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Economic Advantage of No-Tilling Winter Forages for Stocker Grazing

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 $90 per hectare 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.

Keywords: conservation farming, economics, no-till establishment, stocker cattle grazing, winter forage

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 US (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.

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% 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 value 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

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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 no-till winter rye/ryegrass forage production systems

are reported in Table 1. Field operations for the conventional-till 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% 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% 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 glyphosate was applied in late June followed by a partial

application in August to only the places within each field that did not sufficiently

respond to the first application. These herbicide treatments were conducted in

August, prior to establishing winter forage 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. Table 2 provides a list of the operating input prices

and application rates for both systems. Application of fertilizer and seed are

assumed to be the same for each system.

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 (16.6 hectares for the conventional-till system and 9.3 hectares for the no-till 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

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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% 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 3-5 days in the fall phase

and 2-3 days in the spring phase.

Stocking rates ranged between 447 and 672 kg of beef per hectare during

the fall phase of growth (i.e., November 1 – March 1) and between 894 and 1343

kg of beef per hectare 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 relative average difference in net return between the two

establishment systems is defined as the expected net return of the no-till forage

establishment system minus the expected net return of the conventional-till forage

establishment system. Because the winter forage and cattle were managed the

same for each year and system we only consider the costs that are expected to

differ between the two systems in our analysis; that is, the costs associated with

field preparation and planting activities. Expected 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 0.90 kg 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 no-till forage system of 0.95 and 1.04 kg for the fall and spring grazing phases, respectively, and for the conventional-till forage system of 0.82 and 1.04 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 no-till and conventional-till forage establishment methods.

Fixed ownership costs for tillage and planting machinery (i.e., tractors, tillage and seedbed preparation equipment, conventional drill, and a no-till drill) for both systems for a representative 259-hectare farm were obtained from a study conducted by Epplin et al. 2005.[1] Epplin's estimates were utilized for two primary reasons. First, custom no-till drill services for cereal grain forages are not well established in the region, and second their estimates allowed us the

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opportunity to evaluate machinery labor expenses between the two establishment

methods. We utilized a 2007 local retail price of $3.69 per liter of glyphosate

herbicide, and a custom application rate of $9.88 per hectare (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 $0.73 per liter for both systems, instead

of the $0.265 per liter price they used. All fertilizer application was applied using

custom application services. Lastly, $1.21 per kg of gain and a $10 per hour wage

rate for operating farm machinery were assumed.

Expected net return for each system was calculated as the difference

between expected gross revenue and total operating plus machinery costs. 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 conventional till and no-till forage

systems for each year are reported in Table 3. Average fall forage production

based on clipping measurements taken prior to the placement of steers on the

growing forage was substantially greater (188 kg) for the conventional-till system

than the no-till 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 no-till forage establishment system realized a significantly greater number of grazing days in the fall (13 days) than they realized in the conventional-till system. This difference was statistically significant at the 95 percent level of confidence.

During the spring grazing period, cattle realized a greater number of grazing days on the no-till pastures than they did on the conventional-till 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 land, labor, and management by system are reported in table 4. Expected gross receipts (calculated as 8-year average grazing days times average daily gain times value of gain) for the no-till system was about five percent greater (or $29.88 per hectare) relative to the conventional-till system. Again, note that this estimate is based on the assumption that cattle performance in terms of average daily gains was the same for both systems.

Net differences in operating plus machinery expenses provides for an addition $60.12 per hectare benefit to the no-till system relative to the conventional-till system. The no-till system did require approximately $22.97 per hectare worth of herbicide (glyphosate) and herbicide application expenses, but the reduction in the quantity and hence cost of diesel fuel ($53.9 per hectare), the reduction in the machinery labor expenses ($13.34 per hectare) and the relative

reduction in the cost associated with owning the tillage and planting equipment ($13.83) for the no-till 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 no-till in place of the conventional-till systems. Sharp increases in herbicide requirements and application rates would reduce the value of no-till; 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 value of the no-till system ($90 per hectare) is likely to be sensitive to local differences in fixed ownership expenses. For example, a producer may have access to a custom no-till drill service offered by a neighbor at a per hectare rate that is substantially less than the cost we report in this paper. In that case, the value of using no-till forage establishment would be greater to that producer. On the other hand, if a producer who currently utilizes conventional-till 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 no-till would be less to him. However, in this case note that there is only about a $14.82 per hectare 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 no-till system relative to the conventional-till system was $90 per hectare. Stocker cattle response data was not measured. As a result, 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 no-till system relative to the conventional-till system was calculated. Holding all other variables constant, if the average daily gain of cattle grazing the no-till system was equal to 0.81 kg (a relative reduction of 15.5 percent) then the expected value of the no-till system relative to the conventional-till system would be zero. Second, the sensitivity of the average advantage of the no-till system ($90 per hectare) to animals on the conventional system was determined. Holding all other variables constant, if the average daily gain of the conventional-till system was 1.04 kg instead of 0.91 kg (a relative increase of 14 percent) then the expected economic advantage of the no-till system would reduce to zero. In either of these two scenarios, producers would likely choose not to adopt the no-till forage establishment system. Hales et al. 2007 utilized the no-till system described in this paper for a two year grazing trial and reported average daily gains of 1.18 and 1.41 kg per day in 2005 and 2006, respectively.

Estimated expected net return of no-till and conventional-till 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 5. Holding all other variables constant, if the

number of grazing days of the no-till system was only 15% of those realized by

the convention system (190 days instead of 224 days), then the $90 per hectare

advantage would reduce to a disadvantage of $2.09 per hectare. Conversely, if

the number of grazing days of the no-till 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

no-till system. Table 5 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 no-till 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 (no-till drills), and (3) expenditures on diesel fuel.

Recent changes in these factors provide the impetus to reinvestigate the

economics of no-till farming practices used to establish winter cereal forages for

the stocker cattle grazing enterprise in the southern Plains region of the US. The

objective of this research was to determine the expected economic difference in

net return associated with using a no-till (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 no-till conservation farming practice was approximately $90 per hectare. 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 $64.22 per hectare, or about 66 percent of the average advantage. The relative reduction in fixed machinery ownership costs was approximately $14.82 per hectare, 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 no-till system.

Grazing days for each system and year were measured. Over the eight years of the study, the average grazing days for the no-till system were 11 days greater than the conventional-till system. As a result of this difference the no-till system realized approximately $29.64 per hectare greater revenue on average that the conventional-till system, accounting for about 33 percent of the total value of the system.

Sensitivity analysis showed that the economic advantage ($90 per hectare) of no-till system relative to the conventional-till 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.

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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 no-till 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 4 using their own data. Second, production scientists working at regional experiment stations can implement grazing trials using the no-till system described in this paper to determine its feasibility under the specific growing conditions found in their specific 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 expected economic advantage in 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 no-till relative to the conventional-till practices commonly used in the region. Lastly, estimates of the expected value of no-till

farming of winter forages for grazing needs to be determined for different farm

sizes as different types and sizes of no-till drill equipment is available at different

prices and hence would likely influence costs of production and forage yields.

Footnotes

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 Conventional-Till and No-Till Rye/Ryegrass Forage Establishment Systems

Field Operation	Month	Conventional-till	No-till
Moldboard Plow (used on 20% of hectares)	June	*	
Chisel (used on 80% of hectares)	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. Operation Inputs for Conventional-Till and No-Till Rye/Ryegrass Forage Establishment Systems

Operating Inputs	Date	Unit	Price ($)	CT	NT
Glyphosate	June	L	0.83		0.59
Custom Application		Hectare	9.88		1.5
Urea (46-0-0)	August	Kg	1.10	89.3	89.3
Custom Application		Hectare	7.41	1	1
Rye Seed	September	Kg	0.054	89.3	89.3
Ryegrass Seed	September	Kg	1.10	13.4	13.4
Urea (46-0-0)	February	Kg	1.10	89.3	89.3
Custom Application		Hectare	7.41	1	1

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Table 3. Forage Production and Steer Grazing Days for Conventional Till and No-Till Winter Forage Systems by Year (1999-2003)

Establishment Method/Variable	Production Period (1996-2003)								Avg.†	St. Dev.
	96	97	98	99	00	01	02	03		
Conventional-Till Establishment										
Forage production (kg ha^{-1})	1362	1588	889	1393	652	2132	1158	2134	1413[a]	499
Grazing days ha^{-1}, period 1	203	235	195	178	0	225	185	124	168[c]	71
Grazing days ha^{-1}, period 2	408	358	395	309	336	464	215	380	358[e]	70
Grazing days ha^{-1}, total	610	593	590	487	336	689	400	504	526[f]	110
No-Till Establishment										
Forage production (kg ha^{-1})	1206	876	545	1112	304	1473	1567	1257	1042[b]	412
Grazing days ha^{-1}, period 1	306	240	193	175	0	190	267	232	200[d]	86
Grazing days ha^{-1}, period 2	314	351	277	329	422	474	225	440	354[e]	80
Grazing days ha^{-1}, total	620	590	469	504	422	664	492	672	554[f]	89

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

Table 4. Estimates of Gross Revenue, Variable and Fixed Production Costs, and Net Return for No-till and Conventional-Till Rye/Ryegrass Forage Establishment Systems ($/acre)

Receipt/Expense	System[a]		
	NT ($ ha^{-1})	CT ($ ha^{-1})	DF ($ ha^{-1})
Average Gross Receipts[b]	608.61	578.72	29.89
Production Costs that Vary by System			
Herbicide Expenses	8.10	0.00	8.10
Custom Herbicide Application Expenses	14.82	0.00	14.82
Diesel Fuel, Lube and Repairs for Tillage and Planting Activities	9.96	63.86	-53.90
Machinery Labor Expenses	3.46	16.80	-13.34
Portion of Annual Operating Capital for Inputs that Differ Between Systems	1.78	3.77	-1.98
Fixed Machinery Expenses for Tillage and Planting	55.55	69.38	-13.83
Total Operating Plus Machinery Cost	93.68	153.81	-60.12
Net Return to Field Preparation and Planting ($ ha^{-1})	514.93	424.92	90.01

[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 hectare 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 $1.21 per kilogram for each system.

Table 5. Estimated net return of no-till and conventional till systems and differences in estimated 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 ($ L^{-1})	Custom rate ($ ha^{-1}) for applying herbicide	Price of diesel fuel ($ L^{-1})	Net return for the NT system ($ ha^{-1})	Net return for the CT system ($ ha^{-1})	Difference in net return between the NT and CT systems ($ ha^{-1})
Change in number of NT grazing days							
190					422.81	424.91	-2.10
200					449.91	424.91	25.00
224[a]	213[a]	0.83[a]	9.88[a]	0.73[a]	514.92	424.91	90.01
235					544.73	424.91	119.82
260					612.46	424.91	187.55
Change in number of CT grazing days							
	180				514.92	335.85	179.10
	197				514.92	381.74	133.21
224[a]	213[a]	0.83[a]	9.88[a]	0.73[a]	514.92	424.91	90.01
	230				514.92	470.81	44.11
	247				514.92	516.70	-1.75
Change in price of Glyphosate							
		0.36			519.79	424.91	94.87
224[a]	213[a]	0.83[a]	9.88[a]	0.73[a]	514.92	424.91	90.01
		1.30			510.08	424.91	85.14
		1.78			505.21	424.91	80.30
		2.25			500.35	424.91	75.43
Change in custom rate for applying herbicides							
224[a]	213[a]	0.83[a]	9.88[a]	0.73[a]	514.92	424.91	90.01
			14.82		507.17	424.91	82.23
			19.76		499.38	424.91	74.47
Change in price of diesel fuel							
				0.71	518.03	445.12	72.91
				0.83	517.42	441.07	76.35
224[a]	213[a]	0.83[a]	9.88[a]	0.73[a]	514.92	424.91	90.01
				1.77	512.45	408.76	103.69
				2.37	509.34	388.56	120.76

[a] represent the baseline parameter values