Economic Advantage of No-Tilling Winter Forages for Stocker Grazing

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Abstract

The stocker cattle grazing enterprise in the Southern Plains regions of the United States is an important economic activity. The objective of the study was to determine the difference in the expected net return of a no-till forage establishment system relative to the intensive clean-till establishment system typically used in the region. Results show a reduction in fuel, lube, repairs and labor expenses, and fixed machinery costs of the conventional-till system outweigh the expenses associated with herbicide and herbicide application of the no-till system. Over the eight-year duration of the study, the no-till system realized an average of 11 greater days of grazing compared to the conventional-till system. The expected net return of the no-till establishment system was $36.44 per acre greater than the conventional-till system; however, this economic advantage is sensitive to relative differences in cattle performance between systems. It is also sensitive to the price of herbicide and price of diesel fuel.

Introduction

Stocker cattle grazing of annual winter cereal forages such as wheat (Triticum aestivum L.) and rye (Secale cereal L.) is a vital economic activity in the Southern Plains region of the U.S. (Peel and Baggett, Ward, and Childs). A key ingredient for economic success in the stocker cattle business in this region is an economically viable winter forage production system. Traditionally, producers in the region utilize intensive tillage and seed bed preparation methods for establishing winter cereal forages. However, over the past three decades winter forage producers have been asking production scientists whether or not using conservation farming practices such as no-till and reduced till establishment methods would be more economical than conventional practices. In response to their questions, several studies focusing on determining the economic factors that drive the adoption of conservation farming practices were conducted (Epplin and Tice, Aw-Hassan and Stoecker, Napier et al., and Rahm and Huffman). Results of these earlier studies showed that several factors, including farm size, insufficient stands due to ineffective no-till drills, expensive herbicide management practices and substantially large investments necessary for conservation machinery and equipment, prohibitively reduced the likelihood of adoption of conservation farming practices.






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In recent years however, the factors affecting the adoption of conservation farming practices used for establishing winter cereal forages have changed. For instance, Epplin et al., 2005 points out two primary factors that favor conservation establishment practices for winter wheat: (1) the development of more effective no-till grain drills and air seeders; and (2) the expiration of the original patent for the herbicide glyphosate in 2000. In addition, we point out here that another factor is the price of diesel fuel, which has increased 120 percent since 2000 (USDA, NASS). Conventional tillage practices in the region often require that cropland used for forage production for stocker cattle grazing lay fallow over the summer months, resulting in soil moisture loss and soil erosion due to wind. As a result, changes in environmental policies may also provide incentives that favor the adoption of no-till farming practices. For instance, the Environmental Quality Incentives Program (EQIP) was reauthorized in the 2002 Farm Bill to provide financial and technical help to farmers that implement conservation practices (USDA, 2008). Changes in these factors provide the impetus to reinvestigate the economics associated with using conservation farming practices to establish winter forages for the stocker cattle grazing enterprise in the Southern Plains.

The goal of this research is to determine the expected economic advantage of a no-till (NT) winter forage establishment system relative to the conventional-till (CT) winter forage establishment system that is typically used by producers in the region. Research that focuses specifically on determining the economic feasibility of no-till conservation farming techniques for producers engaged in a forage-only stocker cattle grazing system is limited in the region. As a result, information provided by this study will be valuable to winter forage producers, production scientists, and forage and crop extension specialists making decisions about the adoption of a no-till establishment system.

Forage Establishment and Management

An on-farm demonstration project was conducted in south-central Oklahoma at the Noble Foundation's Pasture Demonstration Farm beginning the fall of 1996 and continued through the spring of 2003. Field operations for conventional clean-till and conservation NT winter rye/ryegrass forage production systems are reported in Table 1. Field operations for the CT system were conducted to mirror the operations commonly used in the region. First, in June after the spring graze-out period (i.e., after the stocker cattle are removed from pastures and sold), 20 percent of the pastures were tilled with a moldboard plow in order to breakup soil that has been overly compacted due to extreme summer temperatures while the other 80 percent of the pastures were tilled with a chisel. In August a disc operation was conducted followed by broadcasting Urea (46-0-0). A final disc activity was conducted just prior to planting winter forage seed in early September with a conventional drill. For the no-till establishment system, an initial application of 1.25 pints of glyphosate was applied in late June followed by a partial application of 0.625 pints per acre in August to only the places within each field that did not sufficiently respond to the first application. The custom application costs were $4.00 and $2.00 per acre for initial and partial application, respectively. Winter forage was established using a no-till drill in early September. A second application of Urea (46-0-0) was applied to all fields in the demonstration in February.

Herd and Grazing Protocol

Each year of the project, a typical set of sale barn bull/steer calves are purchased in mid-September and shipped to a dry lot facility where they are preconditioned for 30 to 45 days. During this process, bull calves are castrated, calves bearing horns are dehorned and all calves are vaccinated for bovine shipping fever complex, and treated for both internal and external parasites. These activities better prepare calves to cope with the stresses associated with a stocker cattle production system (e.g., exposure to extreme weather and animal commingling), and typically renders higher rates of gain.

Because this project was designed as an on-farm demonstration, the paddocks used for each system were grazed by a single herd. As a result, animal response data for each system (e.g., average daily gains) were not collected. In addition, establishment methods for each of the two systems were not randomized or replicated over space, and hence statistical inference of the data is limited. However, the size of the grazing paddock used in the demonstration (41 acres for the CT system and 23 acres for the NT system) does provide very good insight into how these two systems compare under an actual large-scale production scenario, which is similar to the reality of an actual producer. Grazing of each system was conducted over an eight year period, which allowed us the opportunity to ferret out some of the variation in forage yields and grazing days due to differences in weather and soil mineralization from year to year.

Each year the group of stockers was placed on the pasture with the highest amount of forage as determined by forage height measurement (normally about November 1) and would continue to be rotated to the pasture with the next highest amount of forage. Cattle were moved from a paddock at the time that approximately 25 percent of the initially measured forage was removed and moved to the next best paddock. Grazing was terminated at a three-inch residual forage height for each of the paddocks in the fall grazing period. Therefore the number of days on a specific pasture depended upon initial forage height measurement and stocking rate. Typically, the grazing rotation was three to five days in the fall phase and two to three days in the spring phase.

Stocking rates ranged between 400 and 600 pounds of beef per acre during the fall phase of growth (i.e., November 1 – March 1) and between 800 and 1200 pounds of beef per acre during the spring phase of grown (i.e., March 1 – June 1). Forage production was measured prior to the first phase of grazing in November by taking height measurement and forage clippings from each pasture for each system. Grazing days were collected for each treatment throughout the grazing period and divided into fall and spring production.

Partial Budgeting

The average economic advantage between the two establishment systems is defined as the average net return of the NT forage establishment system minus the average net return of the CT forage establishment system. Because the winter forage and cattle were managed the same for each year and system we only consider the production costs that differ between the two systems in our analysis; that is, the costs associated with field preparation and planting activities. Average gross revenue for each system is calculated using the eight-year average number of grazing days measured in the study for each system.

Since cattle performance data were not obtained from the demonstration project, it was assumed that cattle realized an average daily gain of two-pounds per head per day for both systems. This assumption is supported by the findings reported by Anders et al., who report a four-year average daily gain for the NT forage system of 2.1 and 2.3 pounds for the fall and spring grazing phases, respectively, and for the CT forage system of 1.8 and 2.3 for the fall and spring grazing phases, respectively. Anders et al. reported that establishment method did not have a significant effect on average daily gain in their study. This finding from the Arkansas study conducted by Anders et al. seem to help solidify our assumption of equal animal performance for each system, even though that study was conducted at a different site with a different set of growing conditions. It is worth noting that the Arkansas study is the only known study in the region that measured cattle performance on forage produced with both NT and CT forage establishment methods.

Fixed ownership costs for tillage and planting machinery (i.e., tractors, tillage and seedbed preparation equipment, conventional drill and a NT drill) for both systems for a representative 640-acre farm were obtained from a study conducted by Epplin et al., 2005.[1] Epplin's estimates were utilized for two primary reasons. First, custom NT drill services for cereal grain forages are not well established in the region; and second, their estimates allowed us the opportunity to evaluate machinery labor expenses between the two establishment methods. We utilized a 2007 local retail price of $1.75 per pint of glyphosate herbicide, and a custom application rate of $4.00 per acre (Kletke and Doye). In addition, the estimated diesel fuel expense reported in Epplin et al. 2005 was re-calculated using a 2007 local price of $2.75 per gallon for both systems, instead of the $1.00 per gallon price they used. All fertilizer application was applied using custom application services. Lastly, $0.55 per pound of gain and a $10 per hour wage rate for operating farm machinery were assumed.

Average net return for each system was calculated as the difference between average gross revenue and the production costs that vary between each system. In addition, sensitivity analysis was conducted to determine how robust differences in the expected net returns between the two systems are to relative changes in uncertain variables, such as average daily gain, grazing days and prices of herbicide and diesel fuel.

Results

Forage production and grazing days for the CT and NT forage systems for each year are reported in Table 2. Average fall forage production based on clipping measurements taken prior to the placement of steers on the growing forage was substantially greater (416 lbs.) for the CT system than the NT system. This difference was statistically significant at a 95 percent level of confidence. Forage clippings were only taken in the fall, so differences in forage production between systems could not be evaluated for the spring grazing period. Measurements for grazing days were recorded in both the fall and spring grazing periods. In the fall grazing period, cattle grazing the NT forage establishment system realized a significantly greater number of grazing days in the fall (13 days) than they realized in the CT system. This difference was statistically significant at the 95 percent level of confidence.

At first glance, this result seemed to be a paradox; that is, it seemed contradictory that during the fall grazing period the CT system realized a significantly greater average level of fall forage production above the NT system, but during the same period the NT system, on average, realized a significantly greater number of grazing days (13 days) than the CT system. It turns out that over the eight-year study, cattle were not able to graze the CT pastures as efficiently and effectively as the NT pastures during periods of inclement weather. The NT pastures did not get as "boggy" as conventional tilled pastures, which resulted in substantially less forage damage by cattle and more days for the animals to access the forage over a typical grazing cycle. Anders et al. also reported a higher average number of grazing days for the no-till grazing system relative to the conventional grazing system; however, they did not report forage production data.

During the spring grazing period, cattle realized a greater number of grazing days on the NT pastures than they did on the CT pastures, but the difference was not significant at the 95 percent level of confidence. Because forage clipping data were not collected in the spring, we do not know if the same contradiction between forage production and grazing days existed between the two systems.

Estimates for gross receipts, operating expenses, fixed machinery ownership costs and net return to production costs that vary between systems are reported in Table 3. Average gross revenue (calculated as 8-year average grazing days times average daily gain times value of gain) for the NT system was about five percent greater (or $12.10 per acre) relative to the conventional-till system.

Net differences in production costs that vary between systems provides for an addition $24.34 per acre benefit to the NT system relative to the CT system. The NT system did require $3.28 per acre worth of herbicide (Glyphosate) and $6.00 per acre of herbicide application expenses, but the reduction in the quantity and hence cost of diesel fuel ($21.82), the reduction in the machinery labor expenses ($5.40) and the relative reduction in the cost associated with owning the tillage and planting equipment ($5.60) for the NT system more than compensated for the additional herbicide application expenses. In fact, there was an 84 percent reduction in the diesel fuel expenses associated with using NT in place of the CT systems. Sharp increases in herbicide requirements and application rates would reduce the value of NT; however, since the patent expiration of glyphosate, there has been a steady downward trend in its price.

The estimates provided by Epplin et al. (2005) for fixed ownership costs for tillage and planting equipment can be viewed as an upper bound on those costs, and that the average economic advantage of the NT system ($36.44) is likely to be sensitive to local differences in fixed ownership expenses. For example, a producer may have access to a custom NT drill service offered by a neighbor at a per acre rate that is substantially less than the cost we report in this paper. In that case, the economic advantage of using NT forage establishment would be greater to that producer. On the other hand, if a producer who currently utilizes CT establishment practices, but has fully depreciated his equipment, may in fact have reduced ownership costs compared to the estimates reported in this paper, and hence the average value of NT would be less to him. However, in this case, note that there is only about a $6 dollar difference between fixed ownership costs between the two systems, so in the latter example the producer who uses his own equipment would still incur the fuel, lube, repairs and labor expenses from using it, even at a reduced ownership expense. It is unlikely that he will be able to overcome differences between these expenses by not charging a fixed fee for owning his own equipment.

The eight-year average difference in net return of the NT system relative to the CT system was $36.44 per acre. Two separate breakeven analyses were conducted on average daily gain to determine how sensitive average daily gain is to the differences in the expected net return between the two systems. First, the average daily gain of cattle grazing the NT system relative to the CT system was calculated. Holding all other variables constant, if the average daily gain of cattle grazing the NT system was equal to 1.79 (a relative reduction of 15.5 percent), then the expected value of the NT system relative to the CT system would be zero. Second, the sensitivity of the average advantage of the NT system ($36.44 per acre) to animals on the conventional system was determined. Holding all other variables constant, if the average daily gain of the CT system was 2.3 pounds instead of 2 pounds (a relative increase of 14 percent), then the expected economic advantage of the NT system would reduce to zero. In either of these two scenarios, producers would likely choose not to adopt the NT forage establishment system. Hales et al. (2007) utilized the NT system described in this paper for a two year grazing trial and reported average daily gains of 2.6 and 3.1 pounds per day in 2005 and 2006 respectively.

Estimated average net return of NT and CT systems and differences in expected net return between systems for alternative levels of grazing days, price of herbicide, custom rate for herbicide application and price of diesel fuel are reported in Table 4. Holding all other variables constant, if the number of grazing days of the NT system was only 15 percent of those realized by the convention system (190 days instead of 224 days), then the $36 advantage would reduce to a disadvantage of $0.85 per acre. Conversely, if the number of grazing days of the NT system were to increase relative to the conventional system, the economic advantage would increase. The results are also sensitive to relative differences of grazing days for the conventional system. Prices for herbicide and diesel fuel also influence the economic advantage of the NT system. Table 4 shows that a relative increase in the price of glyphosate reduces the economic advantage of the no-till system. However, even at a high price, the economic advantage is only reduced by a relatively small amount. The analysis also shows that a relative increase in the price of diesel fuel increases the value of the NT system which is expected.

Summary

There are three primary economic factors that influence producers' decisions regarding whether or not they should adopt no-till forage establishment methods: (1) herbicide management expenses; (2) cost and efficiency of forage establishment equipment (NT drills); and (3) expenditures on diesel fuel. Recent changes in these factors provide the impetus to reinvestigate the economics of NT farming practices used to establish winter cereal forages for the stocker cattle grazing enterprise in the Southern Plains region of the U.S. The objective of this research was to determine the expected economic difference in net return associated with using a NT establishment practice relative to the conventional-till CT forage establishment system common to the region.

Using the partial budgeting approach, it was found that the average economic advantage of the NT conservation farming practice was approximately $36 per acre. Out of this value, the relative reduction in fuel, lube, repairs, machinery labor and operating interest expenses for the no-till system accounted for approximately $26 per acre, or about 66 percent of the average advantage. The relative reduction in fixed machinery ownership costs was approximately $6 per acre, and accounted for about 15 percent of the average value. Net benefits from the relative reduction in these factors more than compensate for the additional costs associated with purchasing and applying the herbicide glyphosate when establishing pastures using the NT system. Grazing days for each system and year were measured. Over the eight years of the study, the average grazing days for the NT system were 11 days greater than the CT system. As a result of this difference the NT system realized approximately $12 per acre greater revenue on average that the CT system, accounting for about 33 percent of the total value of the system.

Sensitivity analysis showed that the average economic advantage ($36.44 per acre) of NT system relative to the CT system was most sensitive to uncertainty regarding average daily gain, grazing days, price of herbicide, custom rate for herbicide application and price of diesel fuel. However, the level of sensitivity to relative changes in these factors was not found to be severe.

Information reported in this paper is valuable to winter forage producers, production scientists and forage and crop extension specialists in two primary ways. First, it has been shown that early adopters of new production systems or management practices (such as the NT system described in this paper) will typically only adopt them on a small portion of their farms in order to test the system under their own specific growing conditions. From these tests, producers glean important information, such as average daily gains, that they use to compare with their conventional practices. Once they obtain this information, they will be able to utilize the partial budgeting outlined in Table 3 using their own data. Second, production scientists working at regional experiment stations can implement grazing trials using the NT system described in this paper to determine its feasibility under the specific growing conditions found in their respective regions. In turn, they can then provide recommendations to area extension specialists who are working closely with producers in their regions that they consider to be early adopters.

A primary limitation of this study is the lack of data that reflect differences in environmental factors such as water quality and soil quality between the two systems. As a result, potential benefits to the environment could not be quantified into analysis of this study. In addition, the paper does not consider potential program payments and incentives associated with the adoption of conservation farming practices. Such benefits would likely increase the value of NT relative to the CT practices commonly used in the region. Lastly, estimates of the expected economic advantage of NT farming of winter forages for grazing needs to be determined for different farm sizes as different types and sizes of NT drill equipment is available at different prices and hence would likely influence costs of production and forage yields.

Endnote

[1] Epplin et al. (2005) used a farm machinery selection template (MACHSEL) to obtain estimates of machinery fixed costs associated with using tillage and planting equipment for the conventional-till and no-till establishment of winter wheat in Oklahoma. Conventional-till and no-till establishment methods for annual winter forages for stocker grazing are essentially the same as establishment methods used for winter wheat in the region. MACHSEL also provides the estimates for costs of diesel fuel, lube, repairs and machinery labor requirements necessary for operating the equipment with its calculations for fixed machinery ownership costs. MACHSEL was developed by Kletke and Sestak.

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Table 1. Field operations and stocker activity for CT and NT rye/ryegrass forage establishment systems

Field Operation	Month	Conventional-till	No-till
Moldboard Plow (used on 20% of Acres)	June	*	
Chisel (used on 80% of acres)	June	*	
Initial Application of Herbicide (Glyphosate)	June		*
Partial Application of Herbicide (Glyphosate)	August		*
Disk	August	*	
Broadcast (46-0-0)	August	*	*
Disk	September	*	
Band Fertilizer (18-46-0)	September	*	*
Plant Rye/Ryegrass (Conventional-Till Drill)	September	*	
Plant Rye/Ryegrass (No-Till Drill)	September		*
Place Stocker Cattle on Forage	November		
Broadcast (46-0-0)	February	*	*
Remove Stocker Cattle	June	*	*

Table 2. F orage production and steer grazing days for CT and NT winter forage systems by year (1999-2003)

	Production Period									
Establishment Method/Variable	1996	1997	1998	1999	2000	2001	2002	2003	Age.†	St. Dev.
Conventional-Till Establishment										
Forage production (lbs/acre)	1525	1778	995	1560	730	2387	1297	2390	1583[a]	558
Grazing days per acre, period 1	82	95	79	72	0	91	75	50	68[c]	29
Grazing days per acre, period 2	165	145	160	125	136	188	87	154	145[e]	28
Grazing days per acre, total	247	240	239	197	136	279	162	204	213[f]	44
No-Till Establishment										
Forage production (lbs/acre)	1350	981	610	1245	340	1650	1755	1408	1167[b]	462
Grazing days per acre, period 1	124	97	78	71	0	77	108	94	81[d]	35
Grazing days per acre, period 2	127	142	112	133	171	192	91	178	143[e]	32
Grazing days per acre, total	251	239	190	204	171	269	199	272	224[f]	36

† Results with letters that differ are significantly different at the 0.05 level. For example, fall forage production was significantly different between systems, but steer days per acre in the spring were not different between systems.

Table 3. Estimates of gross revenue, variable and fixed production costs and net return for NT and CT rye/ryegrass forage establishment systems ($/acre)

Receipt/Expense	System[a] NT($/ac)	CT ($/ac)	DF ($/ac)
Average Gross Receipts[b]	246.4	234.3	12.10
Production Costs that Vary by System			
Herbicide Expenses	3.28	0.00	3.28
Custom Herbicide Application Expenses	6.00	0.00	6.00
Diesel Fuel, Lube and Repairs for Tillage and Planting Activities	4.03	25.86	-21.82
Machinery Labor Expenses	1.40	6.80	-5.40
Portion of Annual Operating Capital for Inputs that Differ Between Systems	0.72	1.52	-0.80
Fixed Machinery Expenses for Tillage and Planting	22.49	28.09	-5.60
Total Operating Plus Machinery Cost	37.93	62.27	-24.34
Net Return to Field Preparation and Planting ($/acre)	208.47	172.03	36.44

[a] NT is no-till; CT is conventional-till; and DF is the difference in net return between no-till and conventional till systems.
[b] Calculated as total grazing days times average daily gain per acre times value of gain. Average daily gain was assumed to be two pounds per day for each system and value of gain was assumed to be $0.55 per pound for each system.

Table4. Average net return of no-till and conventional till systems and differences in average net return between no-till and conventional till systems for alternative levels of grazing days, price of herbicide, custom rate for herbicide application, and price of diesel fuel

Grazing days for the NT system	Grazing days for the CT system	Price of glyphosate herbicide ($/pint)	Custom rate for applying herbicide ($/acre)	Price of diesel fuel ($/gallon)	Net return for the NT system ($/acre)	Net return for the CT system ($/acre)	Difference in net return between NT and CT systems ($/acre)
Change in number of NT grazing days							
190					171.18	172.03	-0.85
200					182.15	172.03	10.12
224[a]	213[a]	1.75[a]	4.00[a]	2.75[a]	208.47	172.03	36.44
235					220.54	172.03	48.51
260					247.96	172.03	75.93
Change in number of CT grazing days							
	180				208.47	135.97	72.51
	197				208.47	154.55	53.93
224[a]	213[a]	1.75[a]	4.00[a]	2.75[a]	208.47	172.03	36.44
	230				208.47	190.61	17.86
	247				208.47	209.19	-0.71
Change in price of glyphosate							
		0.75			210.44	172.03	38.41
224[a]	213[a]	1.75[a]	4.00[a]	2.75[a]	208.47	172.03	36.44
		2.75			206.51	172.03	34.47
		3.75			204.54	172.03	32.51
		4.75			202.57	172.03	30.54
Change in custom rate for applying herbicides							
224[a]	213[a]	1.75[a]	4.00[a]	2.75[a]	208.47	172.03	36.44
			6.00		205.33	172.03	33.29
			8.00		202.18	172.03	30.15
Change in price of diesel fuel							
				1.50	209.73	180.21	29.52
				1.75	209.48	178.57	30.91
224[a]	213[a]	1.75[a]	4.00[a]	2.75[a]	208.47	172.03	36.44
				3.75	207.47	165.49	41.98
				5.00	206.21	157.31	48.89

[a] represent the baseline parameter values