FARM Assistance Focus

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The Economic Foundation for Tillage System Selection

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In non-irrigated cotton producing areas characterized by a high cotton acreage failure rate, conservation tillage systems could provide cost management flexibility advantages over conventional tillage systems.

Conservation tillage systems have been a long studied method for potential cost reductions for U.S. cotton producers as well as for providing positive soil improving qualities and other environmental benefits. The purpose of this study is to identify the economic differences between tillage systems in the Southern Rolling Plains (SRP) of Texas. The SRP of Texas is an area which has historically planted 200,000 to 350,000 acres of cotton per year. Approximately 85 percent of the cotton production in this region is dry-land with about 15 percent receiving supplemental or full irrigation. The SRP is a relatively low input production area with low historical yields as compared to other regions of the state and country.

Conservation tillage, in general, and no-till practices in particular, have increased over the past few years. Yet, despite the apparent advantages of conservation tillage, especially cost savings from reduced labor, fuel and machinery costs, conservation tillage has been adopted by some farmers, but not all (Martin, 2002). In many previous studies, there has been little to no increased yield from no-till or reduced tillage compared to conventional tillage but there are economic advantages. These come from: 1) reduced labor input 2) reduced fuel usage 3) fewer repairs and lower maintenance costs 4) better field accessibility 5) lower capital investment and 6) smaller horsepower equipment (Stichler, 2005).

A number of studies have attempted to quantify the economic benefits of conservation tillage systems for cotton production. Smart et al. (1999) identified reduced production costs of $55 to $66 per acre and higher net returns of $119 to $129 per acre for conservation tillage cotton production following grain sorghum versus conventional tillage systems in the semi-arid climate of south Texas. 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) found that growers employing conservation tillage systems (reduced tillage and no till) did not realize significantly lower estimated total costs of production. 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. Conservation tillage systems were found, on average, to result in total variable costs that were $7 to $12 per acre higher and fixed costs that were $6 to $8 per acre lower. Collectively, the differences in total costs of production were estimated to be less than $4 per acre (approximately 3%) between tillage systems. However, Polk and Johnson (2007) identified that in non-irrigated cotton producing areas characterized by a high cotton acreage failure rate, conservation tillage systems could provide cost management flexibility advantages over conventional tillage systems.

Table 1 shows the ten-year production and yield history for non irrigated upland cotton in Tom Green County, Texas. Cotton yields in Tom Green averaged 337 per harvested acre. Because the SRP of Texas is characterized by wide variations in rainfall, there is often a great divergence between planted upland

Table 1. Historical production and yield of non-irrigated upland cotton for Tom Green County, Texas 1998-2007 (USDA , 1998-2007)

Year	Planted Acres	Harvested Acres	Production (bales)	Yield per Harvested Acre	Yield per Planted Acres
1998	71,600	17,000	10,200	288	68
1999	77,800	66,600	27,000	195	167
2000	104,600	16,300	1,900	56	9
2001	74,800	66,800	36,000	259	231
2002	58,200	53,000	24,800	225	205
2003	58,300	55,200	35,100	305	289
2004	59,800	58,000	59,200	490	475
2005	64,000	63,700	71,000	535	533
2006	65,900	23,900	9,100	183	66
2007	57,400	57,400	100,000	836	836
Average	**69,240**	**47,790**	**37,430**	**337**	**288**

cotton acres and harvested acres. For the SRP, the average failure rate, or difference between planted and harvested acres, averaged 31 percent.

Methods

Table 2 illustrates the expected costs associated with conventional, reduced, and no-till production systems for each harvested acre of non-irrigated upland cotton in the SRP of Texas. These costs are estimated using farm level producer costs from the Texas Financial And Risk Management (FARM) database as well as Texas AgriLife Extension crop budgets (Texas A&M University, 2008). Expected seed costs reflect stacked gene varieties which are held constant across all tillage systems. Fertilizer and herbicide costs increased from conventional till to reduced till and from reduced till to no-till systems. Fuel costs were estimated using $2.33 per gallon for farm diesel and variable harvesting costs were $0.10 per pound.

In the SRP of Texas budget, variable fuel, labor, repair costs, and interest on operating capital decreased across tillage systems (conventional to reduced and reduced to no-till) while boll weevil and scouting costs were constant across tillage systems. Other major costs for insecticides and herbicides varied based on the tillage system employed. In the SRP budgets, reduced and no-till systems displayed a significant fixed cost advantage versus conventional tillage systems.

Non-irrigated upland cotton budgets for each tillage system in Tom Green County and historical county yields were inputted into the Financial And Risk Management (FARM) Assistance computerized decision aid. This decision aid links actual production and financial data with long-term projections of prices, interest rates, and inflations rates. It is a whole-farm decision support system designed to help producers' access likely outcomes of strategic decisions up to ten years into the future. Unique to FARM Assistance is the ability to evaluate the potential impacts of business alternatives under risk. Results from the FARM Assistance analysis provide a projection of the different financial performances of the alternative tillage systems over a ten-year study period.

A representative farm was evaluated consisting of 1,000 acres planted to non-irrigated upland cotton. In the SRP region, the prevailing planting pattern consisted of a 2 and 1 pattern which means that the equivalent of 667 continuous acres was built into the FARM Assistance decision aid. Price projections from the Food and Agricultural Policy Institute (FAPRI) were used to forecast cotton prices for 2008-1017. Since these price projections included cotton prices for the projection period that exceeded the U.S. loan rate, no government payments were included in this analysis. Because direct payments and counter-cyclical payments are not tied to current cotton production, it was

Table 2. Non-irrigated upland cotton budgeted costs per harvested acre for conventional, reduced, and no-till systems in the Southern Rolling Plains of Texas.

Variable Cost	Conventional Till	Reduced Till	No-Till
Seed ($/acre)	23.15	23.15	23.15
Fertilizer ($/acre)	13.00	16.75	18.45
Herbicides ($/acre)	10.00	21.43	28.87
Insecticides ($/acre)	0	0	0
Fungicides ($/acre)	0	0	0
Custom Application ($/acre)	0	0	0
Scouting ($/acre)	0	0	0
Fuel ($/acre)	35.20	24.31	21.85
Defoliant ($/acre)	4.75	4.75	4.75
Harvesting ($/pound) @ 337 lbs.	37.00	37.00	37.00
Boll Weevil ($/acre)	8.00	8.00	8.00
Labor ($/acre)	18.36	12.86	12.04
Repairs & Maintenance	22.30	16.08	13.58
Int. on Operating Capital ($/acre)	6.20	5.54	7.18
Total Variable Cost	**177.96**	**169.87**	**174.87**
Fixed Costs- Equipment ($/acre)	**49.94**	**36.12**	**31.21**
Total Costs ($/acre)	**227.90**	**205.99**	**206.08**

On a net cash farm income basis, superior returns were provided by the reduced tillage system followed by the no tillage and the conventional tillage system.

decided to ignore these potential payments as they should not influence the decision to produce (or not produce) cotton. Projections for inflation based input costs were also taken from FAPRI. Three tillage systems were developed for the representative farm in the SRP of Texas. The representative farm utilized the variable and fixed cost structures illustrated in Table 2 for each tillage system in order to provide a financial comparison between tillage systems.

Results

Table 3 shows break-even price sensitivity estimates for Tom Green County, Texas for each tillage system (for both variable and total costs) with four alternative yield levels spanning the ten-year average yield. These break-even estimates reflect the credit producers receive for their cotton seed production valued at $150 per ton and an adjustment for variable harvesting costs. The table identifies alternative yield levels and their respective break-even prices for cotton lint. Whenever the resulting yield level and break-even price to recover variable costs exceeds the prevailing cotton price (or cotton price plus pending loan deficiency payments), then the producer would actually be better off not producing cotton. Using the $0.52 loan rate level as a realistic price floor for cotton prices, producers in the SRP of Texas could expect to make contributions toward fixed costs using any tillage system provided they achieved average yields exceeding 275 pounds per acre. However, only producers employing reduced or no-till systems would recover variable and fixed costs with yields exceeding 350 pounds per acre.

Table 3. Break-even cotton prices ($/pound) to recover variable and total costs of production for Tom Green County, Texas.

	Yield (pounds per acre)			
Tillage System	**200**	**275**	**350**	**425**
Conventional				
Variable Costs	$0.7013	$0.5046	$0.3922	$0.3194
Total Costs	$0.9510	$0.6862	$0.5349	$0.4369
Reduced				
Variable Costs	$0.6609	$0.4752	$0.3691	$0.3004
Total Costs	$0.8415	$0.6065	$0.4723	$0.3854
No-Till				
Variable Costs	$0.6859	$0.4933	$0.3833	$0.3122
Total Costs	$0.8419	$0.6068	$0.4725	$0.3856

Tables 4 - 6 provide selected results from the FARM Assistance analysis for Tom Green County, Texas. Table 4 shows the average forecasted net cash farm income by tillage system. Projected net cash farm incomes represent returns to land, management and equipment. Since depreciation is not a cash expense, this fixed cost component is not represented in these projections. Over the ten year projection period, average net cash farm income ranged from $36,120 to $41,070 across tillage systems. On a net cash farm income basis, superior returns were provided by the reduced tillage system followed by the no tillage and the conventional tillage system.

Table 4. Average forecasted net cash farm income by tillage system for Tom Green County, Texas.

Year	Conventional Till	Reduced Till	No-Till
2008	$20,240	$25,660	$22,310
2009	$20,920	$26,050	$22,120
2010	$24,840	$29,580	$25,270
2011	$25,960	$30,780	$26,200
2012	$28,220	$33,160	$28,460
2013	$35,420	$40,540	$35,700
2014	$44,890	$50,090	$45,060
2015	$48,860	$53,760	$48,620
2016	$55,340	$60,110	$54,670
2017	$56,490	$60,980	$55,300
Average	**$36,120**	**$41,070**	**$36,370**

Table 5 reports the average forecasted net farm returns to land and management by tillage system. The difference between Table 4 and Table 5 is that net returns to land and management includes fixed costs and depreciation of equipment. Over the ten-year projection period, average net farm returns to land and management ranged from $2,660 to $16,870 across tillage systems. The conventional tillage system actually failed to provide sufficient returns to cover all fixed costs for the first five years of the ten year study period.

Table 5. Average forcasted net farm returns to land and management by tillage system for Tom Green County, Texas

Year	Conventional Till	Reduced Till	No-Till
2008	-$13,220	$1,460	$1,400
2009	-$12,540	$1,850	$1,210
2010	-$8,620	$5,380	$4,360
2011	-$7,500	$6,580	$5,290
2012	-$5,240	$8,960	$7,550
2013	$1,960	$16,340	$14,790
2014	$11,430	$25,890	$24,150
2015	$15,400	$29,560	$27,710
2016	$21,880	$35,910	$33,760
2017	$23,030	$36,780	$34,360
Average	**$2,660**	**$16,870**	**$15,460**

Table 6 illustrates the average forecasted annual operating expense to receipts ratio for each tillage system for Tom Green County, Texas. The operating expense to receipts ratio measures financial efficiency. This ratio proxies the cost of growing a dollar's worth of receipts. A ratio of 0.80 indicates that for every dollar's worth of receipts, 80 cents are tied up in operating costs with the remaining 20 cents available for returns to land, management, and equipment. The reduced tillage system proved to be the most efficient tillage system (0.77) with the no-till and conventional tillage systems exhibiting similar efficiency (0.80).

Conclusions

Wide variations in prices and yields present a precarious environment for cotton production in any region, but these impacts are especially prominent in non-irrigated production regions. Unfortunately the quest to adequately address these uncertainties does not end with proper tillage system selection. Appropriate farm size, realized cotton yields, and manageable input costs have proven to be prominent factors in the cost structure of a financially prosperous cotton operation. While tillage system selection can help to address some of these challenges, it should be considered the first of many tasks.

In the SRP of Texas, reduced and no-till cotton production systems demonstrate some superior cost management capabilities versus a conventional tillage system. However, extremely volatile input prices can magnify or lessen these advantages. This research indicates that the magnitude of the economic differences among cotton tillage systems is regionally specific. Growers need a comprehensive evaluation of the variable and fixed cost implications before switching

Table 6. Average forecasted annual operating expense/reciepts by tillage system for Tom Green County, Texas.

Year	Conventional Till	Reduced Till	No-Till
2008	0.86	0.83	0.85
2009	0.87	0.83	0.86
2010	0.84	0.82	0.84
2011	0.84	0.81	0.84
2012	0.83	0.80	0.83
2013	0.80	0.77	0.80
2014	0.76	0.74	0.76
2015	0.75	0.72	0.75
2016	0.72	0.70	0.73
2017	0.72	0.69	0.72
Average	**0.80**	**0.77**	**0.80**

to a new tillage system. This includes the trade-offs between cash expenses, equipment requirements, labor requirements and overall profitability that could reasonably be expected from any proposed transition.

This analysis did not assume any yield advantage for any tillage system over another. Any yield differences between tillage systems likely appear during years with limited moisture. As such, the yield advantage for conservation tillage systems is possibly masked by crop insurance indemnities compensating for overall poor yields and resulting revenue advantages. Further, no attempt was made to consider non-economic factors such as longer-term soil property characteristics that might be influenced by the selection of a specific tillage system. Therefore, the relative merit of alternative tillage systems remains open to further modification.

Farmers adopt new methods and technologies cautiously and only after direct observation of expected benefits. The investigation of the costs for the SRP of Texas indicate that much of the economic benefit of adopting a conservation tillage system is embedded in an improved fixed cost structure (i.e. reduced depreciation). These impacts do not immediately affect cash expenses and are sometimes difficult to observe. This may help to explain why widespread adoption of conservation tillage technologies has not been more rapidly embraced. The continuation of an environment of high and volatile input prices may provide the incentive that producers need to make necessary changes in their operation. Upon careful reflection, producers may determine that selecting an alternative tillage system is warranted.

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