EXTENSION

AGEC-336

What is the Value of No-Tilling to Establish Winter Cereal Pasture for Growing Beef Cattle in Oklahoma?

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Introduction

Grazing winter cereal pasture with light weight stocker cattle is an important economic activity in the Southern Great Plains (SGP). Historically, forage producers in the region have used clean-till (CT) methods to establish winter pasture on their farms, which typically include plowing, discing and field cultivating. No-till (NT) establishment methods are being promoted to have greater agronomic and economic benefits compared to CT methods. The agronomic benefits of NT include increased soil organic matter, reduced erosion, better soil fertility, improved soil health, increased moisture retention and availability (Anders et al., 2010; Schmidt & Triplett, 1967; Moschler et al., 1969). The economic benefits reported include significant reductions in cost of fuel and machinery labor compared to CT (Biermacher et al., 2009; Sestak et al., 2022). Despite the economic advantages that have been reported for NT over CT methods, its adoption in the SGP has been low, primarily because NT plots often times produce lower yields compared to CT (Varner et al., 2011; Wiatrak et al., 2004). In this fact sheet, we determine the net economic value of using NT to establish winter pasture for a stocker cattle graze-out production system in Oklahoma, and measure how the net economic value of NT responds to incremental changes in the prices of glyphosate and diesel fuel and the wage rate for machinery labor.

Methods and Data

This study used data from a four-year (2009/2010– 2012/2013) winter small grain stocker cattle grazing-only (i.e., no grain) study conducted at the Noble Research Institute's Pasture Research Farm located near Ardmore in south-central Oklahoma. The grazing-only study was conducted on a 100-acre cropland site subdivided into ten 10-acre grazing pastures. Five pastures were established using CT methods and the remaining five pastures were established by NT methods. The activities used for establishing pastures under each system are reported chronologically in Table 1. Tillage operations for the CT pastures involved chisel-plowing, tilling with an offset disc, and a subsequent tilling with a tandem disc and seedbed cultivation using a field cultivator. The NT pastures did not require any tillage operations; however, NT pastures did receive an application of one quart/acre of herbicide glyphosate in mid-August and again in the first week of September to burn down existing wheat stubble and weeds. A conventional drill and a no-till drill were used to plant 120 pounds/acre mixture of wheat seed and 15 pounds/acre annual ryegrass on the CT and NT pastures, respectively. In addition, 80 pounds/acre of nitrogen in the form of urea (46-0-0), 40 pounds/acre of phosphorous (as P2O5), and 30 pounds/acre of potassium (as K2O) were applied to all ten pastures at the time of establishment in September. Based on soil test recommendations, lime (100% ECCE) was applied at a rate of a ton/acre every third year. Also, 1.64 ounces/acre of Lambda-cyhalothrin (Silencer, ADAMA) was applied to all 10 pastures after plant emergence in the fall to control fall armyworm, and 13 ounces/acre of 2,4-D amine was applied in the early spring to all pastures to control broadleaf weeds.

1 From the fall of 2003 to spring of 2008, the 100-acre study site was used to demonstrate a NT-established winter small grain pasture stocker cattl grazing-only system common to the region. In an effort to reduce the effects of the previous years' establishment method on the study, one year prior to project initiation, the 100-acre study site was established to winter small grain pasture using the CT establishment method.

Each year during the first week of October, a typical set of black-hided steers weighing on average 430 pounds/head were purchased from local sale barns. Steers were observed daily for signs of bovine respiratory diseases and were preconditioned for at least 44 days in each year of the study. A put-and-take system was used to manage grazing on the pastures. Tester steers were placed on pasture when forage reached 1,340 pounds/acre of dry matter and were removed when forage mass declined to 1,200 pounds/acre. Grazer steers were added and removed from pasture when necessary to maintain equal grazing pressure on pastures. Measures of animal performance, including body weight (pounds/head) at purchase, grazing initiation and grazing termination; average daily gain (pounds/day); grazing period (days); steer grazing days (head days); stocking rate (head/acre); and total gain (pounds/head) during the grazing period; and total gain (pounds/head) across cattle ownership (preconditioning to grazing termination) were calculated for each pasture establishment system.

Enterprise budgeting techniques were used to calculate average revenues, costs and net return for each establishment system. Gross revenue for each system for each year was calculated as the 10-year average value of gain ($/pound) multiplied by total gain (pounds/acre) measured during the period of cattle ownership. Costs for marketing and preconditioning expenses were calculated on a ($/head) basis then multiplied by the stocking rate to convert them to a ($/acre) basis. Costs for tillage, planting, fertilizers and pesticides were all calculated on a ($/acre) basis. Marketing costs at the sale barn included commission, feed, yardage, beef checkoff program, insurance, veterinary examination and transportation. Custom machinery rates were used to calculate the costs for tillage, planting, and fertilizer and pesticide applications (Sahs & Bir, 2020). Prices for fertilizers and pesticides were obtained from a local farm input supply dealer, Stillwater Milling Company, Davis, Oklahoma (Table 2). Sensitivity analysis was conducted to determine how sensitive the relative net returns between CT and NT establishment systems are to incremental changes in the prices of glyphosate, fuel and wage rates.

Results

Measures of animal performance for the CT and NT systems are reported in Table 3. On average, grazing started 13 days earlier for the CT pastures compared to the NT pastures because of differences in pasture growth between the two systems. The reason for this difference was because of the low organic matter content in the soil, which made the soil less stable. In such conditions, tilling the soil can improve seed-to-soil contact for faster germination, emergence and root development. Stocking rates between CT and NT systems were similar (1.19 versus 1.20 head/acre) (P = 0.0250). However, because grazing on the NT pasture started later than grazing on the CT pastures, the NT system realized 17.56 fewer (P = <0.0001) steer grazing days compared to CT pastures. Although steer grazing days were greater for the CT system, steers that grazed the NT pastures realized an additional (P = 0.0007) average daily gain of 0.04 pounds/day compared to steers that grazed the CT pastures. However, cattle that grazed the CT pastured realized an extra 35.39 pounds/acre total gain during the grazing period (P = <0.0001) and 10.44 lbs/acre total gain over the entire period of cattle ownership (P = 0.0084). A research study in Arkansas reported similar animal performance for cattle grazing pastures established by NT and CT methods (Bowman et al., 2008).

Costs of production, revenues and net returns by system are also reported in Table 3. Costs of fertilizer, seed, insecticide and herbicide to control annual broadleaf weeds did not differ between systems. The differences in costs between systems were due to activities associated with preconditioning; marketing; glyphosate application; machinery labor, fuel and fixed costs associated with forage establishment; and interest on operating capital and cattle ownership. Preconditioning costs were $32.43/acre greater for the NT system because of the delayed grazing due to stunted pasture growth on the NT plots. Marketing costs were slightly higher for the NT system because of its slightly higher stocking rate compared to CT. Machinery costs for fuel, labor and capital recovery (interests and depreciation) were $19.05/acre, $43.84/acre and $23.31/acre greater for CT compared to NT. These costs were approximately 72%, 64%, and 52% more for the CT system compared to the NT establishment method. Overall, total production cost was $42.29/acre lower for the NT pastures relative to the CT pastures.

The average value of gain for the CT and NT system are $1.14/pound and $1.13/pound, respectively. Based on the total gain across the period of cattle ownership of 569.22 pounds/acre and 558.78 pounds/acre for the CT and NT systems, gross revenues for the two systems are $647.96/acre and $633.54/acre, respectively or a $14.42/acre advantage favoring the CT system. This advantage is due to the higher level of total gain realized by the CT system compared to NT. However, due to the relatively higher costs of establishing the CT pastures, the net return per acre was $27.88/acre higher for the NT system compared to the CT system.

The results of the sensitivity analysis (Table 4) suggest that the $27.88/acre relative value of the NT system is not overly sensitive to the price of glyphosate. For instance, if the price of glyphosate increases by 30% from $23.04/gallon to $29.44/gallon, the relative value of NT (i.e., the difference in net return between CT and NT) will decline by $3.36/acre. For an increase of 60%, the relative value of NT will decline by $7.09. Holding all other variables constant, the net returns between the two systems would be the same at a price of glyphosate equal to $79.36/gallon. It is unlikely that the price of glyphosate will increase to that amount in the near future.

The relative value of the NT system increases with increases in the price of diesel fuel. This is so because CT requires more fuel on each acre relative to NT. For instance, if the price of fuel increases by 60% (i.e., from $2.50/gallon to $4.01/gallon), the net return of the CT system is expected to decline from $177.04/acre to $41.32/acre (a 77% reduction), increasing the relative value of NT from $27.88/acre to $163.6/acre.The results also indicate that the relative value of the NT system increases with increases in the wage rate for labor used to operate machinery. For instance, increasing the wage rate by 100% from $7.50/hour to $15/hour reduced the net return of the CT system from $177.04/acre to $150.47/acre (a 15% reduction), increasing the value of the NT system from $27.88/acre to $46.97/acre. Reductions in the wage rate would increase the relative net return between the CT and NT system; however, it is unlikely that the wage rate will decline below the base-case rate of $7.50/hour.

Conclusions

Utilizing NT methods to establish winter cereal pasture for stocker cattle grazing have substantial economic benefits in Oklahoma. The results indicate that stocker cattle realized a higher total gain and gross revenue on pastures established using CT compared to NT. However, the average net return was greater for the NT system because of the greater costs incurred with the CT system. In addition, sensitivity analysis suggests that the $27.88 value of the NT system is resilient to varying levels of the price of glyphosate, price of fuel for machinery and the wage rate for machinery labor.

Comprehensive details about this study have been published in the Agronomy Journal and can be accessed at acsess.onlinelibrary.wiley.com/doi/epdf/10.1002/agj2.21281

Table 1. Chronology of production activities by month and establishment system

Production Activity	Month	Clean -till (CT)	No-till (NT)
First application of glyphosate for chemical burndown	August		x
Second application of glyphosate for chemical burndown	September		x
Apply lime at 100% ECCE (every third year)	–	x	x
Chisel plowing	–	x	
Offset discing	–	x	
Tandem discing	–	x	
Field cultivation	–	x	
Plant small grain seed with conventional drill	–	x	
Plant small grain seed with no-till drill	–		x
Apply N, P2O5, and K2O fertilizers	–	x	x
Apply insecticide (Lambda-cyhalothrin) to control armyworm	October	x	x
Purchase and precondition stocker steers	–	x	x
Turn out stocker cattle on winter pasture	November	x	x
Apply herbicide (2,4-D) to control broadleaf weeds	March	x	x
Terminate grazing	April	x	
Terminate grazing	May		x
Offset discing to incorporate stubble	June	x	

Table 2. Prices and custom rates for operating inputs

Activity	Unit	Price
N (46-0-0)	$/lb	0.34
P2O5 (18-46-0)	$/lb	0.40
K2O (0-0-60)	$/lb	0.40
Lime (100% ECCE)	$/ton	38.60
Wheat seed	$/lb	0.25
Ryegrass seed	$/lb	0.25
Glyphosate	$/gal	23.04

2,4-D Amine	$/gal	21.30
Lambda-cyhalothrin (Silencer)	$/gal	50.00
Fuel	$/gal	2.50
Wage rate	$/hour	7.50
Interest rate on operating capital and steer ownership	(%)	5.5
Custom fertilizer application	$/acre	7.82
Custom herbicide application	$/acre	7.60
Custom chisel plow	$/acre	14.11
Custom tandem discing	$/acre	12.00
Custom offset discing	$/acre	12.86
Custom no-till drilling	$/acre	19.00
Custom clean-till drilling	$/acre	15.32
Custom field cultivation	$/acre	13.04

Table 3. Average measures of animal performance and average costs, revenues and net returns to land, management, and overhead by establishment systems

Variables of Interest	**Clean-till (CT)**	**No-till (NT)**	**Difference (CT-NT)**	***P*-value**
Measures of Animal Performance				
Purchase date	1-Oct	1-Oct	0	–
Purchase weight (lbs)	431.3	431.3	0	–
Grazing initiation date	14-Nov	27-Nov	-13	–
Grazing initiation weight (lbs)	497.71	517.82	-20.11	< 0.0001
Grazing termination date	30-Apr	5-May	-5	–
Grazing termination weight (lbs)	892.83	898.78	-5.95	0.0084
Grazing period (days)	167	150.7	16.3	< 0.0001
Average daily gain (lbs/day)	2.47	2.51	-0.04	0.0007
Stocking rate (head/acre)	1.19	1.2	-0.01	0.0250
Steer grazing days (head days)	198.52	180.96	17.56	< 0.0001
Total gain during grazing period (lbs/acre)	490.27	454.88	35.39	< 0.0001
Total gain across cattle ownership (lbs/acre)	569.22	558.78	10.44	0.0084
Economics				
Cattle preconditioning costs ($/acre)	105.85	138.28	-32.43	–
Cattle marketing and mortality costs ($/acre)	64.31	64.62	-0.31	–
Glyphosate for chemical burn down ($/acre)	0	11.41	-11.41	–
Fertilizer (N, P2O5, K2O, lime) ($/acre)	67.67	67.67	0	–
Seed cost ($/acre)	33.75	33.75	0	–
Herbicide for annual weeds control ($/acre)	13.18	13.18	0	–
Insecticide to control armyworm ($/acre)	1.56	1.56	0	–
Machinery labor ($/acre)	26.53	7.48	19.05	–
Machinery fuel, lube, and repairs ($/acre)	68.41	24.57	43.84	–
Machinery fixed cost ($/acre)	44.68	21.37	23.31	–
Interest on operating capital ($/acre)	18.09	17.21	0.88	–
Interest on capital for owning cattle ($/acre)	26.88	27.54	-0.66	–
Total cost ($/acre)	470.91	428.62	42.29	–
10-Year average price at purchase ($/lb)	1.7	1.7	0	–
10-Year average price at end of grazing ($/lb)	1.41	1.41	0	–

Value of gain ($/lb.)	1.14	1.13	0	–
Gross revenue ($/acre)	647.96	633.54	14.42	–
Net returns ($/acre)	177.04	204.92	-27.88	–

Table 4. Relative changes in expected net returns due to changes in prices of glyphosate, fuel and machinery labor

Input	Price Scenario	Price	Clean-till (CT)	No-till (NT)	Difference (CT-NT)
Glyphosate ($/gallon)	Base-case	23.04	177.04	204.92	-27.88
	Base-case minus 30%	15.36	177.04	208.72	-31.68
	Base-case plus 30%	29.44	177.04	201.56	-24.52
	Base-case plus 60%	37.12	177.04	197.83	-20.79
	Base-case plus 90%	43.52	177.04	194.63	-17.59
Fuel ($/gallon)	Base-case	2.50	177.04	204.92	-27.88
	Base-case plus 30%	3.26	156.24	197.44	-41.20
	Base-case plus 60%	4.01	135.72	190.08	-54.35
	Base-case plus 90%	4.77	114.92	182.60	-67.68
	Base-case plus 120%	5.49	95.22	175.52	-80.30
Machinery labor ($/ hour)	Base-case	7.50	177.04	204.92	-27.88
	Base-case plus 50%	9.75	169.06	202.68	-33.62
	Base-case plus 100%	15.00	150.47	197.44	-46.97
	Base-case plus 150%	18.75	137.19	193.71	-56.52
	Base-case plus 200%	22.50	123.92	189.97	-66.05

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