AN ECONOMIC ANALYSIS OF GEORGIA COTTON PRODUCTION WITHIN MULTIPLE-CROP TILLAGE SYSTEMS

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Abstract

The choice of tillage practice in cotton production can affect the overall profitability of the enterprise. A five-year study of three tillage practices commonly used in the Coastal Plain region of Southern Georgia compared input expenditures and net returns for cotton within a multi-crop production system. Changes in relative yields, input quantities, and relative expenditure levels are generated for each tillage practice and compared on a current price basis. The study period spans the treatment years of the Georgia Boll Weevil Eradication Program. Comparisons drawn among the study years can suggest the adjustment path for cotton production inputs and outputs under an eradication program. Some insights may also be provided on the expected revenue and expenditure effects from initiating an eradication program in other states when producers employ different tillage practices.

Introduction

Georgia cotton production acreage has increased dramatically in the early 90's following the implementation of a state-wide boll weevil eradication program (BWEP). Estimated Georgia cotton planted acreage in 1995 exceeded 1.5 million acres. Prior to the mid 80's, Georgia cotton acreage had been in a long term decline, from more than 700,000 acres in the early 60's to a low of 120,000 acres in 1983 (Georgia Agricultural Statistics Service 1995). Recent cotton acreage expansion has meant many new, first-time producers. And the BWEP success has given all cotton farmers an opportunity to reconsider their total production system. Environmental and economic concerns continue to prompt second thoughts about the use of chemical inputs. Erosion and crop residue issues suggest possible tillage adjustments. To make proper decisions when faced with these and other production decisions, cotton producers need accurate estimates of yield and costs under each available production system.

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Objective

A five-year cotton production study was conducted at the Coastal Plain Experiment Station, Tifton, Georgia, to compare the predominant multiple-crop systems, with primary emphasis on the effects of tillage practices. Yield, returns, and costs data were collected for each crop grown in the system to make both agronomic and economic comparisons among the systems, and to determine producer cost and net return changes that occurred during the BWEP years.

Literature Review

Economic studies of tillage systems have been conducted over numerous crops for many years. Martin et al. (1991) used linear programming to examine alternative tillage systems, crop rotations, and herbicide use in the East-Central Corn Belt. They found net farm incomes to be generally higher with moldboard plow versus chisel plow tillage systems for wheat-corn-soybean production. Halvorson et al. (1994) compared three winter wheat-fallow tillage systems in the Central Great Plains. Yields were not significantly different among the systems, but reduced-till and no-till practices generated net returns that equaled or exceeded net returns on conventional stubble-mulch tillage.

Tillage studies in cotton have shown 60% higher yields for strip tillage than no-till in North Carolina and no-till yields varying from 5% greater in North Carolina to 2% less in Alabama over conventional cotton production systems (York). Delta region comparisons between conventional tillage without a cover crop and no-till cotton plantings into a killed cover crop revealed consistently higher productivity and profits in the no-till system (Dabney). Cotton net returns for the Texas High Plains did not include conventional tillage in the optimal solution set (Segarra et al.). And a Southern Great Plains study of conservation tillage systems in cotton found profits/hectare from both dryland and irrigated no-tillage systems to exceed the traditional practice of repeated glyphosate applications and conventional disk tillage (Wiese et al.) Long run ranking of the dryland tillage systems placed all systems using soil residual herbicides first, followed in order by glyphosate alone during fallow and conventional disking, respectively.

Project Design

Three commonly-used tillage systems in the Coastal Plain region were selected for the cotton study: deep turn, no-till, and row-till. Deep turn (25-30 cm) tillage utilizes a moldboard plow for the primary tillage. The soil is subsequently worked with a disk harrow or other soil preparation implements to create a bare ground seedbed. Weed and pest control is maintained through a combination of mechanical cultivation and chemical methods. The no-till system relies primarily on chemicals for suppression of pests, both plant and non-plant. Mechanical cultivation is not used and all crop residue is allowed to remain on the soil surface. Row crop establishment is attained by utilizing a no-till planter that opens a narrow seed furrow with disk openers and subsequently closes the furrow after the seed has been mechanically placed in the opening. The row-till system uses techniques adapted from both previous systems. A modified no-till planter mechanically tills a narrow seedbed strip, but leaves the remaining soil surface intact. Post-planting control of pests is maintained entirely by chemical applications.

The row crop production sequence was an annual rotation between cotton and soybean. Both row crops were preceded by a winter small grain crop, primar-ily triticale. Two areas under a center pivot irrigation system were utilized in the study with cotton production alternating annually. Four replications of each tillage treatment were made in a randomized block design. Initial tillage treatments were maintained for each replication throughout the five-year study.

The primary application method for chemicals and plant nutrients under all systems was through the center-pivot irrigation system. Fertility levels were maintained on the basis of annual soil tests and utilized Georgia Cooperative Extension Service recommendations for cotton, soybean, and small grain production.

Data and Methodology

Agronomic and economic data were recorded annually by crop and replication. Using this data and enterprise budget formats of the Georgia Cooperative Extension Service, annual returns and costs of production under each tillage system were calculated for cotton and the other crops. Production input prices were estimated from a combination of agribusiness supply center interviews and AGCHEMPRICE, a national survey of product prices (DPRA, Inc.). Output prices were estimated from a three-year average of Georgia seasonal crop prices and adjusted to 1994-95 dollars using the Georgia All Crop Index of Prices Received (Georgia Agricultural Statistics Service 1992-95). Readers should note that while the marketing year average price for cotton was $73.20 per cwt. in 1994, the 1992 and 1993 Georgia crop prices had averaged $55.70 and $59.90 respectively.

Agronomic Results

Cotton yields over the five-year period were highly variable, both among tillage treatments and the replications of each treatment. Highest average yields were obtained under the deep turn tillage treatment, exceeding 818 pounds of lint per acre. The deep turn average yield was statistically different from the row-till and no-till treatment yields (Table 1). The no-till treatment had the greatest range of yield values with a difference of more than 700 pounds per acre between highest and lowest replication yields.

Economic Results

Economic budget analysis for cotton grown in the three tillage systems showed net returns over all costs to be negative for all replications and over all treatments (Table 2). The difference between the levels of average net returns generated under no-till and row-till treatments was not statistically significant. But deep turn tillage had the lowest losses among all systems and average net return was significantly different from the levels of other treatments.

The average market price computed for this study was $57.80 per cwt. of lint. This price is about 21% under the $73.20 seasonal average price for 1994 and raised the question of what price would be required for profitable cotton production. A price sensitivity analysis was conducted to determine the breakeven price required for cotton under each tillage treatment. Results of this analysis are presented in Figure 1. As would be expected, given the ordering of net return levels, the deep turn treatment had the lowest breakeven price required to cover all costs ($0.940) and no-till had the highest ($1.159).

Variability in net return levels paralleled the yield differences found among tillage treatments. But the proportional costs of different input categories are also changing (Table 3). All of the tillage systems received identical fertilizer, insecticide, and irrigation water quantities within any given year. Herbicide expenses varied with the tillage practice. But producer outlays for these input categories changed at different stages of the BWEP. Herbicide expenditures generally increased throughout the five-year study period. Fertilizer expenditures remained virtually constant. But insecticide costs declined sharply in the latter two years of the study. Total 1991 expenditures on insecticide were approximately 1/6 of the 1987 total. This decrease in input costs raises the issue of net returns over all costs versus net returns over "out-of-pocket" costs.

Average total costs were significantly different among tillage systems (Table 4). Given the rankings for net returns over all costs, it was surprising that the no-till system had the lowest average total cost per acre over the five-year period. Row-till was second with the deep turn system having the highest total costs. When fixed costs and a charge for producer overhead and management are deducted, a measure of "out-of-pocket" costs is derived. Subtracting this cost from total net returns provides a measure of net returns over out-of-pocket costs (Table 5). Comparisons of this costs measure among tillage systems show net return losses for no-till to be larger than the losses generated from the other systems and significantly different.

A major objective of this study was to identify producer cost and net return changes that occurred during the BWEP years. During the final two years of this study, changes had been noted for individual input items. Conducting a sensitivity analysis for lint market price over only 1990 and 1991, the ranking of the tillage systems underwent a slight change (Table 6). Deep turn tillage remained the most profitable system with a breakeven market price of $0.74 per pound of lint. But no-till moved into second place with a breakeven market of $0.78. The breakeven price for row-till was $0.82 per pound, a very attainable price for the 1995 crop.

Conclusions

Economic analyses of three tillage systems for cotton production indicated that traditional deep turn was most profitable among the three systems studied. Average net return over all costs, including a charge for producer overhead and management, was significantly greater for the deep turn system than either no-till or row-till tillage. Similarly, per acre yield was greatest for the deep turn system. This contradicts earlier studies that had indicated both yield and net return advantages for the conservation tillage systems. Economic losses were indicated for all three tillage systems over the five-year period of research when using an adjusted three-year average market price. Five-year average breakeven prices required for the deep turn system were calculated at $0.94/pound for all costs and $0.71 to cover "out-of-pocket" costs. When the two most recent years were considered alone, deep turn tillage remained the most profitable with a required breakeven price of $0.74, but breakeven prices covering total costs were less than $0.83 for all three systems. Over this five-year period, the most noteworthy trend among individual input expense categories was for insecticides. Average annual cost decreased by more than 50% when comparing the first three years to the latter two. Much of this savings could seemingly be attributed to the BWEP and represents a considerable change in relative expenditures.

In closing, the results from this study are most applicable for Georgia and other southeastern states that have completed the treatment phase of the BWEP. But cotton producers in other areas may be able to identify potential savings associated with the BWEP and derive an estimate of the input costs incurred during the treatment phase.

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Table 1. Mean Cotton Yields by Tillage Treatment (1987-91)

TREATMENT	AVERAGE YIELD (lbs. lint per acre)	RANGE (lbs. lint per acre)
Deep Turn	818.89 a	644.71 to 1063.26
No-Till	644.91 b	176.64 to 996.69
Row-Till	708.35 b	309.12 to 869.94

Means with the same letter are not statistically different at the 5% level.

Table 2. Mean Cotton Net Returns by Tillage Treatment (1987-91)

TREATMENT	AVERAGE NET RETURN ($ per acre)	RANGE ($ per acre)
Deep Turn	-$295.92 a	-$34.91 to -$552.73
No-Till	-$374.65 b	-$14.03 to -$804.80
Row-Till	-$348.68 b	-$397.31 to -$742.01

Means with the same letter are not statistically different at the 5% level.

Table 3. Selected Cotton Input Expenditures by Tillage Treatment and Year (1987-91)

TILLAGE	FERT.	INSECT.	HERB.	IRRIG.
Deep Turn				
1987	$32.17	$236.31	$33.	$113.08
1988	$38.06	$211.92	$43.	$18.33
1989	$27.54	$343.50	$54.	$29.61
1990	$40.29	$110.49	$57.	$33.40
1991	$30.15	$37.02	$65.	$44.55
No-Till and Row-Till				
1987	$32.17	$236.31	$33.	$113.08
1988	$38.06	$211.92	$46.	$18.33
1989	$27.54	$343.50	$65.	$29.61
1990	$40.29	$110.49	$57.	$33.40
1991	$30.15	$37.02	$71.	$44.55

Table 4. Mean Cotton Total Costs by Tillage Treatment (1987-91)

TREATMENT	AVERAGE TOTAL COST ($ per acre)	RANGE ($ per acre)
Deep Turn	$822.62 a	$611.99 to $994.81
No-Till	$804.28 b	$571.62 to $965.05
Row-Till	$789.45 c	$588.21 to $1009.33

Means with the same letter are not statistically different at the 5% level.

Table 5. Mean Cotton Net Returns Over Out-Of-Pocket Costs by Tillage Treatment (1987-91

TREATMENT	AVERAGE NET RETURN OVER OUT-OF-POCKET COST ($ per acre)	RANGE ($ per acre)
Deep Turn	-$151.85 a	+$155.52 to -$328.92
No-Till	-$235.91 b	+$168.13 to -$593.33
Row-Till	-$180.26 a	+$97.09 to -$525.78

Means with the same letter are not statistically different at the 5% level.

Table 6. Breakeven Cotton Prices Over All Costs by Tillage Treatment (1990-91)

TREATMENT	BREAKEVEN MARKET PRICE OVER ALL COSTS ($ per pound of lint)
Deep Turn	$0.742
No-Till	$0.777
Row-Till	$0.823

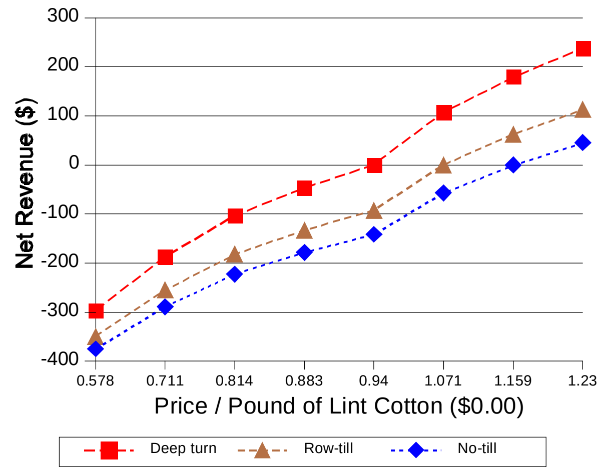

Figure 1. Breakeven Market Prices by Tillage Treatment