NO-TILLAGE AND REDUCED TILLAGE COTTON PRODUCTION IN SOUTH TEXAS

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Abstract

Conservation tillage reduces wind and water erosion and increases water storage in the soil profile, but growers will generally not accept new management practices unless they are profitable. Conservation tillage trials were initiated at dryland and irrigated sites in the Lower Rio Grande Valley of Texas in 1992. The purpose of this paper is to compare lint yields and economics of cotton production in conventional (CT), reduced tillage (RT), and pre-plant no-tillage (PPNT) systems. Three crop rotational schemes were used at the irrigated site and six at the dryland. At the irrigated site within a tillage treatment, rotation effect was not significant. In 1994, lint yields among tillage treatments were not significantly different. In 1993, RT was significantly greater, and in 1995 both RT and PPNT were greater, compared to the others. In 1993, net returns for double crop cotton-corn under PPNT were $106/ha greater than CT; in 1994, $182 greater; and in 1995, $541 greater. At the dryland site, cotton lint yields did not differ in 1993 and 1994. In 1995, yields were significantly lower for CT and significantly greater for cotton following two years sorghum, compared to the other treatments. At the dryland site, net returns for PPNT were $126 greater than CT in 1993; $131 greater in 1994; and $153 in 1995. Data from this study strongly suggests greater profitability in conservation tillage compared to conventional tillage systems. The system, however, requires a much higher level of soil and crop management.

Introduction

Adoption of reduced tillage farming practices for irrigated and dryland cotton in the Lower Rio Grande Valley of Texas has been slow due to lack of knowledge of benefits and risks under a subtropical climate. The conservation compliance provision of the Food Security Act, however, is forcing producers to adopt conservation tillage practices. The warm, subtropical climate creates conditions very different from the Midwest U.S., where conservation tillage methods are widespread. To assist cotton producers in making decisions regarding conservation tillage in the Valley, the USDA-Agricultural Research Service initiated large plot experiments on dryland and irrigated lands in the fall of 1992.

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Conservation tillage production systems can help producers to reduce wind and water erosion and can help reduce water evaporation which occurs with each tillage operation. Other possible advantages of conservation tillage systems are reductions in total pre-harvest production costs per acre, trips over the field, soil compaction, labor and man hours, fuel, and equipment needs. Timeliness of operations such as planting or cultivation is improved by using conservation tillage. The effect of crop residues and mulch on the soil surface in a reduced and no-tillage cropping systems is of concern due to fears of greater insect populations and increased habitat for insects to overwinter.

This study determines the effect of conservation tillage on cotton yields and compares the economics of cotton production under conventional (CT), reduced (RT), and pre-plant no-tillage (PPNT) systems under irrigated and dryland conditions in the Lower Rio Grande Valley of Texas in 1993, 1994, and 1995.

Materials and methods

Three tillage treatments as main plots and cropping system rotational schemes as subplots were studied at a dryland and irrigated site. The study was initiated in the fall of 1992.

Irrigated Site. The irrigated study was conducted on an Hidalgo silty clay loam soil (hyperthermic Typic Calciustolls) located on the Soil and Water Conservation District Farm north of Weslaco, Texas. Additional soils and precipitation data are listed in Table 1. Yearly rainfall for 1995 was about 150 mm below normal. About 150 mm of irrigation water were applied twice each season to supplement the 129, 185, and 150 mm of rainfall which fell during the growing seasons (March through July) of 1993, 1994, and 1995, respectively.

Three tillage systems, CT, RT, and PPNT, are described in Table 2. CT treatment was a moldboard plow and disk system. In the RT treatment a wide undercutting "V" sweep was used postharvest and the following cotton crop was planted into the existing crop residue, and fall and winter weeds were chemically controlled. The PPNT treatment was a modified form of ridge tillage and consisted of planting into existing beds which remained from the previous crop where fall and winter weeds were chemically controlled. After cotton harvest in the PPNT system, cotton stalks were removed with a mechanical stalk puller and fall germinating weeds were chemically controlled.

The study included three cropping systems, composed of spring cotton and sorghum, and spring and fall corn. Crop production sequences are presented in Table 3. Main plot size was 41 by 110 m and subplot size was 13.7 (18, 0.76-m rows) by 121.9 m. Treatments were replicated four times.

Cotton was planted in late February or early March with a John Deere 7200 Maxemerge conservation tillage planter. Different attachments and settings were used for the three tillage systems. In the CT system, double disk openers were used to provide a firm level seedbed on top of the ridges. The RT and PPNT treatments were planted with a 0.55 m diameter fluted (51 mm wide flutes) coulters mounted in front of the double disk openers to slice through residue. Disk openers and planter boxes had an increased downpressure from springs to achieve the same planting depth (38 mm) as for the CT treatment. Cotton variety DPL-50 was planted at all locations and at a seeding rate of 123,500 seeds/hectare.

Crop residue was sampled at least monthly using a Soil Conservation Service approved stringline method for estimating percent residue cover on the soil surface. A 30.5 m line was stretched across the field at a diagonal angle to the previous crop rows. The stringline has marks every 0.305 m for a total of 100 marks. If a piece of crop residue which was greater than 6 mm in diameter intercepted the line where one of the 100 marks were on the line the residue was counted as 1% residue cover. If there were 35 interceptions directly where the marks on the line were then it would be recorded as 35% crop residue cover. These counts were used to estimate the percent residue cover on the soil surface for each of the various tillage and cropping sequence treatments.

All cotton was fertilized twice with 56 kg N per hectare applied as liquid N32 with a "CADY" brand spoke wheel applicator. One application was made at 30 and 50 days after planting for a total of 112 kg/ha of N. Cotton for all treatments were irrigated twice each season.

Weed control in the CT was accomplished by the use of Pendimethalin (1 kg/ha) applied in a 0.254 m band (0.336 kg/ha actual chemical/ha) over the crop row at planting using spray nozzles and shallow incorporation time rakes attached to back of the planter. The crop also received two mechanical cultivations, the second cultivation was done with ridging wings to form a water furrow for irrigation and to rebuild beds for the next cropping season. In the RT and PPNT systems a pre-plant burndown application of glyphosate (0.74 kg/ha) was used. Following planting, weed control methods in the RT and PPNT systems were similar to the CT.

Insecticides included Guthion, methyl parathion, and a Danitol and Orthene mixture. Between 10 and 12 applications were needed to manage insects. Cotton was defoliated about l40 days after planting with DEF™ (720 g/l) at 1.68 kg a.i./ha plus 0.165 l/ha Silwett. Estimates of cotton lint yield were made by handpicking 6 subsamples from each plot. Cotton was handpicked twice about 130 and 140 days after planting.

Dryland Site. The dryland study was conducted on a Brennan fine sandy loam soil (hyperthermic Aridic Haplustalfs) near McCook, Texas, in western Hidalgo County. Main plot size was 82 by 91 m and subplot size of 13.7 (18, 0.76 m rows) by 91 m. Tillage treatments (CT, RT, And PPNT) were identical to the irrigated site. Six cropping systems composed on one monocrop (sorghum), two biennial rotations (cotton and sorghum, and sorghum and cotton), and three triennial rotations (sorghum, sorghum, and cotton) were studied (Table 4). Treatments were replicated five times.

Planting, fertilization, and insect and weed control were similar to the irrigated site, except for fewer applications of insecticides.

Results and Discussion

Cotton lint yields at the irrigated site did not differ among cropping sequence treatments in 1993, 1994, and 1995, and yields did not differ among tillage treatments in 1994. In 1995, lint yields for CT were significantly lower than for RT and PPNT (Table 5). Cotton lint yields at the dryland site did not differ among cropping sequence treatments and rotations in 1993 and 1994. In 1995, cotton lint yields were significantly lower for CT, and in the RT and PPNT tillage treatments, the sorghum-sorghum-cotton lint yields were significantly greater than the cotton-sorghum-cotton lint yields (Table 6). This increase in lint yield results in greater economic returns for these two rotations within the RT and PPNT treatment.

At the irrigated site, plant residue cover in the conventional tillage system (CT) remained below the target residue cover level of 30% (Table 7). The highest value immediately following planting was 14.8%. The plowing and disking following harvest reduced residue cover levels to an average below 10%. In the RT and PPNT treatments, however, residue levels were seldom below 30%. Following planting in 1994, the highest level was 43% in the double-crop cotton-corn treatment. Following cotton harvest, as expected, residue levels were at a minimum (10.8% and 15.3% for the RT and PPNT treatments).

At the dryland site, residue cover levels for CT were below levels needed to protect the soil surface from wind and water erosion or to reduce soil water evaporation (Table 8). Following planting, the 30% level was not achieved. Following cotton in RT and PPNT, the residue levels at planting averaged about 16%; following sorghum, about 24%. As seen in the crop yield data in Table 6, following two years of sorghum (rotation number 4 in RT and PPNT) cotton lint yields were significantly greater than other treatments. This was most likely due to the added residue cover levels and the additional soil moisture in the profile. Also, cotton is a deep-rooted plant which extracts water for longer periods in the growing season.

Economic returns are present in Table 9 for the irrigated site and in Table 10 for the dryland site. At the irrigated site in 1993, net returns for the PPNT, double crop cotton-corn were $106/ha greater than CT; in 1994, $182 greater; and in 1995, $541 greater. As noted, 1995 was an extremely dry year with heavy insect infestations. Return between RT and PPNT did not differ greatly in 1994 and 1995; pounds of cotton lint yield were also not different between RT and PPNT in 1994 and 1995.

At the dryland site, net returns for PPNT were $126/ha greater in 1993 than CT; $131 greater in 1994; and $153 greater in 1995, for the cotton-sorghum-cotton rotation. In 1995, an extremely dry year, the net returns were positive only in the sorghum-sorghum-cotton rotation for RT and PPNT. Soil moisture measurements are being conducted to determine amounts of extra water stored.

At both the dryland and irrigated sites, cost of insecticides among the three tillage systems was identical. Herbicide costs were greater in the RT and PPNT systems, compared to CT. At the irrigated site, the increase was between $12-25/ha, and at the dryland site, $35-45/ha, depending on year. Significantly reduction in input costs occurred in planting and tillage. At both the irrigated and dryland sites , reduction in PPNT planting and tillage costs was about $150/ha averaged over year, compared to CT. Furthermore, reduction in tractor horsepower, equipment repairs, and labor hours contributes to a lower cost, conservation tillage system.

In conclusion, conservation tillage systems (RT and PPNT) result in greater economic returns due to higher yields in dry years, and lower production costs resulting from reduced tillage and tractor requirements, as compared to a conventional tillage system.

Table 1. Annual rainfall, soil type, and selected soil percentages at dryland and irrigated study sites, Mission and Weslaco, Texas.

Location	Year	Rain fall[1] (mm)	Soil type	Texture % sand	% silt	% clay	Organic carbon	pH
Moore Field,	1993	507	Brennan,	63	21	16	1.54	
7.6								
Mission, Tx	1994	432	fine sandy					
(dryland)	1995	399	loam					
ARS Farm	1993	505	Hidalgo,	56	19	25	1.23	8.0
Weslaco, Tx	1994	556	sandy clay					
(irrigated)	1995	279	loam					

[1] 1995 rainfall values through November 1.

Table 2. Description of conventional and reduced tillage systems at dryland and irrigated sites. Parentheses ( ) indicate number of operations, Weslaco, Texas.

Conventional (CT)	Reduced (RT)	Pre-Plant No-tillage (PPNT)
shred residue	shred residue	shred residue if needed
disk	-----	-----
moldboard plow	"V" sweeps	stalk puller
disk (2)	-----	-----
form beds	-----	-----
cult. beds (3)	spray weeds (2)	spray weeds (2)
plant	plant	plant
cultivate (2)	cultivate (2)	cultivate (2)

Table 3. Crop production sequences within a tillage treatment for corn, sorghum, and cotton grown at the irrigated site, Weslaco, Texas, beginning in 1993.

Rotation treatment no.	Crop year 1993 spring	1993 fall	1994 spring	1994 fall	1995 spring	1995 fall
1	cotton	fallow	corn	fallow	sorghum	fallow
2	corn	fallow	cotton	corn	corn	fallow
3	cotton	corn	cotton	corn	cotton	corn

3 yr cotton-corn-sorghum
2 yr corn-cotton-corn
1 yr cotton-corn

Table 4. Crop production sequences within a tillage treatment for cotton and sorghum at the dryland site near Mission, Texas.

Rotation treatment no.	Crop Production Sequence crop year 1993	1994	1995	1996
1	sorghum	sorghum	sorghum	sorghum
2	sorghum	cotton	sorghum	cotton
3	cotton	sorghum	cotton	sorghum
4	sorghum	sorghum	cotton	sorghum
5	sorghum	cotton	sorghum	sorghum
6	cotton	sorghum	sorghum	cotton

Table 5. Cotton lint yields for tillage treatments at the irrigated site, Weslaco, Texas.

Tillage	Rotation no.	Yields (kg/ha) 1993	1994	1995
CT	1	1030 a	---	---
	2	---	747 a	---
	3	1040 a	573 a	289 b
RT	1	856 b	---	---
	2	---	765 a	---
	3	877 b	756 a	550 a
PPNT	1	962 a	---	---
	2	---	693 a	---
	3	1003 a	755 a	535 a

Table 6. Cotton lint yields for tillage treatments at the dryland site, Mission, Texas.

Tillage	Rotation no.	Yields (kg/ha) 1993	1994	1995
CT	1	---	---	---
	2	---	547 a	---
	3	413 a	---	168 b
	4	---	---	160 b
	5	---	498 a	---
	6	413 a	---	---
RT	1	---	---	---
	2	---	640 a	---
	3	408 a	---	192 b
	4	---	---	305 a
	5	---	524 a	---
	6	408 a	---	---
PPNT	1	---	---	---
	2	---	564 a	---
	3	428 a	---	159 b
	4	---	---	240 ab
	5	---	516 a	---
	6	428 a	---	---

Table 7. Plant residue cover immediately following planting and 30 days following summer harvest for irrigated sites.

Trt.	Till	Previous cropping history			Residue cover planting		harvest		age
No.	trt.	1993	1994	1995	1994	1995	1994	1995	
1	CT	cot-fal	cor-fal	sor-fal	13.5	3.3	21.0	6.52	
		cor-fal	cot-cor	cor-fal	10.5	14.8	11.3	8.1	
3		cot-cor	cot-cor	cot-cor	14.1	5.9	10.3	1.2	
4	RT	cot-fal	cor-fal	sor-fal	26.8	31.8	54.6	71.8	
5		cor-fal	cot-cor	cor-fal	38.6	25.0	21.7	71.3	
6		cot-cor	cot-cor	cot-cor	37.5	30.3	20.3	10.8	
7	PPNT	cot-fal	cor-fal	sor-fal	29.1	33.3	55.3	79.2	
8		cor-fal	cot-cor	cor-fal	36.6	41.8	29.0	73.0	
9		cot-cor	cot-cor	cot-cor	43.0	25.2	25.6	15.3	

Table 8. Plant residue cover immediately following spring planting are 30 days following summer harvest.

Tillage trt	Previous crop	% Residue cover Following planting 1994	1995	crop	% Residue cover Following harvest 1994	1995
CT	cotton	8.3	3.0	cotton[1]	2.0	4.1
	sorghum	9.5	2.3	sorghum[1]	1.9	6.7
RT	cotton	21.1	10.8	cotton	32.9	7.0
	sorghum	25.9	23.1	sorghum	46.0	23.7
PPNT	cotton	19.6	12.0	cotton	32.2	10.8
	sorghum	23.1	23.6	sorghum	42.3	24.7

[1]Plow and one disking.

Table 9. Economic analysis (U.S. dollars/ha) for irrigated cotton on alternative tillage systems for 1993, 1994, and 1995.

Year	CT corn/cot	CT cot-corn /cot-corn	RT corn/cot	RT cot-corn /cot-corn	PPNT corn/cot	PPNT cot-corn /cot-corn
1993						
herbicide	----	43.05	----	59.28	----	59.28
insecticide	----	189.70	----	189.70	----	189.70
planting & tillage	----	197.20	----	78.64	----	58.88
harvest	----	503.39	----	420.22	----	481.30
irrigation	----	67.93	----	67.93	----	67.93
other	----	53.52	----	53.52	----	53.52
Total variable	----	1105.84	----	911.11	----	954.48
Net returns	----	343.77	----	342.49	----	450.01
1994						
herbicide	50.66	50.66	93.27	73.43	93.27	73.43
insecticide	230.25	230.25	230.25	230.25	230.25	230.25
planting & tillage	254.01	216.96	93.46	93.46	73.70	73.70
harvest	346.02	287.51	376.03	371.88	342.07	370.65
irrigation	67.93	67.93	67.93	67.93	67.93	67.93
other	54.51	54.51	60.93	60.93	46.11	46.11
Total variable	1075.83	952.14	967.15	936.77	894.93	904.12
Net returns	(33.54)	(151.91)	101.20	119.05	72.52	149.31
1995						
herbicide	----	41.52	----	53.72	----	53.72
insecticide	----	288.10	----	288.10	----	288.10
planting & tillage	----	241.52	----	100.48	----	85.91
harvest	----	165.93	----	275.36	----	270.64
irrigation	----	135.85	----	135.85	----	135.85
other	----	106.70	----	85.24	----	85.24
Total variable	----	1025.64	----	983.63	----	963.08
Net returns	----	(463.57)	----	86.45	----	78.27

No cost attributed for land usage
Approximately 210.00/hectare is standard rent

Table 10. Economic analysis (U.S. dollars/ha) for dryland cotton on alternative tillage systems for 1993, 1994, and 1995.

Year	CT SSC	CT CSC	RT SSC	RT CSC	PPNT SSC	PPNT CSC
1993						
herbicide	----	50.29	----	92.90	----	92.90
insecticide	----	74.69	----	74.69	----	74.69
planting & tillage	----	179.60	----	61.75	----	47.42
harvest	----	209.88	----	208.27	----	217.04
other	----	54.51	----	54.51	----	54.51
Total variable	----	615.25	----	516.30	----	510.08
Net returns	----	(32.90)	----	58.34	----	93.02
1994						
herbicide	----	50.29	----	92.90	----	92.90
insecticide	----	74.69	----	74.69	----	74.69
planting & tillage	----	197.60	----	61.75	----	47.42
harvest	----	258.71	----	292.74	----	267.40
other	----	54.51	----	54.51	----	54.51
Total variable	----	666.53	----	605.00	----	562.96
Net returns	----	61.40	----	225.63	----	190.56
1995						
herbicide	27.59	27.59	60.39	62.86	62.86	62.86
insecticide	47.28	47.28	47.28	47.28	47.28	47.28
planting & tillage	145.73	145.73	44.46	44.46	37.05	37.05
harvest	103.86	107.52	169.99	117.57	140.79	103.12
other	85.24	85.24	85.24	85.24	85.24	85.24
Total variable	431.95	435.78	431.51	376.48	393.72	353.51
Net returns	(149.36)	(109.00)	106.04	(3.95)	29.20	(44.16)

No cost attributed for land usage
Approximately $85.00/hectare is standard rent