Impacts of Farm Size and Tenure on the Profitability of No-Till Rice Production in Arkansas

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ABSTRACT

Rice in Arkansas is typically produced using intensive tillage. No-till rice has been studied, but the research focus has been limited to impacts on yields and per acre net returns. Impacts of farm size and tenure on no-till profitability could not be evaluated in these studies. This analysis evaluates the profitability of no-till rice at the whole-farm level using both enterprise budget analysis and linear programming. The results indicate that no-till management can be profitable for Arkansas rice production due to savings in machinery ownership expenses resulting from less dependence on land preparation equipment prior to planting. Large operations may benefit more from no-till than smaller operations due to a combination of size economies that arise from spreading machinery inputs over more acres and lower machinery ownership expenses for no-till relative to conventional till management. No-till economic benefits may be greater on rented land than on owned land due to the nature of current rental arrangements used in Arkansas rice production. Greater economic benefits of no-till on rented land appears to be due to a combination of lower ownership expenses from less land-preparation equipment in the machinery complement and lower irrigation-ownership expenses due to use of irrigation wells that are supplied and maintained by the landlord.

INTRODUCTION

Most rice production in Arkansas involves intensive cultivation. Fields are “cut-to-grade” every few years and disked and “floated” (land planed) annually in early spring to ensure smooth water movement across the field. Conventional tillage accounts for nearly two-thirds of all planted rice acres, while stale seedbed (seedbed preparation in fall followed by burn-down herbicides prior to planting in the spring) accounts for over a quarter of all planted rice acres. True no-till (rice planted directly into the previous crop residue without tillage at any time) accounts for 10 percent of planted rice acres in Arkansas (Wilson and Branson, 2004).

Siltation is the primary pollutant identified for most eastern Arkansas waterways (ADEQ, 2002), and conservation practices like no-till will likely be recommended as remedial mechanisms. The economics of no-till management in rice have not been fully explored. Economic studies of the subject (Pearce et al., 1999; Smith and Baltazar, 1992; Watkins et al., 2004) have been limited to enterprise budget analyses based on experimental plots and have produced mixed findings. A shortcoming of such studies is that production costs from plot research often poorly reflect true machinery costs observed for typical commercial farms. Also, operation size and tenure are ignored in these studies. The objectives of this study were to evaluate the profitability of no-till relative to conventional till rice and determine the impacts of farm size and tenure on no-till rice profitability at the whole farm level.

PROCEDURES

This study compares the profitability of no-till to conventional till rice management for a medium rice farm (1200 acres) and a large rice farm (2400 acres) growing both rice and soybeans in a two-year rotation. Machinery complements were developed for both operation sizes under conventional till (CT) and no-till (NT). The machinery complements were constructed based on actual equipment observed in Arkansas rice production and closely tied to timing for completion of land preparation, planting, and harvesting operations.

Ownership expenses (depreciation, interest, taxes, insurance, and housing) for machinery-complement items were calculated based on American Society of Agricultural Engineers machinery standards formulas (ASAE, 2003a,b). Depreciation in particular was estimated for each item based on current list prices and remaining value equations that account for both machinery age and annual usage. Operating expenses for each rice and soybean enterprise were calculated using the Mississippi State Budget Generator (MSBG). The machinery labor, fuel, and repairs and maintenance expenses used in the MSBG corresponded with the timing of operations, annual use hours, and performance rates (hours/acre) of items in each machinery complement. Other operating expenses (seeds, fertilizer, pesticide, custom application) were based on production inputs obtained from an ongoing long-term rice-based cropping systems study at Stuttgart, Ark. (Watkins et al., 2004).

Net returns were calculated as gross returns (price x yield) less operating and ownership expenses. Five-year season average market prices for rice ($2.37/bu) and soybeans ($5.60/bu) for the period 1999 to 2003 were used as expected prices in the study. A five-year average loan deficiency payment of $1.25/bu was added to the rice market price to obtain a total cash price of $3.62/bu for rice. Hauling and drying expenses of $0.42/bu rice and $0.15/bu soybean were subtracted from expected prices to account for per unit custom charges. Average yields for the period 2000 to 2003 were obtained from the long-term cropping systems study to represent expected yields for rice and soybeans under conventional till and no-till management using standard fertility treatments.

Per-acre net returns were calculated for both owned and rented cropland under no-till and conventional till management. Net returns to rented cropland were calculated using the typical 25 percent straight-share arrangement (Parsch and Danforth, 1994). In this arrangement, the landlord receives 25 percent of the crop, pays 25 percent of the custom hauling and drying charges associated with the crop, and pays 100 percent of all belowground irrigation expenses (well, pump, and gearhead). The farm operator receives 75 percent of the crop, pays 75 percent of the custom drying and hauling expenses related to the crop, pays 100 percent of all aboveground irrigation expenses (power unit, fuel), and pays 100 percent of all other production expenses.

Linear programming models were constructed for each farm size to evaluate the whole-farm profitability of no-till relative to conventional till management for typical Arkansas rice farms growing both rice and soybeans in a two-year rotation. The objective functions of each LP model maximized whole farm returns to CT and NT subject to constraints on total cropland available, owned cropland, and rented cropland. Buying activities for labor and diesel fuel were incorporated into each LP model to evaluate the impact of different wage rates and fuel costs on whole-farm profitability.

RESULTS AND DISCUSSION

Returns and Expenses by Operation Size and Tenure

Per-acre returns and expenses by operation size and crop for owned and rented cropland are presented in Table 1. Gross returns are lower for NT compared with CT due to lower expected rice and soybean yields for no-till relative to conventional till at Stuttgart, Ark., over the 2000 to 2003 period (184 bu/acre conventional till rice vs. 173 bu/acre no-till rice; 46 bu/acre conventional till soybeans vs. 42 bu/acre soybeans). Operating (variable) expenses for rice and soybeans are slightly lower for NT compared with CT due to lower diesel fuel costs, repairs and maintenance costs, and labor costs resulting from fewer machinery operations devoted to land preparation under no-till management. However, much of these cost savings are offset by higher herbicide application costs for no-till relative to conventional till management.

Operating expenses vary little across operation size and remain invariant for owned and rented cropland since the farm operator pays virtually all of the operating expenses in a typical straight-share arrangement. However, ownership (fixed) expenses vary considerably by operation size, tillage, and tenure. Per-acre ownership expenses decline in every case when going from 1200 acres to 2400 acres due to size economies resulting from spreading machinery inputs over more acres. Per-acre ownership expenses also decline when going from CT to NT due to less land preparation equipment in the machinery complement for NT. Finally, ownership expenses decline when going from owned to rented land due to all belowground irrigation expenses being paid by the landlord rather than the farm operator in a straight-share arrangement.

Net returns to the farm operator tend to vary most by operation size. Per-acre net returns to rice, soybeans, and the farm increase when going from 1200 acres to 2400 acres due to size economies resulting from spreading machinery across more acres. Net returns to the farm operator are also impacted by tenure. Per-acre net returns to the farm are nearly the same across tillage treatments on owned land. However, per-acre net returns to NT are larger than those to CT on rented land. This is due in large part to a combination of lower ownership expenses for NT resulting from less land preparation equipment in the machinery complement and lower irrigation ownership expenses resulting from the farm operator's use of irrigation wells supplied and maintained by the landlord.

Per-acre net returns to the landlord for a typical 25 percent straight-share rental arrangement are reported for comparison purposes in the last column in Table 1. Net returns to the landlord are invariant by operation size since these returns are derived primarily from the share of the crop and therefore are driven primarily by crop yields. Since expected crop yields in this study are lower for no-till than for conventional till management, per-acre net returns to the landlord for NT are smaller than those for CT.

Linear Programming Results

Optimal LP net-return solutions for a 1200-acre rice operation under CT and NT are presented in Table 2. Solutions are reported for four scenarios: 1) the "Base Solution," in which the price of diesel and the labor wage are held at levels reported in 2004 Arkansas crop budgets ($0.90/gal diesel; $6.70/hour labor); 2) a "High Fuel Cost" scenario, in which the price of off-road diesel is raised to levels observed in Arkansas during the latter part of 2004 ($1.63/gal); a "High Labor Cost" scenario, in which the per-hour labor wage rate is raised to the level reported by the Arkansas Agricultural Statistics Service for Arkansas field workers in 2004 ($8.12/hour); and 4) a "High Fuel and Labor Cost" scenario where the price of diesel and the wage rate are the same as those in scenarios 2 and 3 above. Optimal solutions for each scenario were generated assuming 32 percent of total cropland acres are owned and 68 percent rented. These percentages were calculated using tenure data from the 2002 Census of Agriculture for counties comprising the Arkansas Grand Prairie region (Arkansas, Lonoke, Monroe, and Prairie Counties).

The optimal solutions for the 1200-acre operation are similar across tillage practices under the Base scenario. The NT strategy is slightly more profitable than CT under the Base scenario (+$3,333). The larger return for NT is totally attributable to higher returns on rented cropland, where NT nets $4,127 more return than CT. The NT strategy earns $794 less return on owned acres relative to CT under the Base scenario.

An increase in wage rate from $6.70/hour to $8.12/hour produces similar results relative to the Base Scenario. Under the High Labor Cost scenario, the NT strategy earns slightly more return for the 1200-acre operation when compared to the CT strategy (+$5,165). Again, the larger return for NT is attributed exclusively to higher returns on rented cropland, where NT nets $5,372 more return than CT. The NT strategy earns $208 less return on owned acres relative to CT under the High Labor Cost scenario.

Return differences between NT and CT are much larger for the 1200-acre operation under the High Fuel Cost scenario and the High Fuel and Labor Cost scenario. Under the former scenario NT earns $7,358 more return than CT, while under the latter scenario NT earns $9,190 more return than CT. In both cases, NT earns more return than CT on both owned and rented cropland, with the largest share of the return difference attributable to rented cropland.

Optimal LP net-return solutions for a 2400-acre rice operation under CT and NT are presented in Table 3. The optimal solution for NT is larger than that for CT in all four scenarios, with return differences ranging from +$18,603 under the Base scenario to +$31,551 under the High Fuel and Labor Cost scenario. The greater profitability of NT for the 2400-acre operation relative to the 1200-acre operation is due primarily to greater size economies for the larger farm operation. In all instances, NT earns more return than CT on both owned and rented cropland. However, as in the case of the 1200-acre operation, the largest share of the return difference is attributable to returns from rented cropland.

SIGNIFICANCE OF FINDINGS

The results of this study indicate that because of cost savings, no-till management can be profitable for Arkansas rice production. The primary cost savings of no-till are attributable to reduced ownership expenses resulting from less dependence on land preparation equipment. Operating-expense savings are also evident for no-till in the form of lower fuel, repair and maintenance, and labor expenses resulting from fewer land preparation operations prior to planting. However, a large portion of these cost savings is offset by higher herbicide application costs for no-till compared with conventional till management.

Operation size has a large impact on the profitability of no-till rice management. Larger operations may benefit more from no-till than smaller operations due to greater size economies resulting from more efficient use of machinery. No-till management may magnify size economics that are already present in large operations by further lowering per-acre ownership costs. Tenure also has a major impact on the profitability of no-till management in Arkansas rice production. The economic benefits from no-till management may be greater on rented land than on owned land given the structure of rental arrangements used in Arkansas rice production. On rented land, the farm operator benefits from use of irrigation wells that are supplied and maintained by the landlord. The landlord pays these "belowground" expenses. Thus, the farm operator's ownership expenses are lower on rented acres than on owned acres. No-till further magnifies ownership cost savings on rented acres by further reducing ownership costs associated with land preparation.

The current structure of rental arrangements in Arkansas rice production may act as a deterrent to no-till adoption. Crop-share arrangements are the primary rental strategies used in Arkansas rice production, and the landlord's return is driven primarily by crop yields. Since cost savings from no-till accrue exclusively to the farm operator in these arrangements, the landlord benefits only if crop yields increase. Ancillary evidence from agronomic studies suggests that no-till crop yields are generally lower or not significantly different from conventional-till crop yields in rice production, at least in the short run (Bollich, 1991; Cartwright et al., 1998; Pearce et al., 1999; Smith and Baltazar, 1992). Crop yields in this study were slightly lower for no-till than for conventional till, and corresponding per-acre net returns to the landlord were also slightly lower. Thus adjustment may be required in current rental arrangements to allow landlords to receive some of the economic benefits of no-till management.

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Table 1. Per-acre returns and expenses for 1200- and 2400-acre Arkansas rice farms producing rice and soybeans in a two-year rotation.

		Owned				Rented				
Enterprise	Tillage	Gross return	Operating expenses	Ownership expenses	Net return	Gross return	Operating expenses	Ownership expenses	Net return	Landlord's net return
1200-acre operation		($/acre)								
Rice	CT[z]	588.80	196.38[y]	83.17	309.25	441.60	193.26	73.88	174.46	134.79
	NT	553.60	192.49	62.47	298.64	415.20	189.37	53.18	172.65	125.99
Soybean	CT	250.70	141.39	73.41	35.90	188.03	140.46	64.12	-16.55	52.45
	NT	228.90	133.41	53.12	42.37	171.68	132.47	43.83	-4.63	47.00
Farm[x]	CT	419.75	168.88	78.29	172.58	314.81	166.86	69.00	78.96	93.62
	NT	391.25	162.95	57.80	170.51	293.44	160.92	48.50	84.01	86.50
2400-acre operation		($/acre)								
Rice	CT	588.80	194.48	67.88	326.44	441.60	191.36	58.59	191.65	134.79
	NT	553.60	187.13	46.16	320.31	415.20	184.01	36.87	194.32	125.99
Soybean	CT	250.70	140.92	64.00	45.78	188.03	139.98	54.71	-6.67	52.45
	NT	228.90	130.04	42.33	56.53	171.68	129.10	33.04	9.53	47.00
Farm	CT	419.75	167.70	65.94	186.11	314.81	165.67	56.65	92.49	93.62
	NT	391.25	158.58	44.25	188.42	293.44	156.56	34.95	101.93	86.50

[z] CT = Conventional Till; NT = No-Till.
[y] Owned and rented operating expenses calculated assuming a labor wage of $6.70/hour and a diesel price of $0.90/gal.
[x] Per-acre farm returns and expenses are calculated as one-half acre rice plus one-half acre soybean.

Table 2. Linear programming net-return optimal solutions for 1200-acre Arkansas rice farm producing rice and soybeans in a two-year rotation.

Optimal solution	CT[z]	NT	Difference
Diesel price = $0.90/gal, Labor = $6.70/hour (Base solution)			
Farm[y]	130,699	134,032	3,333
Owned return	66,270	65,476	-794
Rented return	64,429	68,556	4,127
Diesel price = $1.63/gal, Labor = $6.70/hour (High fuel cost)			
Farm	104,498	111,856	7,358
Owned return	57,885	58,379	494
Rented return	46,613	53,476	6,864
Diesel price = $0.90/gal, Labor = $8.12/hour (High labor cost)			
Farm	125,263	130,428	5,165
Owned return	64,530	64,322	-208
Rented return	60,733	66,105	5,372
Diesel price = $1.63/gal, Labor = $8.12/hour (High fuel and labor costs)			
Farm	99,062	108,252	9,190
Owned return	56,146	57,226	1,080
Rented return	42,916	51,026	8,109

[z] CT = Conventional Till; NT = No-Till.
[y] Assumes 32 percent of total cropland acres are owned and 68 percent are rented.

Table 3. Linear programming net-return optimal solutions for 2400-acre Arkansas rice farm producing rice and soybeans in a two-year rotation.

Optimal solution	CT[z]	NT	Difference
Diesel price = $0.90/gal, Labor = $6.70/hour (Base solution)			
Farm[y]	292,448	311,051	18,603
Owned return	142,935	144,708	1,773
Rented return	149,513	166,344	16,830
Diesel price = $1.63/gal, Labor = $6.70/hour (High fuel cost)			
Farm	238,233	266,699	28,467
Owned return	125,586	130,515	4,929
Rented return	112,647	136,184	23,538
Diesel price = $0.90/gal, Labor = $8.12/hour (High labor cost)			
Farm	282,173	303,860	21,687
Owned return	139,647	142,406	2,760
Rented return	142,526	161,454	18,928
Diesel price = $1.63/gal, Labor = $8.12/hour (High fuel and labor costs)			
Farm	227,957	259,508	31,551
Owned return	122,298	128,214	5,916
Rented return	105,660	131,295	25,635

[z] CT = Conventional Till; NT = No-Till.
[y] Assumes 32 percent of total cropland acres are owned and 68 percent are rented.