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Economic analysis of no tillage and minimum tillage cotton-corn rotations in the Mississippi Delta

Steven W. Martin [a,*], James Hanks [b]

[a] Mississippi State University, Delta Research and Extension Center, P.O. Box 69, Stoneville, MS 38776, United States
[b] USDA/ARS, 197 Stoneville Road, Stoneville, MS 38776, United States

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ABSTRACT

Crop rotations have been shown to have agronomic benefits. An increasingly common crop rotation in the Mid-South is cotton rotated with corn. Many previous studies have focused on tillage systems or crop rotations. Few have evaluated a combination of the two (crop rotations and tillage) especially from an economics perspective. Field studies were conducted at Stoneville, MS for the period 2001–2006. Treatments included no till continuous cotton, minimum till continuous cotton, one year corn followed by two years cotton no till, one year corn followed by two years cotton minimum till, one year corn-one year cotton no till and one year corn-one year cotton minimum till. Results revealed that cotton yields were increased in all four systems rotated with corn. Lower risk was associated with minimum till cotton. Gross returns were higher in a monoculture minimum till cotton system. Net returns were larger in a system that included minimum tillage and a corn rotation. The highest net returns and lowest risk were obtained from a minimum till system of cotton rotated with corn every other year. For those producers required to use a no till system, a one year corn-two year cotton rotation provided the highest net returns and least risk.

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1. Introduction

Crop rotations have been shown to have agronomic benefits for several years (Spurgeon and Grissom, 1965; Kurtz et al., 1987; Ebelhar and Welch, 1989; Bechel et al., 2000). An increasingly common crop rotation in the Mid-South is cotton rotated with corn. In addition to the agronomic benefits, crop rotations are often considered for the economic benefits as well. The recent interest in ethanol production as a result of high petroleum prices has led many producers to consider corn as an alternate crop. Previous studies have suggested cotton produced the first year after a corn crop to have yield advantages as high as 12% compared to continuous cotton and a 6% increase in yield for cotton the second year after a corn crop (Martin et al., 2002).

Additionally, the aforementioned increases in fuel prices have renewed interest in reduced tillage systems previously considered for conservation reasons but now considered for economic reasons as well. Cotton production in some areas has switched to no till and/or conservation tillage due to mandates associated with highly erodible soils. Other cotton growing areas have begun using less tillage as a means to cut production costs. Conventional farming methods (sub-soiling, disking, cultivating, etc.) often require 7–10 trips across the field for field preparation and weed control (Delta Planning Budgets, 1999). As production costs have risen (diesel fuel in 1999 was $0.64 per gallon versus $2.41 in 2007, [Delta Planning Budgets, 1999, 2007]), producers have sought alternative methods to produce cotton.

Previous studies have focused on tillage systems or crop rotations. Few have evaluated a combination of the two (crop rotations and tillage) especially from an economics perspective. This study evaluates and compares two tillage systems (no till and minimum till) in combination with three cropping systems (continuous cotton, two years cotton following a corn crop and a one year cotton-one year corn rotation).

2. Materials and methods

Field studies were conducted at Stoneville, MS for the period 2001–2006. Land area was approximately 80 acres with cotton grown on 38 inch row spacings. Plots were 64 rows wide and 825 feet in length. Soils consisted of Tunica clay, Dundee silty clay loam and Bosket/Dundee very fine sandy loam. Treatments were no till continuous cotton (NTC), minimum till continuous cotton (MTC), one year corn followed by two years cotton, no till (CORN/NTC/

* Corresponding author. Tel.: +1 662 686 3234; fax: +1 662 686 7336.
E-mail address: smartin@ext.msstate.edu (S.W. Martin).

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NTC), one year corn followed by two years cotton, minimum till (CORN/MTC/MTC), one year corn, one year cotton no till (CORN/NTC/CORN) one year corn, one year cotton minimum till (CORN/MTC/CORN).

The no till treatments consisted of no tillage during fall or spring. The minimum tillage treatments consisted of fall bed preparation and spring drainage preparation. Nitrogen fertilizer was applied with an eight-row coulter-type applicator (Bell, Inc., Inverness, MS Model 3pt-88JB-HF), and was consistent on all plots.

Furrow irrigation was used to supply supplemental water to the entire test each year as needed. Irrigation was accomplished by applying water through 15 inch diameter poly pipe with outlets at every other furrow. The poly pipe was located at the west side of the field, and water flowed from west to east.

Cotton yield data were collected with an AgLeader Model PF3000 Pro yield monitor installed on a John Deere Model 9965 four-row cotton picker. Cotton from each plot was weighed in the field using a boll buggy equipped with load cells (Short Line, Mfg., Shaw, MS) to verify and calibrate the yield monitor data. Corn was harvested with a four-row John Deere 9410 combine equipped with a Green Star yield monitor. Corn from each plot was weighed in the field using a Grain-Weigh (Par-Kan Company, Silver Lake, IN) grain cart equipped with Weigh Tronix™ Scale System.

All other inputs were supplied consistently to all plots as normal production practices with commercial size equipment. Treatments were established with three replications of the six treatments. Treatments remained in the same plots throughout the duration of the study.

All production data were entered into the Mississippi State University Budget Generator (MSBG) in order to calculate net returns (Laughlin and Spurlock, 2006). The MSBG is the program used to prepare the Mississippi State University enterprise planning budgets. Budgets were developed for each treatment over the six years of the study based 2006 input prices. Within the budgets, both direct and total specified expenses per acre for the specified tillage and cropping practices were calculated. Total specified expenses included all direct and fixed production expenses (assuming full utilization of equipment) related to tillage, seed-bed preparation, stalk shredding, seeding, fertilizer, insecticide and herbicide application, including interest expense, labor and fixed costs of equipment ownership, but did not include any other general farming expenses. Returns are reported as average returns over the six year study period to include both cotton and corn returns per acre for each of the treatments. Returns for each of the treatments were calculated using 10 year season average prices from the National Agricultural Statistics Service (NASS) with the national loan rates of $0.52 per pound of lint and $1.95 per bushel of corn substituted in years where the NASS prices were below the loan. Net returns were calculated as returns minus total specified costs. A mean–standard deviation analysis was conducted for each of the systems to evaluate the risk-return levels associated with each of the production systems. Risk-return analysis is often used to rank a set of alternatives based on the trade-off between mean returns and risk (Robison and Barry, 1987). Additionally, net returns are compared at current prices to evaluate the sensitivity of the obtained results to adjustment in crop prices.

3. Results and discussion

As can be seen in Table 1, cotton yields were greater in the cotton-corn rotational plots. This is similar to the results of previous research (Martin et al., 2002) that suggested that cotton following corn produced higher yields compared to continuous cotton. The highest cotton yields were in treatments that rotated corn with cotton on a one year to one year basis followed by treatments where a corn crop was followed by two years of cotton. The lowest cotton yields were in the monoculture cotton treatments.

Table 1
Average treatment yields for the period 2001–2006, Stoneville, MS

Treatment	Yield	
	Cotton (lbs of lint per acre)	Corn (bu. per acre)
NTC	992[a]	–
MTC	1006[a]	–
Corn/NTC/NTC	1097[b]	174[a]
Corn/MTC/MTC	1096[b]	173[a]
Corn/NTC/Corn	1138[c]	172[a]
Corn/MTC/Corn	1182[c]	188[b]

No till continuous cotton (NTC).
Minimum till continuous cotton (MTC).
One year corn followed by two years cotton, no till (CORN/NTC/NTC).
One year corn followed by two years cotton, minimum till (CORN/MTC/MTC).
One year corn, one year cotton no till (CORN/NTC/CORN).
One year corn, one year cotton minimum till (CORN/MTC/CORN).
[abc]Superscripts indicate significant yield differences at the 5% level.

Table 2
Average treatment net returns per acre from 2001–2006, Stoneville, MS

Treatment	Average returns ($)
NTC	565.64
MTC	573.56
CORN/NTC/NTC	548.32
CORN/MTC/MTC	546.80
CORN/NTC/CORN	535.37
CORN/MTC/CORN	548.82

No till continuous cotton (NTC).
Minimum till continuous cotton (MTC).
One year corn followed by two years cotton, no till (CORN/NTC/NTC).
One year corn followed by two years cotton, minimum till (CORN/MTC/MTC).
One year corn, one year cotton no till (CORN/NTC/CORN).
One year corn, one year cotton minimum till (CORN/MTC/CORN).

Results from the six-year average enterprise budgets suggested that the highest returns were obtained, however, from the monoculture cropping systems. The highest returns were derived from the MTC treatment followed by the NTC treatment (Table 2). The CORN/NTC/CORN treatment with a one year corn and one year cotton rotation had the lowest returns.

When different crops are considered as well as different tillage systems total returns may be misleading. Table 3 shows the net returns associated with each of the treatments. The CORN/MTC/CORN treatment provided the highest net returns. Even though the average returns per acre were higher for the monoculture cotton

Table 3
Average treatment net returns per acre and standard deviations from 2001–2006, Stoneville, MS using historical commodity prices

Treatment	Net returns ($)	Standard deviation ($)
NTC	67.64	19.41
MTC	69.56	2.44
CORN/NTC/NTC	69.32	12.18
CORN/MTC/MTC	61.80	8.34
CORN/NTC/CORN	65.57	35.94
CORN/MTC/CORN	72.82	16.18

No till continuous cotton (NTC).
Minimum till continuous cotton (MTC).
One year corn followed by two years cotton, no till (CORN/NTC/NTC).
One year corn followed by two years cotton, minimum till (CORN/MTC/MTC).
One year corn, one year cotton no till (CORN/NTC/CORN).
One year corn, one year cotton minimum till (CORN/MTC/CORN).

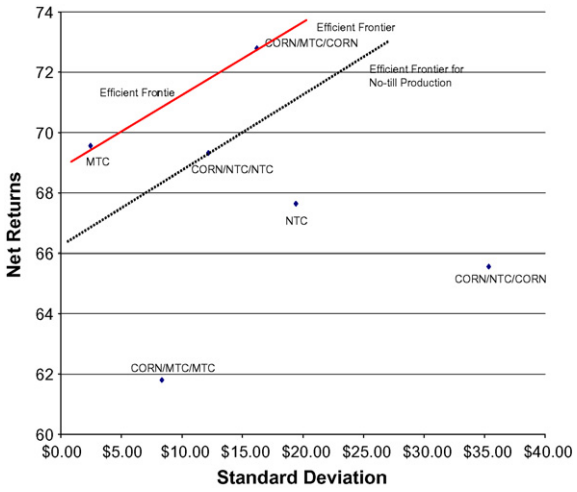

Fig. 1. Mean net returns and standard deviation comparison from 2001–2006, Stoneville, MS.

Table 4
Average treatment net returns per acre and standard deviations from 2001–2006, Stoneville, MS using current fertilizer commodity prices

Treatment	Net returns ($)	Standard deviation ($)
NTC	67.64	25.54
MTC	69.56	3.21
CORN/NTC/NTC	69.32	18.40
CORN/MTC/MTC	61.80	8.33
CORN/NTC/CORN	65.57	50.06
CORN/MTC/CORN	72.82	21.89

treatments, the increased cotton yields from the corn rotation combined with the lower production costs per acre associated with a corn crop every other year resulted in the largest average net returns per acre of any of the treatments. The lowest returns were associated with the CORN/MTC/MTC system. The added cost of tillage combined with two years of cotton production lowered net returns compared to any of the other systems.

The risk-return analysis of the six treatments revealed that the CORN/MTC/CORN treatment would likely be the preferred system (Fig. 1). The CORN/MTC/CORN treatment had the highest mean returns above treatment costs with less variance than the CORN/NTC/CORN and NTC treatments. More risk averse producers might choose the MTC treatment since it had less risk. The CORN/MTC/MTC treatment would not be preferred since it had more variance than the MTC treatment and lower net returns. Only the MTC and CORN/MTC/CORN treatments are on the efficient frontier (Fig. 1). If no till production was required, then the CORN/NTC/NTC treatment would be the preferred system.

When current crop prices ($5 per bushel for corn and $0.75 per pound of lint for cotton) were used, results did not change (Table 4). Obviously, the profitability of all treatments was increased. However, the rankings in terms of preferred treatments from a net returns standpoint did not change. When risk is considered, as measured by the standard deviation, again relative rankings did not change. As would be expected, higher mean values did result in larger standard deviations but preferred treatments did not change.

4. Conclusions

Six tillage-crop rotation systems were evaluated based on net returns and risk over a six-year period in the Mississippi Delta. Cotton yields were increased in all four systems rotated with corn as compared to monoculture cotton. Lower risk was associated with minimum till cotton in a monoculture system. Gross returns were higher in a monoculture minimum till cotton system, followed by a no till monoculture cotton system. Net returns, however, were larger in a system that included minimum tillage and a corn rotation. Results indicated that the highest returns and lowest relative risk were obtained from a minimum till system of cotton rotated with corn every other year. For those producers required to use a no till system, then a corn crop followed by two years cotton production provided the highest net returns and the lowest risk.

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