2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

AN ECONOMIC EVALUATION OF TILLAGE SYSTEMS FOR COTTON PRODUCTION IN TEXAS

J. L. Johnson and M.W. Polk
Texas Cooperative Extension
San Angelo, TX
J.R. Robinson
Texas Cooperative Extension
Weslaco, TX
W.J. Thompson
Texas Cooperative Extension
Fort Stockton, TX
L.L. Falconer
Texas Cooperative Extension
Corpus Christi, TX

Abstract

Cotton producers employing various cotton production tillage systems throughout Texas provided detailed trip-by-trip information related to field operations, inputs, and application rates to Texas Cooperative Extension farm management economists. From this information, production costs and returns for conventional, reduced, and no-till cotton production systems were estimated for various regions in Texas. The Mississippi State University Budget Generator was used to standardize the budget format and make a comprehensive database of Texas cotton production costs and returns available to producers. The resulting budget information enables comparison between tillage systems and highlights regional differences in production practices and input requirements. This information provides the foundation for a comparison of the trade-offs that need to be considered when evaluating tillage systems in the context of a whole farm plan.

Introduction

Alternative tillage systems have been and continue to be the focus of economic analysis for potential improvements in economic efficiency. These studies range from comparisons of enterprise budgets (Cooke et al, 2003) to whole farm mathematical programming approaches (Robinson and Falconer, 2003). The most common method of studying the economics of alternative tillage systems is by comparing cost and return estimates, or budgets. Budgeting is adequate to assess the tradeoffs between changes in productivity and input costs. Of the budget items that growers need to evaluate in considering alternative tillage systems, labor and machinery costs are the most difficult to evaluate with budgets, as they depend largely on the size of the operation.

A number of recent studies have attempted to quantify the various benefits from adopting conservation tillage systems for cotton production. In a two-year study of 11 grower fields in the semi-arid climate of south Texas, Smart et al. (1999) identified reduced production costs of $55-$66 per acre and higher net returns of $119-$129 per acre for conservation tillage cotton production following grain sorghum versus conventional tillage systems. Additionally, cotton lint yields in 1997 and 1998 in the conservation tillage fields were 137 and 87 pounds per acre more than the conventional tillage fields. This yield difference was attributed to increased moisture retention and decreased evaporation under the heavy crop residue mulch in the conservation tillage treatment. These results differed from the results obtained by McConnell and Kirst (1999), who reported that neither combinations of cover crops nor tillage methods significantly affected yield for cotton in Arkansas.

Bradley (2000) investigated the economics of conservation tillage systems across eight cotton-belt states. This study showed reductions in cost of tillage for no till cotton systems amounting to $20.68 and $45.08 per acre versus conservation tillage and conventional tillage, respectively. Further, labor requirements were found to be 0.5 hours per acre lower for conservation and no till systems versus conventional tillage systems.

Johnson and Polk (2004) used grower provided information regarding equipment and labor requirements and input utilization to determine and compare variable and fixed costs of cotton production in the Texas rolling plains. Farm size and management of machinery and equipment inventories appeared to have a greater influence on fixed cost structure than did selection of tillage system. This research did identify the potential for individual cotton growers to achieve lower fixed cost structures (lower per acre depreciation expenses) through adopting reduced tillage or no till systems. However, adopting a reduced tillage system did not immediately provide these savings. Only after adjusting machinery and equipment inventories were growers able to achieve cost savings and enhance machinery and equipment efficiency.

Partial budgeting has been shown to be useful to adequately assess the tradeoffs between changes in productivity and input costs. However, budgeting approaches fail to show how the most profitable choice of crop/tillage system might vary with increasing scale. The optimal crop mix is also influenced by the pattern of acquisition of lumpy resources like full-time labor and equipment (Robinson and Falconer, 2003).

Robinson et al (2004), surveyed 3,838 farmers in the West/South Texas study area to collect information about their tillage practices and machinery costs of production. Based on a ten percent response rate to the survey, on average, Texas cotton growers were only just beginning to adopt reduced tillage systems. This is based on an average 1.8 reported level of employed tillage system, where 1 represented conventional tillage with annual deep plowing and 5 represented a no-till system.

The purpose of this paper was to evaluate the potential cost savings from adopting conservation tillage (reduced tillage or no-till) systems for cotton production in various regions of Texas. From this information, producers can evaluate whether the cost-savings from adopting conservation tillage systems adequately compensates them for any transition costs required and should be further evaluated in the framework of a whole farm plan.

Methods

Cotton producers employing various cotton production tillage systems throughout Texas provided detailed trip-by-trip information related to field operations, inputs, and application rates to Texas Cooperative Extension farm management economists. The regions surveyed include the Rio Grande Valley (in South Texas), Texas Southern Rolling Plains (in West Central Texas), St. Lawrence region (in West Texas), and Lower Coastal Bend (in Southeast Texas). From this information, production costs and returns for conventional and conservation tillage cotton production systems were estimated for the various regions in Texas.

The Mississippi State University Budget Generator was used to standardize the budget format and make a comprehensive database of Texas cotton production costs and returns available to producers. This budgeting software provides estimates of variable and fixed costs of production resulting from the specification of input rates, field operations, application dates, equipment inventories, and input prices. Budget information was then scrutinized to identify the differential input usage and cost estimates among the various tillage systems examined in each region.

Regions of Inquiry

Cotton production in the Rio Grande Valley of Texas is concentrated in the four southernmost counties (Cameron, Hidalgo, Starr, and Willacy) of the state. Annual cotton acreage in this region fluctuates from 200,000 to 300,000 acres with 65 percent of the acreage suitable for irrigation. The region’s climate is sub-tropical and the annual rainfall ranges from 18 to 35 inches, with an average of 14 inches of growing season precipitation.

The southern rolling plain of Texas (Coke, Coleman, Concho, Irion, Mason, McCulloch, Runnels, Schleicher, Tom Green, and Taylor counties) is an area that has historically planted 200,000 to 350,000 acres of cotton. Moisture is a limiting factor in crop production since the average annual rainfall ranges from 20 to 25 inches. Approximately 85 percent of the cotton production in this region is dryland with about 15 percent receiving supplemental or full irrigation. Dryland cotton is typically grown in skip-row planting patterns and crop yield potential varies greatly because of erratic rainfall distribution each year. The southern rolling plains is a relatively low input production area with low historical yields as compared to other regions of the state and country (Johnson and Polk, 2004).

The St. Lawrence area of far west Texas is a three county (Glasscock, Reagan, and Upton) area with an average annual rainfall of 16 inches per year. However, only six to twelve inches of this occurs during the growing season. Water well yields have declined to 20 to 35 gallons per minute, and producers typically tie as many as six wells together to assemble adequate irrigation volume. The limited growing-season rainfall, limited groundwater resources and increasing energy costs have encouraged producers to adopt subsurface drip irrigation technology to maximize irrigation efficiency.

The coastal bend region of Texas includes the cotton growing areas of Kleberg, Jim Wells, Nueces, San Patricio, Aransas, Bee, Refugio and Calhoun counties. In this region, the cotton acreage fluctuates between 150,000 and 300,000 acres. The region's climate is subtropical with an average annual rainfall ranging from 26 to 28 inches. However, annual precipitation can vary greatly depending upon drought cycles and rainfall from tropical disturbances from mid-August to late September.

Results

Tables 1 through 4 show partial budget differentials for conventional and conservation tillage systems in the Rio Grande Valley, Southern Rolling Plains, St. Lawrence region, and Lower Coastal Bend of Texas, respectively. These budgets are particularly useful because they provide examples of dryland, furrow irrigated, and drip irrigated systems. They were all based on either field trials or extensive personal interviews with cooperator growers. Collectively, these partial budgets indicate that the benefits from some form of conservation tillage tend to be positive, but the magnitude of benefits varies from location to location. Given the variability of diesel prices, benefits would likely also vary from year to year.

Conventional wisdom suggests that adoption of conservation tillage practices require the use of higher horsepower machinery to perform multiple activities in one trip across the field. Anecdotal evidence from farmers suggests that a major benefit of reduced tillage systems is enabling them to use smaller tractors for longer periods of time, and with fewer repairs. Besides lower repair costs, smaller horsepower and longer-lived tractors also imply lower total tractor cost per hour, and thus lower production costs. Tables 1 through 4 indicated that the conservation tillage alternatives allowed for reductions in machinery repairs and maintenance ranging from $0.77 to $12.62 per acre across the Texas regions.

One of the biggest advantages frequently cited for conservation tillage adoption is a reduced labor requirement. This research supports the notion that there are significant labor advantages to conservation tillage systems. Compared to conventional tillage systems, the conservation tillage alternatives allowed for operator labor cost savings ranging from $0.78 to $9.19 per acre across the Texas regions. These savings account for a significant percentage of operator labor time, which could be used to oversee expanded cotton or farming acreage. The operator labor man hour reductions for the Rio Grande Valley, Southern Rolling Plains, St. Lawrence region, and lower coastal bend region amounted to 32%, 14%, 43%, and 18% reductions in operator labor hours required, respectively. This illustrates that many of the trips for conservation tillage systems could be completed faster than the more tillage intensive trips required for conventional tillage.

Fewer (and faster) trips across the field with conservation tillage production translate into savings for fuel. The value of this advantage varies proportionately with the price of fuel, but in some years, could be substantial. Using a diesel price of $1.40 per gallon, the fuel savings to conservation tillage systems was estimated to range from $2.14 to $13.36 across the Texas regions.

Table 1. Partial budget differentials for per acre cost of production estimates for cotton with conventional and reduced tillage systems, Texas Rio Grande valley, 2004.

	Conventional	Reduced
Expected Yield (lbs. lint per acre)	825	825
Production Cost		
Herbicide	$ -------	$ 21.52
Seed	$ -------	$ 3.00
Operator Labor ($11 per hour)	$ -------	($ 5.94)
Other Labor ($7 per hour)	$ -------	($ 3.02)
Fuel ($1.40 per gallon)	$ -------	($ 6.85)
Repairs and Maintenance	$ -------	($ 3.49)
Interest on Credit Line	$ -------	$ 0.53
Variable Cost Differential	$-------	$ 5.75
Fixed Cost Differential	$-------	($ 10.01)
Total Cost Differential	$-------	($ 5.24)

Table 2. Partial budget differentials for per acre cost of production estimates for cotton with conventional, reduced, and no-till tillage systems, Texas southern rolling plains, 2004.

	Conventional	Reduced	No-Till
Expected Yield (lbs. lint per acre)	250	250	250
Production Cost			
Herbicide	$ -------	$ 7.14	$ 9.54
Operator Labor ($11 per hour)	$ -------	($ 1.57)	($ 1.71)
Other Labor ($7 per hour)	$ -------	($ 0.22)	($ 0.01)
Fuel ($1.40 per gallon)	$ -------	($ 2.14)	($ 2.69)
Repairs and Maintenance	$ -------	($ 0.77)	($ 1.12)
Interest on Credit Line	$ -------	$ 0.12	$ 0.20
Variable Cost Differential	$-------	$ 2.56	$ 4.21
Fixed Cost Differential	$-------	($ 5.21)	($ 8.42)
Total Cost Differential	$-------	($ 2.65)	($ 4.21)

Table 3. Partial budget differentials for per acre cost of production estimates for cotton with conventional and no-till tillage systems, Texas St. Lawrence region, 2004.

	Conventional	No-Till
Expected Yield (lbs. lint per acre)	1,098	1,118
Production Cost		
Herbicide	$ -------	$14.24
Operator Labor ($11 per hour)	$ -------	($ 9.19)
Other Labor ($7 per hour)	$ -------	($ 1.93)
Fuel ($1.40 per gallon)	$ -------	($13.36)
Repairs and Maintenance	$ -------	($12.62)
Interest on Credit Line	$ -------	($ 1.44)
Variable Cost Differential	$-------	($24.30)
Fixed Cost Differential	$-------	($48.66)
Total Cost Differential	$-------	($72.96)

Table 4. Partial budget differentials for per acre cost of production estimates for cotton with conventional, reduced, and no-till tillage systems, Texas lower coastal bend, 2004.

	Conventional	Reduced	No-Till
Expected Yield (lbs. lint per acre)	656	631	541
Production Cost			
Herbicide	$ -------	$ 6.96	$12.15
Insecticide	$ -------	$ -------	$ 0.95
Growth Regulator	$ -------	$ -------	$ 1.64
Operator Labor ($11 per hour)	$ -------	($ 0.78)	($ 1.30)
Fuel ($1.40 per gallon)	$ -------	($ 2.59)	($ 3.39)
Repairs and Maintenance	$ -------	($ 3.45)	($ 4.56)
Interest on Credit Line	$ -------	$ 0.31	$ 0.79
Variable Cost Differential	$-------	$ 0.45	$ 6.28
Fixed Cost Differential	$-------	($ 6.51)	($ 8.65)
Total Cost Differential	$-------	($ 6.06)	($ 2.37)

From a cash flow perspective, the additional expense for chemicals (herbicides and insecticides) has likely been the biggest deterrent to greater adoption of conservation tillage. This investigation confirmed the obvious by identifying a greater dependence on chemical use to substitute for mechanical tillage activities. Chemical expenses were $6.96 to $21.52 per acre higher for conservation tillage systems compared to conventional tillage.

Variable costs for conservation tillage systems were found to be typically higher ($0.45 to $6.28 per acre) than those for conventional tillage systems. The only exception was identified in the St. Lawrence region where variable costs for conservation tillage were estimated to be $24.30 per acre lower than the production costs using conventional tillage. This anomaly likely reflects the fact that the subsurface drip irrigation systems in the region are much more limited in size than traditional large-scale operations. This means that the cost savings from operator labor, fuel, and repair and maintenance of a scaled down operation possible with conservation tillage far exceeds the additional costs of herbicides in this region.

Actual fixed costs effects will differ from operation to operation based on size. The estimates presented in this analysis reflect a typical farming operation size for each region. The suggested reduction in fixed costs possible from adopting conservation tillage ranges from $5.21 to $48.66 per acre across the Texas regions. The takeaway implication here is that there is significant potential to reduce overall costs through efficient equipment utilization for each particular farm size and regime. These cost efficiencies outweigh (in many cases) the advantages that adoption of a particular tillage system adoption alone can provide.

Conclusions

Given the consensus partial budgeting results across the state, the most obvious question concerns why Texas producers have been slow to adopt conservation tillage practices. Admittedly, a grower would need more than simple partial budgeting analysis to actually adopt a new tillage system over an existing one. This additional information would involve cost analysis concerning rotational crops, sequence of production operations, and overall farm size considerations. The results from field trials and producer interviews across Texas suggest that there is definitely a potential gain from adopting some form of reduced tillage, but that it will depend on things that vary from year to year (e.g., diesel prices, planting moisture and temperature) as well as whole farm investment/disinvestment issues.

Another factor that has potentially slowed the transition from conventional to conservation tillage systems has been the favorable tax treatment policies for capital investments in machinery. Producers have been able to use these measures to invest in newer equipment and reduce taxable income at particularly favorable terms. In this way, growers have been afforded a valuable tax management strategy that has favored the continuation of equipment intensive production systems. Additionally, by extending the life of existing machinery (by postponing replacement of machinery), producers have found ways to minimize the fixed cost advantages that conservation tillage systems provide and by utilizing excess equipment to provide contracted operations for other producers.

Decisions about reduced tillage systems involve trade-offs in different kinds of costs. This analysis focused on the differential financial impacts of choosing among tillage systems and it is widely acknowledged that financial analysis alone seldom captures all of the relevant information taken under consideration. Potential environmental and agronomic benefits, such as enhanced soil moisture retention, increased organic matter content, and reduced soil compaction and erosion levels were not addressed. Further, this analysis does not attempt to differentiate between expected yield differences, which might exist between tillage systems. The preliminary research results identifying yield differences between tillage systems have been confusing at best. Until definitive yield advantages (or acceptable yield differences) between tillage systems in local producing areas can be obtained, producers are likely to be skeptical about changing their existing tillage program.

Conservation tillage systems did appear to provide cost savings for labor, fuel, machinery and equipment, and repairs and maintenance. However, these savings were offset by higher chemical expenses from the increased dependence on chemical applications to substitute for tillage activities. It is very likely that the immediate cash flow impacts (i.e. higher variable cost expenses) from conservation tillage will be more visible to the grower than the less- apparent reductions in fixed costs (i.e. depreciation). The non-cash cost advantages afforded through conservation tillage adoption can only be realized if excess machinery and equipment is liquidated. If growers are not prepared to commit to conservation tillage by right-sizing their equipment inventory, then they would likely be disappointed with the results of adopting a new tillage system.

The benefits of economies of size cannot be denied in traditional row crop agriculture greatly influencing fixed costs of an operation. Perhaps the greatest merit of conservation tillage systems is the ability to enable operators to expand their farming operations or extend their operations when machinery or labor limitations have capped their use with conventional tillage systems. Conservation tillage systems appear to offer opportunities for coping with a small farm base or capitalizing on lower labor per acre requirements. Since cotton can be produced through a conservation tillage program with less machinery and equipment than conventional tillage systems, smaller cotton growers might choose conservation tillage as a lower cost avenue of entering the industry. On the other end of the spectrum, conservation tillage systems were identified to require less labor per acre. Therefore, reduced tillage and no till systems have the potential to facilitate expanding farm size to fully utilize and increase the efficiency of machinery, equipment and labor.

Acknowledgments

This research paper is a summary of a more comprehensive research project supported and funded by Cotton Incorporated, Project #04-538.

References

Bradley, J.F. 2000. Economic comparison of conservation tillage systems across the belt, AL, AR, CA, GA, LA, MS, SC, & TX. In proc. Beltwide Cotton Conference, (1): 290-295. National Cotton Council, Memphis, Tennessee.

Cooke, Fred T., Jr., Gordon L. Andrews, Steven W. Martin, Charles E. Snipes, and David W. Parvin, Jr.. 2003. First year no-till - three regimes. In proc. Beltwide Cotton Conference, 443-449. National Cotton Council, Memphis, Tennessee.

Johnson, Jason L. and M. Wade Polk. 2004. A comparison of production costs for alternative tillage systems in the rolling plains of Texas. In proc. Beltwide Cotton Conference, 563-570. National Cotton Council, Memphis, Tennessee.

McConnell, J.S. and R.C. Kirst, Jr. 1999. Cotton conservation tillage studies in Arkansas. In proc. Beltwide Cotton Conference, (1): 32-33. National Cotton Council, Memphis, Tennessee.

Robinson, John R.C. and Lawrence L. Falconer. 2003. Optimal Land, Equipment and Labor Allocation Under Alternative Tillage Systems in South Texas. In proc. Beltwide Cotton Conference, 438-442. National Cotton Council, Memphis, Tennessee.

Robinson, John R.C., Shelley U. Underbrink, Lawrence L. Falconer, Jason L. Johnson, and Bill J. Thompson. 2004. Measuring lower tractor costs from reduced tillage in cotton: preliminary results. In proc. Beltwide Cotton Conference, 571-574. National Cotton Council, Memphis, Tennessee.

Smart, J.R., J.M. Bradford, T. Lockamy, and E. Perez. 1999. Economic analysis of conservation tillage on producer fields. In proc. Beltwide Cotton Conference, (2): 1291-1292. National Cotton Council, Memphis, Tennessee.