Net Returns for Soybean Reduced Tillage Systems on Three Land Resource Areas

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Introduction

Soybeans are grown on approximately 1.25 million acres in Mississippi where erosion potential exists when current tillage practices are used. Most of this erodible acreage is in central and northern Mississippi. New tillage implements such as the Paraplow® and Ro-till® have recently been introduced in Mississippi as reduced tillage implements. The Paraplow looks similar to a moldboard plow but differs in that the plow-shank only lifts the soil as the shank passes through the soil profile, causing very little surface disturbance. The Ro-till is equipped with trash whippers (disks that remove surface residue from the row), in-row subsoil shanks, two adjustable fluted coulters per shank, and one rolling basket per shank. The coulters are adjustable and move soil over the subsoil slit as the shanks move through the soil profile. The rolling baskets trail the coulters and firm the seedbed. This implement is used as a one-pass seedbed preparation system.

Reducing the amount of tillage in crop production systems is receiving national attention. Literature indicates that soybean response to tillage systems varies widely. In the Midwest (4, 10, and 11), soybean yields are often not affected by tillage systems ranging from complete residue incorporation to no-till. Others reported (9 and 2) that reduced tillage systems produced soybean stands, weed control, and yields comparable to the conventional tillage system. Some research reports (13 and 3) indicate no-till systems produced higher yields than conventional tillage system. Most soybean research in Mississippi, however, has indicated a significant yield increase attributed to tillage (1, 5, 8, and 14).

Economics of reduced tillage systems play a role in the adoption of these systems by producers. No information is available in the literature on the economic comparisons of Paraplow and Ro-till reduced tillage systems. Most comparisons have been made with conventional and no-till systems. On a Blackland Prairie soil (5), conventional tillage and no-till monocrop soybean systems produced net returns of $53 and $24/acre, respectively. On a clay soil in the Mississippi Delta, conventional and stale seedbed systems for soybeans under non-irrigated plantings showed no significant difference in net returns (6). These comparisons have not included new reduced tillage implements such as the Ro-till and Paraplow.

This study was an economic analysis of 3 years (1985-87) of field data evaluating reduced tillage implements for soybean production on three land resource areas. The objective was to estimate short-term net returns to land and management with soybean conservation tillage systems on three land resource areas.

Materials and Methods

Field plots were established for the duration of the project (1985-87) on a Catalpa silty clay at the Northeast Branch Experiment Station, Verona, MS; on a Providence silt loam at the Pontotoc Branch Experiment Station, Pontotoc, MS; and on a Loring silt loam at the Brown Loam Branch Experiment Station, Raymond, MS. The studies at each location were conducted as a randomized complete block with four replications.

Tillage dates for conventional tillage, chisel (6-8 inches deep) + disk, and Paraplow tillage treatment depths of 4-6, 6-8, and 12-14 inches at all locations ranged from April 4 to April 30 for all 3 years. Ro-till tillage treatment depths of 7-8, 11-12, and 14-15 inches were done at the time of planting at all three locations. Soybeans were planted as a separate operation following the use of the Ro-till. Prior to tillage in the spring of each year, dry fertilizer (0-17-34) at 45 and 90 lb/acre of P_20_5 and K_20, respectively, was applied to all plots except the Ro-till fertilizer placement treatment plots. The fertilizer in the Ro-till fertilizer placement plots was applied as a liquid suspension of K_2HPO_4 and KCl, equivalent to the dry fertilizer rates. The liquid fertilizer suspension was injected to the depths (7-8, 11-12, and 14-15 inches) of Ro-till tillage treatments. Roundup@ + X-77® surfactant at 1.0 lb ai/acre + 0.5 percent viv was applied as a burndown herbicide application to no-till, all Paraplow, and Ro-till treatments 7-14 days prior to planting. The conventional tillage and Paraplow plots were smoothed with a do-all (an implement equipped with a rolling cutter bar and section harrow) prior to planting soybeans. Soybean planting dates for 1985-87 ranged from May 31 to June 5 at both Northeast and Pontotoc locations and from June 5 to June 26 at the Brown Loam Station. Centennial soybeans were planted at all locations with

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a John Deere Max-Emerge® no-till planter equipped with ripple coulters. Seeding rate was 7 seeds per linear foot of 30-inch row.

Weed control during the soybean growing season was with postmergence herbicides at Pontotoc and Raymond, and preemergence herbicides plus a post-directed spray at Verona. (Table 1). None of the plots at any locations were cultivated during the soybean growing season. All materials used and operations performed on each treatment were recorded for each location. The two center rows of each plot were harvested with a small plot combine for seed yield. The seed was weighed and seed moisture was determined with a Dickey John GAC II® grain analysis computer and recorded. Yield data were calculated and adjusted to 13 percent moisture and averaged over 3 years of the study.

Economic Analysis

The economic analysis was based on short-term returns to land and management. The total expenses did not include a charge for land, management, and general farm overhead. A dollar value was not included in the economic comparisons for the long-term effect of these tillage systems on soil erosion and soybean yield.

Soybean budgets were developed for each tillage system at the three locations using an economic computer budget generator (12). Net returns were based on 3-year average yield obtained from field studies (1985-87) at all locations (Table 4). Rates of application for all variable inputs were those described in the materials and methods section. The soybean price used in the budgets was $5.32/bu, the statewide average price received by farmers in Mississippi during 1985-86 (7). Costs of variable inputs and machinery were based on 1986 prices paid by Mississippi farmers. In constructing the budgets, performance rates on all field operations were based on 8-row equipment with associated power units. Primary tillage implement widths were 16-foot wide chisel plow, 10-foot wide Ro-till, and 5-foot wide Paraplow. The hourly wage rate was $4.50/hour. Interest on operating capital was computed at 10 percent annual percentage rate.

Results and Discussion

Fixed Costs

Fixed costs for these systems ranged from about $19 to $25/acre (Table 2). Due to fewer implements needed, the no-till production system fixed costs at all locations were about $4 to $7/acre less than chisel + disk, Paraplow, and Ro-till. Fixed costs for Paraplow and Ro-till implements were about the same as the chisel + disk system.

Direct Costs

Direct costs (Table 3) ranged from $97 to $140/acre and were higher for both Pontotoc and Raymond than Verona. The higher costs at both Pontotoc and Raymond were associated with the postemergence herbicide system for weed

Table 1. Herbicides and time of application for weed control in reduced tillage system studies at three locations, 1985-87.

Time of Application*	Location: Verona Herbicide	Verona lb ai/a	Pontotoc-Raymond Herbicide	Pontotoc-Raymond lb ai/a
Burndown	Roundup + x-77	1.0 + 0.5%	Roundup + x-77	1.0 + 0.5%
PRE-E	Dual + Scepter	2.00 + 0.125	—	—
POT	—	—	Poast + Blazer + Crop Oil	0.20 + 0.38 + 1 qt
P-Dir	Sencor + 2.4-DB	0.25 + 0.20	—	—

*Time of application code: Burndown was applied 7 to 14 days before planting; PRE-E = preemergence application made following soybean planting; POT = postemergence over-top application as tank mixtures, twice during soybean growing season; and P-Dir = post-directed application to soybeans 8 to 12 inches tall as a broadcast application.

Table 2. Estimated 1987 fixed costs for reduced tillage systems on three soil resource areas.

Reduced tillage treatment	Tillage depth (in)	Location: Verona	Pontotoc	Raymond
		$/acre		
Chisel + Disk	6-8	24.67	24.37	24.37
No-till	—	19.00	19.32	19.32
Paraplow	4-6	24.50	24.38	24.38
Paraplow	6-8	25.32	25 20	25.20
Paraplow	12-14	26.20	26 09	26.09
Ro-till	7-8	23.98	23.59	23.59
Ro-till	11-12	24.58	24.12	24. I2
Ro-till	14-15	25.37	24.72	25.72
Ro-till	7-8*	23.63	23.06	23.06
Ro-till	11-12*	24.35	23.77	23.77
Ro-till	14-15*	25.30	24.49	24.49

*Depth of fertilizer placement and tillage

Table 3. Estimated 1987 direct costs for reduced tillage systems on three soil resource areas.

Reduced tillage treatment	Tillage depth (in)	Location: Verona	Pontotoc	Ravmond
		$/acre		
Chisel + Disk	6-8	96.99	116.37	116.37
No-till	—	110.22	131.17	130.05
Paraplow	4-6	117.99	137.58	137.58
Paraplow	6-8	118.97	138.70	138.22
Paraplow	12-14	120.11	140.03	139.07
Ro-till	7-8	115.55	135.94	136.10
Ro-till	11-12	116.39	137.75	137.11
Ro-till	14-15	117.63	138.13	136.85
Ro-till	7-8*	113.95	134.60	134.44
Ro-till	11-12*	115.20	135.19	134.87
Ro-till	14-15*	116.23	135.79	135.15

*Depth of fertilizer placement and tillage.

control. The preemergence herbicide followed by a post-directed spray application at Verona was less costly than the all-postemergence system at Pontotoc and Raymond. Due to the burndown herbicide application, no-till, Ro-till, and Paraplow direct costs were higher than those for chisel + disk at all locations. No-till, however, had a lower direct cost than Paraplow and Ro-till. These higher direct costs were related to additional labor and fuel involved in the tillage operation for the Paraplow and Ro-till. Direct costs for Paraplow were slightly higher than Ro-till due to the use of a do-all prior to planting

Table 4. Estimated total expenses, gross income and net returns for reduced tillage systems on three soil resource areas, 1987.

	Reduced tillage treatment	Depth (in)	3-yr av yield Bu/a	Gross income $/a	Total expenses' $/a	Net returns $/a
		Verona				
1.	Chisel + Disk	6-8	38	202.03	121.66	80.37
2.	No-till	—	33	175.45	129.22	46.23
3.	Paraplow	4-6	36	191.40	142.49	48.91
4.	Paraplow	6-8	37	196.72	144.29	52.43
5.	Paraplow	12-14	38	202.03	146.31	55.72
6.	Ro-till	7-8	30	159.50	139.53	19.97
7.	Ro-till	11-12	31	164.82	140.97	23.85
8.	Ro-till	14-15	33	175.45	143.00	32.45
9.	Ro-till	7-8*	30	159.50	137.58	21.92
10.	Ro-till	11-12*	33	175.45	139.55	35.90
11.	Ro-till	14-15*	33	175.45	141.53	33.92
		avg	34	179.80	138.74	41.06
		Pontotoc				
1.	Chisel + Disk	6-8	33	175.45	140.74	34.71
2.	No-till	—	33	175.45	150.49	24.96
3.	Paraplow	4-6	31	164.82	161.96	2.86
4.	Paraplow	6-8	33	175.45	163.90	11.55
5.	Paraplow	12-14	35	186.08	166.12	19.96
6.	Ro-till	7-8	32	170.13	159.46	10.67
7.	Ro-till	11-12	39	207.35	161.87	45.48
8.	Ro-till	14-15	37	196.72	162.85	33.87
9.	Ro-till	7-8*	34	180.77	157.66	23.11
10.	Ro-till	11-12*	33	175.45	158.96	16.49
11.	Ro-till	14-IS*	32	170.13	160.28	9.85
		avg	34	179.80	158.57	21.23
		Raymond				
1.	Chisel + Disk	6-8	33	175.45	140.74	34.71
2.	No-till	—	26	138.23	149.37	-11.14
3.	Paraplow	4-6	31	164.82	161.96	2.86
4.	Paraplow	6-8	30	159.50	163.92	-3.92
5.	Paraplow	12-14	29	154.18	165.16	-10.98
6.	Ro-till	7-8	33	175.45	159.62	15.83
7.	Ro-till	11-12	35	186.08	161.23	24.85
8.	Ro-till	14-15	29	154.18	161.57	-7.39
9.	Ro-till	7-8*	33	175.45	157.80	17.95
10.	Ro-till	11-12*	31	164.82	158.64	6.18
11.	Ro-till	14-15*	28	148.87	159.64	-10.77
		avg	31	163.37	158.12	5.28

[1]Total expenses did not include a charge for land, management, and general overhead

*Depth of fertilizer placement.

Net Returns

Three-year soybean yields, averaged over tillage systems (Table 4), were 34 bu/acre for both Pontotoc and Verona, and 31 bu/acre for Raymond. Gross returns, averaged over tillage systems, were $179.80/acre for both Pontotoc and Verona, and $163.37acre for Raymond. Net returns, averaged over tillage systems, were $41.06, $21.23, and $5.28/acre for Verona, Pontotoc, and Raymond, respectively. The higher net return to land, management, and general farm overhead at Verona than Pontotoc was due to lower direct costs for weed control. Lower net returns at Raymond than Pontotoc were due to lower yield.

At Verona, the chisel + disk treatment had the lowest total expenses, produced the highest gross income, and had the highest net return of $80.37/acre. The Paraplow 12 to 14-inch depth produced the same gross income as chisel + disk, but had $25/acre more total expenses than chisel + disk, and resulted in net returns of $55.72/acre. The Ro-till 11 to 12-inch depth surface-incorporated fertilizer, produced 7 bu/acre less than Paraplow and chisel + disk, had total expenses of $140.97/acre, and showed a net return of $23.8S/acre. The deepest depth of Ro-till (fertilizer surface-incorporated) and Paraplow produced about $12/acre and $7/acre more than the shallowest depths, respectively. Fertilizer placed to the depth of Ro-till tillage generally showed slightly higher net return than surface broadcast and incorporated with Ro-till.

At the Pontotoc Flatwoods soil resource area, total expenses ranged From $140.74/acre for chisel + disk to $166.12/acre for the Paraplow 12 to 14-inch depth. The Ro-till (fertilizer surface-incorporated) 11 to 12-inch depth produced the highest gross income of $207.3S/acre. Both chisel + disk and no-till produced gross incomes of $175,45/acre. Net returns for no-till and chisel + disk were $24.96/acre and $34.71/acre, respectively. Net return for the Ro-till 11 to 12-inch depth surface-incorporated Fertilizer was $45.48/acre, or about $10/acre and $20/acre more than chisel + disk and no-till, respectively. Deeper tillage depths with the Paraplow showed highcr net returns. The 12 to 14-inch depth produced a return of $19.96/acre in comparison to $11.55/acre and $2.86/acre for 7 to 8 and 4 to 6-inch depths, respectively.

Fertilizer injected to the depth of Ro-till tillage generally showed lower net return than fertilizer surface-incorporated with the Ro-till. However, the Ro-till 7 to 8-inch injected fertilizer depth was the only treatment that showed higher net return than fertilizer applied surface broadcast and incorporated with the Ro-till.

At the Brown Loam Station, the Ro-till 11 to 12-inch depth produced the highest 3-year average yield of 35 bu/acre, but showed net returns of $24.85/acre, about $10/acre less return than chisel + disk net return of $34.71/acre. The no-till and both Paraplow tillage depths (6-8 and 12-14 in) produced negative returns of $11.14, $3.92, and $10.98/acre, respectively.

Fertilizer injected to depth of tillage with the Ro-till genera-

ly produced lower net returns than surface applied and incorporated with Ro-till. However, the Ro-till 7 to 8-inch depth was the only Ro-till tillage depth which produced higher net return for injected fertilizer than surface-incorporated fertilizer.

Summary

Economic analyses were based on short-term returns to land and management. Total expenses did not include a charge for land, management, and general farmoverhead. No constraints were placed on farm size for the complement of reduced tillage systems used in this study.

Soybean reduced tillage systems that were evaluated indicated no-till had a lower fixed cost than all other reduced tillage systems at all locations. Fixed costs for Paraplow and Ro-till were about $l/acre more than chisel + disk. The chisel + disk system had lower direct and total expenses than no-till, Paraplow, and Ro-till at all locations. The direct costs of about $20/acre less at Verona than at both Pontotoc and Raymond was related to the different herbicides used for weed control. Pontotoc and Verona, averaged over reduced tillage systems, produced the same gross income — about $16/acre more than at Raymond. Net returns, however, were about $20/acre more at Verona than Pontotoc due to lower herbicide expenses. The Raymond location had the lowest yield average and net returns averaged about $5/acre.

Economic analysis indicated that the chisel + disk system produced the highest net return of all tillage treatments at both the Brown Loam and Northeast Stations. On the Flatwoods soil at the Pontotoc Station, the Ro-till 11 to 12-inch depth with surface-incorporated fertilizer produced the highest net returns of all treatments. Fertilizer placement depth effect on net returns interacted with location and depth. All Ro-till injected fertilizer treatments at Verona produced higher net return than surface applied fertilizer incorporated with the Ro-till. However, at both Pontotoc and Raymond, the Ro-till7 to 8-inch depth was the only treatment showing higher returns for injected fertilizer than surface-incorporated.

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