry spring, excessive rainfall at planting, timely July rain, and warm, dry fall weather ideal for cotton maturity. Heat units for the growing season were near normal. Seasonal rainfall was also near normal, but crops benefited from moisture stored as a result of heavy rains in the fall of 1986.

Yields and net returns of irrigated and dryland cotton cropping systems at Lubbock in 1987 are summarized in Table 1. Excellent cotton yields were produced under both irrigated and dryland conditions. In continuous irrigated cotton, no significant difference in yields was determined between tillage systems. Cotton yields were significantly increased, compared to conventional cotton, with the conservation tillage cotton rotations with sorghum, wheat, and terminated wheat. These three rotational systems also produced significantly increased net returns. For dryland cotton, minimum and no-till continuous cotton systems produced significantly higher yield than conventional tillage production. Conservation tillage-rotation systems producing highest yields and highest net

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’Table 1. Cotton yield and value, production costs, and relative profitability of irrigated and dryland cropping systems at Lubbock, Texas, 1987.

	Irrigated				Dryland			
Cropping system[1]	Cotton yield (lb/a)	Crop[2] value ($/a)	Production cost ($/a)	Net[3] returns ($/a)	Cotton yield (lb/a)	Crop value ($/a)	Production costs ($/a)	Net returns ($/a)
Continuous Cotton								
Conventional Till	801 b-d[4]	425	I50	275 b	691 d	360	103	257 c
Minimum Till	769 d	410	134	276 b	846 ab	435	95	340 a
No-Till	808 b-d	427	I40	287 b	833 a-c	425	86	339 a
Conservation Till-Rotations								
Terminated Wheat-Cotton	965 a	515	156	359 a	817 a-d	425	101	324 ah
Sorghum-Cotton	937 ab	499	156	343 a	753 a-d	388	84	304 ab
Wheat-Cotton	952 a	503	I45	358 a	874 a	445	90	355 a
Forage Sorghum-Cotton	889 a-c	473	I54	319 ab	844 ab	444	89	355 a
Fallow-Cotton	764 cd	400	139	261 b	709 cd	366	82	284 bc

[1]Denotes 1986-1987 crop sequences.
[2]Crop values calculated as per acre yield x loan price without deficiency payments included.
[4]Net returns do not reflect land costs or rent. Net returns = crop value – production cost.
[4]Means followed by the same letter are not significantly different at the 5% level of probability (Duncan’s Multiple Range Test).

returns included wheat-cotton and forage sorghum-cotton rotations. Under both irrigated and dryland conditions at Lubbock, the fallow-cotton rotation produced the lowest yields of the conservation tillage systems compared.

At the sandyland site near Wellman, overall dryland cotton yields were higher than at Lubbock (Table 2). The terminated wheat-cotton and sorghum-cotton conservation tillage rotations produced significantly higher yields than the conventional cotton production system. In continuous cotton, highest cotton yields resulted with the minimum tillage system. In comparing the highest yielding conservation tillage system (sorghum-cotton) to conventional tillage cotton, average yields were increased by 33 percent and net returns by 46 percent.

Table 2. Cotton yield and value, production costs, and relative profitability for cropping systems at Wellman. Texas, 1987.

	Dryland			
Cropping system[1]	Cotton yield (lb/a)	Crop value ($/a)	Production costs ($/a)	Net[3] returns ($/a)
Continuous Cotton				
Conventional Till	773 cd[4]	417	112	305 b
Reduced Till	845 bc	456	111	305 ab
No-Till	702 d	379	98	281 c
Conservation Till-Rotations				
Terminated Wheat-Cotton	902 abc	487	108	379 a
Sorghum-Cotton	1,026 a	554	108	446a
Forage Sorghum-Cotton	818 bc	434	97	337 b
Fallow-Cotton	754 cd	400	100	300 c

[1]Denotes 1986-1987 crop sequences.
[2]Crop values calculated as per acre yield x loan price without deficiency payments included.
[3]Net returns do not reflect land costs or rent. Net returns = crop value – production cost.
[4]Means followed by the same letter are not significantly different at the 5% level of probability (Duncan’s Multiple Range Test).

Excellent yields of high-quality cotton were produced at Halfway in 1987 (Table 3). No significant differences in irrigated cotton yields were found, but net returns were increased when compared to conventional tillage cotton with minimum-till continuous cotton, terminated wheat-cotton, forage sorghum-cotton, and wheat-cotton conservation tillage rotations. Lowest yields and net returns resulted with the fallow-cotton rotation. When comparing the forage sorghum-cotton conservation tillage rotation to conventional tillage, irrigated cotton yields were increased by 7 percent and net returns by 14 percent.

Dryland cotton yields with all conservation tillage-rotation systems at Halfway were significantly higher than cotton yields with conventional tillage. In continuous cotton, minimum and no-till systems produced higher yields and greater net returns than conventional tillage cotton. Highest dryland yields resulted from the sorghum-cotton conservation tillage rotation. When compared to conventional tillage continuous cotton, this production system increased yields by 62 percent and net returns by 94 percent. As in Wellman and Lubbock locations, conservation tillage had the most positive impact on cotton yields under dryland conditions.

Results at all locations indicated that conservation tillage systems can reduce production costs through elimination of tillage operations. These systems also increased cotton yields, especially under dryland conditions, resulting in greater profitability.

In addition to these benefits, these conservation tillage systems, when combined with rotations of high residue crops and cotton, provide a means for reducing soil erosion and satisfying Conservation Compliance provisions of the 1985 Farm Bill.

Literature Cited

1. Brown, S. M., and T. Whitwell. 1985. Weed control programs for minimum-tillage cotton. Weed Sci. 33: 843-847.
2. Brown, S. M., J. M. Chandler, and J. E. Morrison. 1987. Weed control in a conservation tillage rotation in the Texas Blacklands. Weed Sci. 35: 695-699.
3. Harman, W. L., and J. R. Martin. 1987. Economics of conservation tillage research tillage in Texas. Proceedings Southern Region No-till Conference. pp. 24-37.
4. Keeling, J. W., and J. R. Abernathy. 1988. Weed control systems for conservation tillage cotton production on sandy soils. WSSA Abstract% 28: 21.
5. Patterson, M., and D. Monks. 1987. Report of the 1986 Cotton Weed Loss Committee. Proc. 1987 Beltwide Cotton Production Conf. pp. 361-363.
6. Wiese, A. F., and P. W. Unger. 1983. Irrigation, dryland farming, and limited tillage - a profitable combination. J. Soil and Water Conserv. 38: 233-236.

Table 3. Cotton yield and value, production costs, and relative profitability of irrigated and dryland cropping systems at Halfway, Texas, 1987.

	Irrigated				Dryland			
Cropping system[1]	Cotton yield (lb/a)	Crop[2] value ($/a)	Production costs ($/a)	Net[3] returns ($/a)	Cotton yield (lb/a)	Crop yield ($/a)	Production costs ($/a)	Net returns ($/a)
Continuous Cotton								
Conventional Till	992 a[4]	536	167	369 ah	672 d	353	108	245 c
Minimum Till	1,001 a	540	145	395 a	713 cd	383	88	295 c
No-Till	938 a	506	151	355 ah	862 ah	466	100	366 h
Conservation Till-Rotalions								
Terminated Wheat-Cotton	1,058 a	571	164	407 a	948 a	515	112	403 ab
Sorghum-Cotton	927	501	147	354 ah	1,085 a	582	108	474 a
Forage Sorghum-Cotton	1,061 a	573	154	419 a	944 a	509	101	408 ah
Wheat-Cotton	1,003 a	542	151	391 a	979 a	526	103	423 ab
Fallow-Cotton	916 a	495	150	345 b	862 a-c	467	97	370 h

[1]Denotes 1986-1987 crop sequences.
[2]Crop values calculated as per acre yield x loan price without deficiency payments included.
[3]Net returns do not reflect land costs or rent. Net returns = crop value – production cost.
[4]Means followed by the same letter are not significantly different at the 5% level of probability (Duncan's Multiple Range Test).