Economic Performance of Conservation Tillage for Cotton and Tomato Production in California

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In the fall of 1999, we established a field comparison of reduced and standard tillage cotton and tomato rotations with and without winter cover crops at the University of California West Side Research and Extension Center in Five Points, CA. The preliminary four year results suggest that establishing and harvesting processing tomatoes and cotton with conservation tillage systems is possible given some equipment modification and that yields may be maintained relative to standard tillage in CT crop residue environments.

Key Words: conservation tillage, cotton, processing tomato, cover crop, comparative farming systems

Introduction

The term conservation tillage generally refers to a variety of crop production systems that deliberately attempt to minimize primary intercrop tillage operations such as plowing, disking, ripping, and chiseling. As a result, crop residues tend to accumulate at the soil surface. Conservation tillage has, in fact, been defines as a production system in which 30 percent of the soil surface is covered by residues from previous crops (Redder 2000). Several benefits have been reported to result from conservation tillage production systems (Phatak 1992), however, the primary motivations that have driven adoption include reduced soil erosion and costs (Johnson et al. 2002 and Treplett et al. 2002) Conservation tillage systems are common in the Midwest and southeast United States (Gallaher 2002 but are uncommon in California (CTIC 1999).

Other potential positive attributes of conservation tillage, however, are gaining attention in several regions of California. These include the possibility of reducing surface water, sediment, nutrient and pesticide runoff (Bradley 2002), sequestering carbon in the soil through less soil disturbance, decreasing CO_2 emissions from the burning of diesel fuel, and finally reducing fugitive dust emissions.

The Central Valley of California is an area in which considerable intercrop tillage is customarily used. In the fall of 1999, we established a field comparison of reduced and standard tillage cotton and tomato rotations with and without winter cover crops at the University of California West Side Research and Extension Center in Five Points, CA. The objective of this study are to compare reduced tillage and conventional tillage practices in crop rotations common to California's San Joaquin Valley with respect to; productivity and profitability, resource use, soil quality indicator properties, the quantity and composition of dust produced, soil water storage and crop water availability, and pest and crop management requirements. This paper reports the results of the measures of productivity, profitability, and resource use for all systems.

Field Procedures

The reduced, or conservation tillage (CT) systems have been managed from the general principle of trying to reduce primary, intercrop tillage to the greatest extent possible. Zone production practices that restrict tractor traffic to furrows have been used throughout the four years in the CT systems. Conventional intercrop tillage practices that knock down and establish new beds following harvest were used in the standard till (ST) systems.

A 3.23 hectare field experiment comparing conservation and conventional tillage tomato and cotton production systems, with and without winter cover crops was established in the fall of 1999 at the University of California West Side Research and Extension Center in Five Points, CA. Treatment plots consisted of six beds, each measuring 1.4 X 90 m and replicated four times in a randomized complete block design. Six-bed buffer areas separated tillage treatments to enable the different tractor operations that were employed in each experimental system. A cover crop mix of Juan triticale (*Triticosecale* Wittm.), Merced ryegrain (*Secale cereale* L.) and common vetch (*Vicia sativa* L.) was planted at a rate of 112 kg ha-1 (30% triticale, 30% ryegrain and 40% vetch, by weight) in late October in the standard and conservation tillage plus cover crop plots and irrigated once in 1999. In each of the subsequent years, no water was applied to the cover crops due to the advent of timely early winter rains. The cover crops were then chopped in mid-March of the following years using a Buffalo Rolling Stalk Chopper (Fleischer, NE). In the standard tillage + cover crop system, the chopped cover crop was then disked into the soil to a depth of about 19 cm and 1.4 m wide beds were then reformed prior to tomato transplanting and 0.7 m beds were formed ahead of cotton planting. The chopped cover crop in the CT + cover crop plots was sprayed with a 2% solution of glyphosate after chopping and left on the surface as a mulch.

Tomatoes (*Lycopersicon esculentum* '8892') were then transplanted in the center of beds at an in-row spacing of 36 cm during the first week of April in 2000, 2001, 2002 and 2003 using a modified three-row commercial transplanter fitted with a large (51 cm) coulter ahead of each transplanter shoe (Photo insert 1). All systems were fertilized the

same. Dry fertilizer (11-52-0 NPK) was applied preplant at 112 kg ha^{-1}. Additional N was sidedress applied at 150 kg ha^{-1}. The Round Up Ready™ cotton (*Gosypium hirsutum*) variety, 'Riata," was used each year in all systems. A John Deere 1730 No-till 6 row 30" planter was used in the CT systems. All tractor traffic was restricted to the furrows between planting beds in the CT systems; no tillage was done in CT plots following tomatoes and preceding the next cotton crop, and only two tractor passes were conducted following cotton and preceding each subsequent tomato crop. These operations included shredding and uprooting the cotton stalks using a "Shredder Bedder" implement (Interstate Mfg., Bakersfield, CA) in order to comply with "plowdown" regulations for pink boll worm control in the region and a furrow sweep operation to clean out furrow bottoms to allow irrigation water to more readily down the furrows.

The time and equipment required for all operations in each plot was recorded for economic comparisons between the tillage / cover crop systems. Crop yields were determined in each year using field weighing gondola trailers following the commercial machine harvest of each entire plot.

Crop Performance

Yield results during the first four years of this study show that tomato yields have been maintained in the CT system relative to the ST system in each year (Table 1). Processing tomato yields in 2000 were slightly lower in each of the cover cropped systems relative to both the standard and conservation tillage systems without cover crops. This occurrence may have been caused in part by the slower early season tomato growth that was observed in each of the cover cropped systems in both years and this

growth reduction may have resulted from nitrogen immobilization following cover crop termination in each spring, and, in the case of the CT + cover crop system, lower soil and near-surface air temperatures. Additional testing is now underway to evaluate each of these hypotheses.

Data from the 2001 tomato harvest indicate that yields in the CT both with and without cover crops were similar to those in the standard till plots, with an elimination of several tillage operations following the preceding year's cotton crop in the CT plots relative to the standard till systems (Table 1). In both 202 and 2003 the highest yielding system was the conservation tillage system without a cover crop. Using a cover crop meant lower yields for the conservation tillage system in all years. Interestingly, for the standard tillage system a cover crop increased yields in 2001 and again in 2003.

Cotton yields were low in all systems in 2000 due to a devastating infestation of mites in the field that persisted all season and were exacerbated by pesticide resistance that developed presumably because the same miticide was sprayed repeatedly in the field during the same season (Table 2). 2001 cotton yields were reduced 11 and 18% in the CT – cover crop and CT + cover crop systems, respectively, relative to the standard tillage control system (Table 2). In 2001 and 2003 yields were comparable but higher for the standard tillage systems than the conservation tillage systems both with and without cover crops. A cover crop increased yields only in 2003. Reasons for the reduced yields in the CT systems as well as in the ST + CC system, we believe, related largely to difficulties we have experienced establishing the crops in these systems. Further work to

refine and improve our planting and establishment of cotton in these contexts is underway.

Economic Performance

A calendar of operations was recorded along with the equipment used and materials applied for each of the systems. In addition, the hand labor hours for hand weeding were recorded. Costs of production per acre were calculated based on the operations, equipment, materials, and labor used for each system. Total costs are the sum of operating costs, cash overhead costs, and noncash overhead costs. Operating costs include fuel, lube, and repair costs as well as equipment operator labor and material costs. Fuel, lube, and repair costs were based on purchase price, annual hours of use, total hours of expected life, and repair coefficients developed by the American Society of Agricultural Engineers. Obviously, the hours per acre on a field trial will be higher than that for an actual farming operation because of all the turning. Therefore, hours per acre for each operation were based on interviews with Westside growers as to the time required on a farming operation. Material costs were obtained from local suppliers. Cash overhead includes property taxes and insurance. Noncash overhead includes capital recovery for equipment ownership. It is equivalent to the annual payment on a loan for the investment with the down payment equal to the present value of the salvage value. For both cotton and tomato, harvest was a custom operation. Therefore, there are no expenses for owning harvest equipment included in the analysis.

Tomato. Tables 3 and 4 show the operations for tomato with and without cover crops in 2000 – 2003. The first year of the experiment, 2000, showed little difference in

the number of times over the field between standard tillage and conservation tillage. This should be considered a transition period when beds were first established in the conservation tillage systems. Consequently, the remaining discussion will focus on the 2001 through 2003 results.

For the years following the transition year, the number of times over the field were reduced by an average of 10 for the no cover systems and 12 in the cover crop systems (Tables 5 and 6). Specifically, the conservation tillage systems avoided the operations for shredding and undercutting cotton, disking, chiseling, triplane, list beds, and shape beds. Comparing the standard tillage system with a cover crop to the standard tillage without a cover crop, the cover crop added six more operations (two disking operations, one additional list operation, planting and mowing the cover crop, and an extra cultivation) and avoided the Roundup application for a net increase of five operations. For the conservation tillage, the system with a cover crop compared to without a cover crop added one cultivation and the planting operation but did not use any herbicide for a net increase of only one operation.

The conservation tillage systems reduced labor, fuel, lube and repair costs averaged $42 per acre from 2001 – 2003 for the systems without a cover crop. Herbicide costs were also lower in the conservation tillage systems except the cover crop systems in 2002. However, the custom harvest costs were substantially higher (almost $100 per acre) for the conservation tillage system than the standard tillage system without a cover crop because of the higher yields both years. Also, in 2001 hand hoeing costs were slightly higher ($8 per acre). The net result is that the operating costs for the systems

without a cover crop, the conservation tillage system was higher than the standard tillage in all years.

For the systems with a cover crop the savings on machine labor, fuel, lube, and repairs was higher than for the systems without cover crops the cost reduction averaged $60 per acre. Unlike the systems without cover crops, the yields were higher for the standard tillage system than the conservation tillage system with cover crops leading to higher custom harvest costs for standard tillage in all years. As was the case without cover crops, hand weeding costs were higher for the conservation tillage system.

Looking at total costs, the conservation tillage system had lower noncash overhead costs with and without cover crops because of the reduced amount of equipment used and the reduced tractor hours (Tables 7 and 8). Nonetheless, for the systems without a cover crop the total costs for the conservation tillage systems were slightly higher because of the higher custom harvest costs already discussed. Of course, a higher yield also means higher revenue. Using a value of $51.50 per ton, the net returns for the conservation tillage systems were higher by an average of 32 percent for the systems without a cover crop. For the systems with a cover crop the total costs were lower for the conservation tillage system than the standard tillage system. But because yields and revenue were lower for the conservation tillage system, the net returns averaged 10 percent less for the conservation tillage system.

Cotton. As with tomato, the number of times over the field was greatly reduced by the conservation tillage systems; an average of nine operation reduction without cover crops and eight operations with cover crops (Tables 9 and 10). The differences between

the cover crop and without cover crop systems were greater in cotton than in tomato due to the differences in herbicide treatments. Overall, the cover crop systems had more operations than the parallel system without a cover crop. Looking at the systems without a cover crop, the reduced costs from machine labor, fuel, lube, and repairs averaged $42 per acre. Unlike tomato, the hand weeding cost for the conservation tillage system was lower than for the standard tillage system. In 2001 the herbicide costs were lower for the conservation tillage system than for the standard tillage system while the opposite was true in 2002 and 2003.

For the systems with cover crops the savings in operating costs from conservation tillage were very similar to those for the systems without cover crops (Tables 11 and 12). However, these savings were offset in both years by a higher herbicide bill in all years. Unlike tomato, harvest costs are on a per acre basis and not on a yield basis. Therefore, the custom harvest costs were identical across systems. Overall, in 2001 there was a slight savings in operating costs with conservation tillage and in 2002 the cost was actually slightly higher due to the increased cost of herbicides.

The yields for the conservation tillage systems were lower for systems without cover crops in all years except with cover crops in 2001. At a cotton price of $.85 per pound, the difference in gross income without cover crops averaged $145 per acre from 2001 - 2003. For the cover crop systems, the difference was $42 per acre more in 2001 for the conservation tillage system, almost $600 per acre higher for the standard tillage system in 2002, and $153 per acre higher in 2003 for ST for an average of $235 more income per acre for ST+CC that CT+CC. The savings in equipment ownership was

greater in cotton than for tomato with a reduction of about $44 per acre in equipment overhead costs for the systems with and without cover crops. The differences in income were greater than the differences in costs for a bottom line of a net lower income for the conservation tillage systems except for the cover crop system in 2001 with an average of 11 percent higher net income without a cover crop with ST and 19 percent with a cover crop (Tables 13 and 14).

Discussion

The summary findings presented here indicate short-term outcomes and issues related to a conversion to CT production in an irrigated region such as California's CV. These preliminary results suggest that establishing and harvesting processing tomatoes with conservation tillage systems is possible given some equipment modification and that yields may be maintained relative to standard tillage in CT crop residue environments, at least over the short term. A number of possible constraints to the adoption of these high residue production systems were observed during this "transition" period and these require further investigation. First, the continued, long-term accumulation of surface residues may eventually present problems in terms of planting, cultivating and harvesting CT crops such as processing tomatoes. Transplanting and in-season cultivations took more time in the CT + cover crop plots relative to the standard till systems. Second, although we did not attempt to quantify the actual amount of residue that gets picked up by harvesting equipment, there would also seem to be at least the possibility that high surface residue systems may eventually result in greater "material other than tomatoes" being harvested, which will ultimately require increased cleaning effort and expense at

the processing plant. Third, although “zone production” theory might suggest that soil compaction constraints may, to a large extent, be avoided by keeping tractor traffic away from “crop growth zones,” (Carter et al., 1991), longer-term studies that investigate implications of reduced till regimes on compaction are needed and will continue to be evaluated as this study progresses through its eight-year course.

This project is the first of its kind in California to systematically compare tillage system alternatives through a crop rotation. The extent to which such alternatives are adopted in this region will ultimately depend on the extent to which these systems are economically viable, whether or not weed, insect and disease pests can be adequately managed over time, and possibly, whether processors and ultimately consumers find sufficient value in these types of food production approaches to provide cost offsets to support their adoption (R. Rickert, personal communication).

Estimates of production costs for each of the four systems evaluated in this study are attached. These data are being compiled and will be "ground truthed" with several West Side farmers in December 2002. We also include summary data related to the generation of fugitive dust for each field operation. These data are being compiled as part of a thesis by Julie Baker.

A number of questions will need to be answered before widespread adoption of these types of production systems is realized in California. These include 1) Do CT systems remain productive over several seasons? 2) Will subsurface soil compaction ultimately limit CT approaches and eventually require deep tillage interventions? 3) Does CT actually serve to sequester C in California’s semiarid, irrigated environment? And

finally, 4) Does CT reduce fugitive dust emissions enough to positively impact air quality in this region? These are key questions we propose to pursue during the next cycle of this work.

This project has been a hugely successful study to date. It has generated considerable, solid information on the economics, agronomic practicalities, soil quality, dust emissions and productivity of alternative tillage cotton and tomato systems over the short term. This study is now a unique site in California with respect to this type of work. It is critical for us to pursue this work in this field, which now has plots that effectively have not been tilled for three years, for another cycle in order to better assess the mid-term impacts of these cropping approaches. It is in the pursuit of this work over a longer period of time that will yield critically needed information related to the sustainability and feasibility of these systems. The work conducted in this study has clearly needed to be done at the WSREC due to its exploratory, cutting edge nature. Many of the techniques we have developed during the course of this work are now being used and tried by farmers not only in the West Side area, but also in the South Sacramento Valley region as well. Numerous farmers and other visitors have toured the site during these last years. The study has also served as a crucial site for our annual CT conferences and this last year had four speakers talk about their respective work related to it.

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Table 1. Tomato yields 2000 – 2003 (tons/acre)

	2000	2001	2002	2003
Standard tillage no cover crop	58	58	46	42.4
Standard tillage cover crop	53	63	45	45.4
Conservation tillage no cover crop	56	62	56	54.4
Conservation tillage cover crop	51	61	43	51.9

Table 2. Cotton yields 2000 – 2003 (lbs lint/acre)

	2000	2001	2002	2003
Standard tillage no cover crop	360	1,783	1,975	1,228
Standard tillage cover crop	360	1,405	1,949	1,336
Conservation tillage no cover crop	200	1,579	1,728	1,058
Conservation tillage cover crop	372	1,454	1,249	1,157

Table 3. Tomato Without Cover Crop - Comparison of Standard and Conservation Tillage Systems Operations

	2000[1/]		2001		2002		2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Shred Cotton			X		X		X	
Undercut Cotton			X		X		X	
Disk	XX	XX	XX		XX		XX	
Chisel	X	X	X		X		X	
Level (Triplane)	X	X	X		X		X	
List Beds	X	X	X		X		X	
Incorporate/Shape Beds	X	X	X		X		X	
Clean Furrows				X		X		X
Shred Bed				X		X		X
Spray Herbicide: Treflan	X		X		X		X	
Incorporate Treflan (Lilliston)	X		X		X		X	
Spray Herbicide: Roundup	XXX	X	X	X	X	X	XX	X
Spray Herbicide: Shadeout	X		X		X	X	X	X
Cultivate – Sled cultivator	X	X	X	X	XX	XX	XX	XX
Roll Beds			X		X			
Plant Tomatoes	X	X	X	X	X	X	X	X
Fertilize	XX	XX	XX	XX	XX	XX	XX	XX
Spray Insecticides			X	X				
Harvest-Custom	X	X	X	X	X	X	X	X
Times over field	17	12	19	9	19	10	19	10

[1/] Tillage operations took place in 1999 for conservation tillage

Table 4. Tomato With Cover Crop - Comparison of Standard and Conservation Tillage System Operations

	2000[1/]		2001		2002		2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Shred Cotton			X		X		X	X
Undercut Cotton			X		XX		X	
Disc	XXXX	XX	XXXX		XXXX		XXXX	
Chisel	X	X	X		X		X	
Level (Triplane)	X	X	X		X		X	
List Beds	XX	X	XX		XX		XX	
Incorporate/Shape Beds	XX	X	X				X	
Clean Furrows				X		X		
Shred Bed				X		X		X
Spray Herbicide: Treflan	X		X		X		X	
Incorporate Treflan (Lilliston)	X		X		X		X	
Spray Herbicide: Roundup	X	X				X		
Spray Herbicide: Shadeout			X		X		X	X
Cultivate - Rolling Cultivator (Lilliston)								X
Cultivate - Sled Cultivator	XXX		XX					
Cultivate - High Residue Cultivator		XX		XX	XX	XXX	XX	XXX
Roll Beds	X		X		X			
Plant Tomatoes	X	X	X	X	X	X	X	X
Fertilize	XX	XX	XX	XX	XX	XX	XX	XX
Plant Cover Crop	X	X	X	X	X	X	X	X
Mow Cover Crop	X	X	X		X		X	X
Spray Ground-Insecticides			X	X				
Harvest-Custom	X	X	X	X	X	X	X	X
Times Over Field	23	15	24	10	23	11	22	11

[1/] Tillage operations took place in 1999 for conservation tillage

Table 5. Tomato Without Cover Crop - Comparison of Standard and Conservation Tillage Systems Costs per Acre and Resource Use per Acre

	2000		2001		2002		2003		Ave 2001 - 2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Conserve	Conserve	Standard	Conserve
					$ per Acre					
Fertilizer	50	50	50	50	50	50	50	50	50	50
Seed	145	145	145	145	145	145	145	145	145	145
Herbicide	105	68	62	25	62	58	69	65	64	49
Insecticide	0	0	19	19	0	0	0	0	6	6
Water	122	122	142	142	132	132	148	148	141	141
Custom Harvest	551	542	504	600	447	532	403	516	451	549
Labor (Machine)	24	20	26	13	28	15	26	14	27	14
Labor (Irrigation)	64	64	58	58	57	57	78	78	64	64
Labor (Hand Weeding)	220	213	3	8	3	3	60	60	22	24
Fuel	26	22	28	10	29	11	28	10	28	10
Lube and Repair	23	20	25	15	28	17	26	14	26	15
Interest	22	21	19	15	18	16	20	18	19	16
Total Operating Costs	1,352	1,287	1,081	1,100	999	1,036	1,053	1,118	1,044	1,085
Times over the field	17	12	19	9	19	10	19	10	19	10
Hours of Labor	40	38	11	10	11	9	20	19	14	13
Machine	3	2	3	1	3	2	3	1	3	1
Non-machine	37	36	8	9	8	8	18	17	11	11
Gallons of Fuel	23	20	25	9	26	10	25	9	25	9

Table 6. Tomato with Cover Crop - Comparison of Standard and Conservation Tillage Systems Costs per Acre and Resource Use per Acre

	2000		2001		2002		2003		Ave 2001 - 2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Conserve	Conserve	Standard	Conserve
					$ per Acre					
Fertilizer	50	50	50	50	50	50	50	50	50	50
Seed	171	171	171	171	171	171	171	171	171	171
Herbicide	28	25	37	25	37	19	38	46	37	30
Insecticide	0	0	19	19	0	0	0	0	6	6
Water	122	122	142	142	132	132	148	148	141	141
Custom Harvest	504	494	599	590	475	409	431	493	502	497
Labor (Machine)	43	22	41	16	33	17	30	16	35	16
Labor (Irrigation)	64	64	58	58	57	57	78	78	64	64
Labor (Hand Weeding)	95	330	8	15	4	29	60	60	24	35
Fuel	42	24	41	12	35	12	33	12	36	12
Lube and Repair	40	25	40	20	36	20	32	16	36	19
Interest	22	22	21	18	20	17	21	19	21	18
Total Operating Costs	1,181	1,349	1,227	1,136	1,050	933	1,092	1,109	1,123	1,059
Times over the field	23	15	24	10	23	11	22	11	23	11
Hours of Labor	25	53	13	12	11	13	21	19	15	15
Machine	4	2	4	2	3	2	3	2	3	2
Non-machine	21	51	9	10	8	11	18	18	12	13
Gallons of Fuel	38	21	37	10	32	11	30	11	33	11

Table 7. Tomato Without Cover Crop – Gross Income, Costs, and Net Returns per Acre

	2000		2001		2002		2003		Ave. 2001-2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Tomatoes Yields in Tons/Acre	58	57	58	62	46	56	42	56	49	58
Gross Income @ $51.50/ton	2,987	2,936	2,987	3,193	2,369	2,884	2,163	2,884	2,506	2,987
Operating Expense	1,352	1,287	1,081	1,100	999	1,036	1,053	1,118	1,044	1,085
Net Income/Acre Above Operating	**1,635**	**1,649**	**1,906**	**2,093**	**1,370**	**1,848**	**1,110**	**1,766**	**1,462**	**1,902**
Cash Overhead: Property Taxes	2	1	2	1	2	1	2		2	1
Cash Overhead: Property Insurance	1	1	1	1	1	1	1		1	1
Non-Cash Overhead: Equipment	31	28	32	24	38	26	35		35	25
Total Overhead Costs	34	30	35	26	41	28	38	0	38	18
Total Costs	1,386	1,317	1,116	1,126	1,040	1,064	1,091	1,118	1,082	1,103
Net Income/Acre Above Total Costs	**1,601**	**1,619**	**1,871**	**2,067**	**1,329**	**1,820**	**1,072**	**1,766**	**1,424**	**1,884**

Table 8. Tomato With Cover Crop – Gross Income, Costs, and Net Returns per Acre

	2000		2001		2002		2003		Ave. 2001-2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Tomatoes Yields in Tons/Acre	53	51	63	61	45	43	45	52	51	52
Gross Income @ $51.50/ton	2,730	2,627	3,245	3,142	2,318	2,215	2,318	2,678	2,627	2,678
Operating Expense	1,181	1,349	1,227	1,136	1,050	933	1,092	1,109	1,123	1,059
Net Income/Acre above Operating	**1,549**	**1,278**	**2,018**	**2,006**	**1,268**	**1,282**	**1,226**	**1,569**	**1,504**	**1,619**
Cash Overhead: Property Taxes	3	2	2	1	2	1	2	1	2	1
Cash Overhead: Property Insurance	2	2	2	1	2	1	2	1	2	1
Non-Cash Overhead: Equipment	52	39	49	29	48	31	44	24	47	28
Total Overhead Costs	57	43	53	31	52	33	48	26	51	30
Total Costs	1,238	1,392	1,280	1,167	1,102	966	1,140	1,135	1,174	1,089
Net Income/Acre Above Total Costs	**1,492**	**1,235**	**1,965**	**1,975**	**1,216**	**1,249**	**1,178**	**1,543**	**1,453**	**1,589**

Table 9. Cotton Without Cover Crop - Comparison of Standard and Conservation Tillage Systems Operations

	2000		2001		2002		2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Disk	XX	XX	XX		XX		XX	
Chisel	X	X	X		X		X	
Level (Triplane)	X	X	X		X			
List Beds	X	X	X		XX		X	
Incorporate/Shape Beds		X						
Clean Furrows								
Compact Furrows								
Spray Herbicide: Treflan	X		X		X		X	
Incorporate Treflan (Lilliston)	X		X		X		XX	
Spray Herbicide: Roundup	XX	XXXX	XX	XX	XXX	XXX	XX	XXXX
Cultivate- Rolling Cultivator	XXX		XX		X		XX	
Cultivate – Sled Cultivator	X		X					
Open/Close Ditch for Irrigation								
Plant Cotton	X	X	X	X	X	X	X	X
Fertilize (Water Run)								
Spray: Insecticides/Growth Reg	XXXX	XXXX	XXX	XXXX	X	X	XX	XX
Spray: Defoliate	X	X		X	XX	XX	X	X
Spray Insecticides					XX	XX	XX	XX
Custom Spray Defoliants			X	X				
Custom Ground Spray Insect ides							X	X
Aerial Spray Insecticides	XX	XX						
Harvest-Custom	X	X	X	X	X	X	X	X
Times over field	22	19	19	9	19	10	19	12

[1/] Tillage operations took place in 1999 for conservation tillage

Table 10. Cotton With Cover Crop - Comparison of Standard and Conservation Tillage Systems Operations

	2000		2001		2002		2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Disk	XXX	XX	XXX		XXX		XXXX	
Chisel	X	X	X		X		X	
Level (Triplane)	X	X	X					
List Beds	XX	X	XX		XX		XX	
Incorporate/Shape Beds		X						
Clean Furrows								
Compact Furrows								
Spray Herbicide: Treflan	X		X		X		X	
Incorporate Treflan (Lilliston)	X		X		X		XX	
Spray Herbicide: Roundup	XX	XX	X	XXX		XXX	X	XXX
Cultivate – Rolling Cultivator	X		X		XX		X	
Cultivate – Sled Cultivator			X	X	X			
Open/close Ditch for Irrigation (2 operations each X)								
Chain Beds								
Plant Cotton	X	X	X	X	X	X	X	X
Fertilize (Water Run)								
Plant Cover Crop	X	X	X	X	X	X	X	X
Mow Cover Crop	X	X	X	X	X	X	X	X
Spray Insecticides/Growth Reg	XXXX	XXX	XXX	XXX	XX	X	XX	XX
Spray: Defoliate	X	X			XX	XX	X	X
Spray Insecticides					X	XX	XX	XX
Custom Defoliate			X	X				
Custom Spray Insecticides								
Air Spray Insecticides	XX	XX	X	X			X	X
Harvest-Custom	X	X	X	X	X	X	X	X
Times over field	23	18	21	13	20	12	22	13

[1/] Tillage operations took place in 1999 for conservation tillage

Table 11. Cotton Without Cover Crop – Operating Costs and Resource Use per Acre

	2000		2001		2002		2003		Ave 2001 - 2003	
Operation	Standard	Conserve	Standard	Standard	Standard	Conserve	Standard	Conserve	Standard	Conserve
					$ per Acre					
Fertilizer	37	37	37	37	37	37	37	37	37	37
Seed	38	38	38	38	38	38	38	38	38	38
Herbicide	53	20	49	43	30	56	33	51	37	50
Insecticide	166	166	101	101	131	131	135	135	122	122
	42	42	57	57	45	45	51	51	51	51
Water	129	129	129	129	128	128	113	113	123	123
Custom Harvest	111	111	107	107	90	90	100	100	99	99
Labor (Machine)	23	23	20	7	19	8	21	10	20	8
Labor (Irrigation)	46	49	32	32	41	41	41	41	38	38
Labor (Hand Weeding)	25	14	6	4	4	0	0	0	3	1
Fuel	24	24	22	5	21	6	23	8	22	6
Lube and Repair	19	19	16	6	17	7	18	9	17	7
Interest	23	21	21	18	20	15	20	14	20	16
Total Operating Costs	736	693	635	584	621	602	630	607	629	598
					Resource Use					
Times over the field	22	19	19	9	19	10	19	12	19	10
Hours of Labor	12	11	7	5	8	6	8	6	8	6
Machine	2	2	2	1	2	1	2	1	2	1
Non-machine	9	8	5	5	6	5	5	5	5	5
Gallons of Fuel	22	22	20	5	19	5	20	7	20	6

Table 12. Cotton With Cover Crop – Operating Costs and Resource Use per Acre

	2000		2001		2002		2003		Ave 2001 - 2003	
Operation	Standard	Conserve	Standard	Standard	Standard	Conserve	Standard	Conserve	Standard	Conserve
					$ per Acre					
Fertilizer	37	37	37	37	37	37	37	37	37	37
Seed	64	64	64	64	64	64	64	64	64	64
Herbicide	55	43	24	43	5	56	15	32	15	44
Insecticide	166	166	101	101	131	131	135	135	122	122
Plant regulator	42	42	57	57	45	45	51	51	51	51
Water	129	129	129	129	128	128	113	113	123	123
Custom Operations (Harvest)	111	111	107	107	90	90	100	100	99	99
Labor (Machine)	22	23	22	8	22	10	26	11	23	10
Labor (Irrigation)	54	49	33	33	41	41	41	41	38	38
Labor (Hand Weeding)	20	32	7	15	4	0	0	0	4	5
Fuel	24	25	24	7	24	7	28	9	25	8
Lube and Repair	21	21	21	8	22	10	24	11	22	10
Interest	25	26	23	21	22	18	22	16	22	18
Total Operating Costs	770	768	649	630	635	637	656	620	647	629
				Resource Use						
Times over the field	23	18	21	13	20	12	22	13	21	13
Hours of Labor	12	13	7	7	8	6	8	7	8	7
Machine	2	2	2	1	2	1	3	1	2	1
Non-machine	10	11	5	6	6	5	5	5	5	5
Gallons of Fuel	23	18	21	13	22	7	25	8	23	7

Table 13. Cotton Without Cover Crop – Gross Income, Costs, and Net Income per Acre

	2000		2001		2002		2003		Ave. 2001-2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Cotton Yields in lbs/acre	360	200	1,783	1,579	1,975	1,728	1,228	1,058	1662	1455
Gross Income @ $.85/lb. [1/]	306	170	1,516	1,342	1,679	1,469	1,044	899	1413	1237
Operating Expense	736	693	635	584	621	602	630	607	629	598
Net Income/Acre above Operating Costs	**-430**	**-523**	**881**	**758**	**1,058**	**867**	**414**	**292**	**784**	**639**
Cash Overhead: Property Taxes	3	3	3	1	3	1	3		3	1
Cash Overhead: Property Insurance	2	2	2	0	2	0	2		2	0
Non-Cash Overhead: Equipment	54	58	52	13	53	11	54		53	12
Total Overhead Costs	59	63	57	14	58	12	59	0	58	9
Total Cost (Operating plus Overhead)	795	756	692	598	1,000	855	355	292	726	630
Net income/Acre above Total Costs	**-489**	**-586**	**824**	**744**	**1,975**	**1,728**	**1,228**	**1,058**	**1662**	**1455**

[1/] Cotton price $.85 per pound ($.70 plus $.15 government payment).

Table 14. Cotton With Cover Crop – Gross Income, Costs, and Net Income per Acre

	2000		2001		2002		2003		Ave. 2001-2003	
Operation	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve	Standard	Conserve
Cotton Yields in lbs/acre	360	372	1,405	1,454	1,949	1,249	1,336	1,157	1563	1287
Gross Income @ $.85.lb. [1/]	306	316	1,194	1,236	1,657	1,062	1,136	983	1329	1094
Operating Expense	770	768	649	630	635	637	656	620	647	629
Net Income/Acre above Operating Cost s	**-464**	**-452**	**545**	**606**	**1,022**	**425**	**480**	**363**	**682**	**465**
Cash Overhead: Property Taxes	3	3	3	1	3	1	3	1	3	1
Cash Overhead: Property Insurance	2	2	2	0	2	0	2	1	2	0
Non-Cash Overhead: Equipment	58	61	58	12	60	14	64	16	61	14
Total Overhead Costs	63	66	63	13	65	15	69	18	66	15
Total Cost (Operating plus Overhead)	833	834	712	643	957	410	411	345	617	449
Net income/Acre above Total Costs	**-527**	**-518**	**482**	**593**	**1,949**	**1,249**	**1,336**	**1,157**	**1,563**	**1,287**

[1/] Cotton price $.85 per pound ($.70 plus $.15 government payment).