Comparison of Crop Rotation Net Returns under No-till and Conventional Tillage

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INTRODUCTION

Soil conservation through the use of conservation tillage has been a topic of increased importance in recent years. This can be attributed to social pressures on farmers from environmental groups and legislative pressures brought about by recent farm legislation.

With the possible loss of farm program benefits facing farmers with highly erodible land, adoption of conservation tillage has been increasing. The Conservation Technology Information Center (CTIC) in its 1991 executive summary reported conservation tillage was being used on 28.14% of all planted acres in the U.S., up 2.5% from 1989. In particular, no-till soybean and cotton acres have increased dramatically. No-till full season soybean acreage has tripled since 1987 and no-till now accounts for 50.2% of double-crop soybean plantings. No-till cotton acreage has increased from 20,000 acres in 1989 to 101,000 acres in 1991. However, this five fold increase in no-till cotton acres still represents only 0.74% of all U.S. cotton acres.

By comparison, no-till is less prevalent in Arkansas. Of 3.35 million acres of soybeans in 1990 (Arkansas Ag. Statistics Serv. 1991), no-till accounted for only 0.6% of first crop plantings and 10% of double-crop plantings. Likewise, 0.05% of Arkansas cotton plantings were by no-till methods.

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Many factors affect farmers' adoption of conservation tillage. Bultena and Hoiberg (1983) found that farmers adopting conservation tillage had higher gross farm incomes than those not adopting the practices. However, fear of reduced yields and reduced income has often been given as a reason against adoption of conservation tillage. The objective of this study was to compare the economic performance of alternative row-crop systems in eastern Arkansas under conventional and conservation tillage. Economic analysis will provide needed information regarding the profitability of conventional versus conservation systems to assist farmers considering a change to a no-till system.

MATERIALS AND METHODS

Data for this study were taken from a multidisciplinary project conducted at the University of Arkansas Northeast Research and Extension Center (NEREC) at Keiser. The project compared 12 crop rotations grown with conventional and no-till systems over a six year period from 1986 to 1991. Irrigation via overhead sprinkler was applied to 11 of the 12 rotations. The cropping sequence for each of the 12 rotations was as follows:

Rotation 1: Soybean
Rotation 2: Wheat-Double Crop (DC) Soybean
Rotation 3: Wheat-DC Grain Sorghum
Rotation 4: Wheat-DC Rice/Wheat-DC Gr. Sorghum/Wheat-DC Soybean
Rotation 5: Grain Sorghum
Rotation 6: Grain Sorghum/Wheat-DC Soybean/Grain Sorghum
Rotation 7: Soybean/Grain Sorghum
Rotation 8: Vetch-Corn/Wheat-DC Soybean/Vetch-Soybean
Rotation 9: Corn/Soybean

Rotation 10 Cotton/Grain Sorghum/Wheat-DC Soybean

Rotation 11: Cotton
Rotation 12: Soybean (Non-irrigated)

The experimental design of the project was a split-plot with four replications. The main plots were the two tillage systems, conventional and no-till. Each crop in each rotation sequence was planted in every year of the experiment to obtain treatment yields. This was done to remove year*rotation bias and to allow year by year comparisons. Conventional tillage consisted of disking and field cultivation prior to planting, cultivation during the growing season, and diskmg of crop residue in the fall or prior to planting of the next crop in the rotation sequence. No-till main plots were neither tilled nor cultivated. Cotton plots were bedded each spring in both systems to insure a cotton stand. Preplant chemical use was identical between the two tillage systems except for the addition of a burndown herbicide on the no-till plots. Postemergent chemical applications were made on an as-needed basis. Fertilizer and seeding rates and varieties were identical for each tillage system. All field operations performed and material inputs applied were recorded at the project site to allow cost of production estimates to be made.

Enterprise budgets were prepared for each rotation in each year to determine profitability of the rotation. Yields used in developing each budget were the treatment level means averaged across four replications. Price data for 1986-91 estimating representative cost of production and revenue from the sale of crops were taken from Arkansas Cooperative Extension Service (CES) enterprise budgets (various years) and Arkansas Agricultural Statistics Service (various years), respectively. In order to reduce a year*rotation bias and to eliminate the influence of market price

Table 1. Mean yields by crop and tillage system across rotations in the long term rotation study at Keiser, AR for 1986-1991.

	MEAN YIELD							MEAN
	1986	1987	1988	1989	1990	1991	6-YR	GROUP[1]
Soybean (bu/a)								
no till	30.53	50.92	44.99	31.60	44.82	41.43	40.72	A
conventional	24.93	52.57	45.86	35.36	45.92	43.06	41.28	A
Sorghum (bu/a)								
no till	89.38	70.95	61.96	57.86	78.31	58.04	69.42	B
conventional	90.03	85.68	74.89	56.60	87.52	54.54	74.88	A
Corn (bu/a)								
no till	90.28	170.60	135.13	149.71	137.46	48.52	121.95	A
conventional	76.88	165.35	137.93	143.20	135.35	45.59	117.38	A
Cotton (lb lint/a)								
no till	700.87	1125.30	584.28	785.56	NA[2]	NA	799.00	A
conventional	555.44	1101.98	522.48	641.90	NA	NA	705.45	A
Rice (bu/a)								
no till	6.32	33.01	27.90	NA	25.68	20.98	22.78	A
conventional	10.21	44.92	40.87	NA	45.11	10.85	30.39	A
Wheat (bu/a)								
no till	NA	NA	39.55	10.15	NA	NA	25.32	A
conventional	NA	NA	35.57	7.64	NA	NA	21.60	A

[1] Mean separation groupings, Duncan Multiple Range Test (0.05 sig. level)
[2] NA indicates no yields available due to crop failure.

fluctuations, all prices were indexed to 1990 dollars and then averaged to a single value. Costs of field operations and irrigation were estimated using coefficients and equipment values from Arkansas CES budgets. The cost estimation procedure and budget compilation was accomplished by utilizing the Mississippi State Budget Generator (Spurlock and Laughlin, 1987) software package.

All budgets were formulated for a rotated acre. A rotated acre is a concept which allows economic comparison between rotations on a per acre basis regardless of either (a) the number of different crops in the rotation, or (b) the length of time required for the rotation cycle. All cost and return categories in a rotated acre budget are weighted proportionately according to the length of time each crop occupies in the rotation sequence.

YIELD RESULTS

Mean yields for each crop over the life of the study regardless of rotation are shown in Table 1. Statistical analysis showed that only grain sorghum yields were significantly different between tillage systems at the 0.05 level of probablility. Mean grain sorghum yields under conventional tillage (74.88 bu/acre) exceeded no-till yields (69.42 bu/acre) by more than 5 bu/acre. These results indicate that, except for grain sorghum, no-till did not result in a significant yield reduction relative to conventional tillage for the study.

The results in Table 1 do not take differences among rotations into consideration. For soybean, the five lowest-yielding rotations included non-irrigated (rotation 12) and double-crop rotations (rotations 2 and 4). Likewise, grain sorghum yields for double crop rotations (Rotations 3 and 4) were lower than grain sorghum in full season situations. All other crops showed no significant difference among rotations. These results indicate that for the life of this study, rotation yield differences were primarily evident in those rotations involving double cropping and those that were not irrigated.

ECONOMIC RESULTS

Mean gross income, total variable cost (TVC) and total fixed costs (TFC), and net returns (NR) for each rotation and for each tillage system are presented in Table 2. The mean gross income for all no-till rotations ($213.08/acre) was not significantly different from the mean gross income for all conventional rotations ($214.86/acre). This confirms the results presented in Table 1 which indicate that no significant difference in tillage systems exists from a yield standpoint.

Costs of production include both variable costs and fixed costs. Variable costs include seed, fertilizer, chemicals, fuel, repair and maintenance costs, custom application charges, hauling charges, labor, and interest on operating capital. Fixed costs include depreciation and interest on investment. Table 2 shows that, on average, TVC for the no-till system were $127.98/acre compared to $114.76/acre for conventional tillage. This $13.22 difference in TVC between tillage systems was significant at the 0.05 level. By contrast, TFC for the two tillage systems exhibited no significant differences when averaged across all rotations with TFC of $68.82/acre and $76.84/acre for no-till and conventional tillage, respectively. The majority of fixed costs in the study were charged to the irrigation system with identical amounts being attributed to each tillage system ($55.13). These results indicate a significant increase in cash costs (TVC) for those farmers changing from a conventional to a no-till system.

Profitability of a system is measured by net returns. Over the 6-year period of the study, NR by tillage system averaged across all rotations were $16.28/acre for the no-till system and $23.26/acre for the conventional system. Statistical analysis of these values reveals no significant difference at the 0.05 level, demonstrating that there is no difference in profitability of no-till and conventional systems.

Table 2 ranks the mean NR for each rotation within tillage system across the six years of the study. Several points are noteworthy

regarding these rankings. First, both irrigated and non-irrigated continuous soybean were among the top three rotations for both no-till and conventional tillage. Second, the four lowest ranked rotations for both no-till and conventional tillage contained grain sorghum, or some combination of grain sorghum and double cropping. Third, the highest ranked rotation under no-till (continuous cotton) demonstrated below average performance for conventional systems.

These results support several hypotheses concerning profitability. First, irrigation of soybean results in increases in yield and gross income, but these increases are more than offset by the increased TVC and TFC of irrigation. In this study, full season continuous soybean (rotation 12) does not justify the increased cost of sprinkler irrigation (rotation 1). Second, although grain sorghum resulted in negative net returns when grown continuously (rotation 5), low grain sorghum returns were amplified when double-cropping with wheat under both conventional and no-till (rotations 3 and 4). Soybean works well in a double crop rotation (rotation 2), but grain sorghum yields suffer when following wheat due to late planting. Finally, although no-till continuous cotton (rotation 11) yields were not significantly greater

Table 2. Ranking of net returns within tillage systems for the long term rotation study at Keiser, AR for 1986-1991.

RANK	ROTATION NUMBER	GROSS INCOME	TVC*	TFC	NR
		$/ rotated ac			
NO-TILL					
1	11	279.34	104.86	67.03	107.45
2	12	192.49	84.18	16.91	91.40
3	1	259.37	99.72	72.04	87.61
4	8	259.43	154.12	62.88	42.43
5	2	259.65	133.88	83.51	42.26
6	10	247.83	128.89	78.72	40.23
7	9	254.10	141.06	74.28	38.77
8	7	213.99	115.99	71.87	26.13
9	6	187.86	132.93	57.26	-2.32
10	5	133.79	128.87	71.70	-66.78
11	4	171.72	155.16	86.37	-69.81
12	3	97.35	156.07	83.27	-142.00
NO-TILL AVG.		213.08	127.98	68.82	16.28
CONVENTIONAL					
1	12	214.79	57.40	23.28	134.11
2	1	275.38	75.13	78.41	121.85
3	2	277.58	110.08	91.03	76.48
4	9	255.92	121.98	80.09	53.85
5	8	254.52	143.89	69.94	40.69
6	7	216.34	99.86	78.36	38.12
7	10	238.26	120.21	87.62	30.42
8	11	227.15	119.78	88.13	19.24
9	6	189.01	118.90	64.10	6.00
10	5	148.39	120.01	77.38	-49.00
11	4	182.43	140.87	92.28	-50.72
12	3	98.57	148.98	91.45	-141.86
CONVENTIONAL AVG.		214.86	114.76	76.84	23.26

* TVC = Total Variable Costs 6-yr mean
TFC = Total Fixed Costs 6-yr mean
NR = Net Returns 6-yr mean

than conventional cotton yields, TVC of no-till cotton production was lower than conventional cotton production for this study. For all other rotations, no-till TVC exceeded TVC under conventional tillage.

CONCLUSIONS

This study compared yields and net returns of long term rotations grown with no-till and conventional tillage. The conclusions of the study can be summarized as follows: First, with the exception of grain sorghum, tillage does not have a significant effect on crop yields. Second, from an economic standpoint, although TVC were significantly higher for no-till systems, there is no statistical difference between gross income or net returns under no-till and conventional tillage. These points suggest that the adoption of no-till may be an economically feasible method of decreasing soil erosion. Overall, a farmer with adequate ability to cover cash costs of production should see no significant loss of yields or profitability when changing from a conventional to a no-till system.

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