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A. K. Watson
University of Nebraska-Lincoln, awatson3@unl.edu

T. J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Walter H. Schacht
University of Nebraska-Lincoln, wschacht1@unl.edu

G. E. Erickson
University of Nebraska-Lincoln, gerickson4@unl.edu

D. R. Mark
University of Nebraska-Lincoln

See next page for additional authors

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Smooth bromegrass pasture beef growing systems: Fertilization strategies and economic analysis[1]

A. K. Watson,* T. J. Klopfenstein,*[2] W. H. Schacht,† G. E. Erickson,* D. R. Mark,‡ M. K. Luebbe,* K. R. Brink,† and M. A. Greenquist*

*Department of Animal Science, University of Nebraska, Lincoln 68583-0908; †Department of Agronomy and Horticulture, University of Nebraska, Lincoln 68583-0915; and ‡Department of Agricultural Economics, University of Nebraska, Lincoln 68583-0922

ABSTRACT

In recent years, prices for N fertilizer have increased dramatically, reducing net returns of fertilized pasture systems. A 5-yr study from 2005 to 2009 was conducted to evaluate management strategies and relative differences in profitability for 3 methods of backgrounding calves on smooth bromegrass pastures. Forty-five steers were used each year for a total of 225 animals in a randomized complete block design. Treatments included pastures fertilized in the spring with 90 kg N/ha (FERT), nonfertilized pastures with calves supplemented daily with dried distillers grains plus solubles (DDGS) at 0.6% of BW (SUPP), and control (CONT) pastures that had no fertilizer or supplementation applied. Pastures were rotationally stocked and put-and-take cattle were used to maintain similar grazing pressure on all treatments. Forage production was greatest for the FERT paddocks, intermediate for SUPP paddocks, and least for CONT paddocks ($P < 0.01$). Stocking rates were greater for SUPP pastures compared with nonfertilized pastures because of increased forage production and replacement of approximately 0.79 kg of forage for each 1 kg of supplement fed. At the conclusion of grazing, SUPP steers were 40 kg heavier than either the FERT or CONT steers, which resulted in increased gross revenue of \$44.14/steer for the SUPP treatment ($P < 0.01$). Net returns were greatest for SUPP at \$17.55/steer ($P < 0.01$), whereas both the CONT and FERT treatments had negative net returns of −\$6.20 and −\$8.71/steer, respectively. In the future, the relationship between prices for land, N fertilizer, and DDGS will affect the net returns of all 3 treatments.

Key words: beef cattle, dried distillers grains plus solubles, economics, fertilizer, supplementation

INTRODUCTION

With increasing grain costs, growing cattle on pasture before placement in the feedlot may become more economically favorable. Nitrogen fertilizer can be used to increase forage yields of pastures to increase stocking rates. In eastern Nebraska, many studies have reported increasing DM yields of forage with increasing N fertilization rates. Rehm et al. (1971) showed DM yields of 1,100, 3,571, and 5,076 kg/ha of smooth bromegrass (*Bromus inermis*) for N fertilizer rates of 0, 45, and 90 kg/ha, respectively. Nitrogen fertilizer prices are increasing because of escalating energy prices and increasing demand for N fertilizer, largely because of high grain prices. Another source of N fertilizer for pastures is from grazing cattle that are supplemented on pasture.

Supplementing grazing cattle with dry distillers grains with solubles (**DDGS**) supplies the cattle with excess N in their diet as well as increasing ADG of the cattle (Klopfenstein et al., 2007). When cattle have excess N in their diet, the majority of it is excreted in the urine as urea and can be taken up by plants. Spatial distribution of urea through excretion of urine onto pastures by cattle may be improved with higher stocking densities commonly resulting from more

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[2] Corresponding author: tklopfenstein1@unl.edu

intensive, rotational grazing systems (Haynes and Williams, 1993). With recent increases in production of ethanol from grain sources, DDGS have become a common, relatively inexpensive source of CP, energy, and P for cattle. Typically, demand for DDGS is lower during the summer months because of decreased numbers of cattle on feed in feedyards. This results in lower DDGS prices, which is ideal for producers supplementing DDGS to grazing cattle during this time period. Feeding supplements to growing cattle on pasture can also decrease forage intake (Horn and McCollum, 1987; Moore et al., 1999). By replacing forage intake and possibly increasing forage production through N cycling, DDGS supplement can increase stocking rates.

The objective of this experiment was to determine both cattle and pasture performance under 3 different combinations of pasture N fertilization and DDGS supplementation and the economic implications of these treatments.

MATERIALS AND METHODS

Data were collected in 5 consecutive years, from 2005 through 2009, at the University of Nebraska's Agriculture Research and Development Center near Mead, Nebraska, on smooth bromegrass pastures. Results from 2005 through 2007 have been previously reported by Greenquist et al. (2009) and will be added to the results from 2008 and 2009 in this paper. The combined data from all 5 yr are used in the economic analysis. Pasture and animal management were the same all 5 yr and are described in detail by Greenquist et al. (2009). All animals involved in this study were managed in accordance with the protocols approved by the Animal Care and Use Committee at the University of Nebraska. Three treatments were applied: 1) **SUPP**—supplemented treatment calves received 0.6% BW in DDGS (DM basis) with pastures receiving no additional fertilizer; 2) **FERT**—pastures received 90 kg N/ha in the spring (approximately March 30), the calves in FERT received no supplemental DDGS; and 3) **CONT**—pastures received no N fertilization and calves were not supplemented with DDGS.

Pasture and Animal Management

Each year 45 crossbred steers (325 ± 22 kg) were used in a randomized complete block design with each of the 3 treatments allocated randomly to a pasture area within each of 3 blocks at the start of the trial. Treatments were maintained on the same pasture locations for the duration of study. Each experimental pasture area consisted of 6 paddocks that were approximately 0.33 ha for FERT and SUPP and 0.48 ha for CONT. These paddocks were rotationally stocked, with one full rotation through all 6 paddocks being a cycle that consisted of either 24 or 36 d. In cycle 1, cattle were rotated every 4 d for a total cycle length of 24 d. Cycles 2, 3, and 4 were 36 d in length with cattle being rotated every 6 d. Cycle 5 varied in length with cattle rotated every 4 or 6 d depending on rainfall and forage growth. Grazing was initiated in late April each year and lasted 156 to 168 d, with cattle removed from pastures in late September or early October. For the FERT treatment, pastures were fertilized in late March or early April each year, before the initiation of grazing.

Put-and-take cattle were used to maintain similar grazing pressure on all treatments. Paddocks varied in production capabilities, and forage production was greater than planned in wet years, especially in fertilized paddocks. Forage yield measurements and visual observations were taken periodically to determine if these extra cattle should be added or removed from treatments. The goal was to use forage mass by the end of the grazing season, leaving approximately 10 cm of stubble (equal to about 1,000 kg/ha). Five tester animals were maintained at all times on every treatment. The put-and-take cattle were not used in determining animal performance. The number of head days was calculated for each treatment by multiplying the number of tester steers by the number of stocking days on the pasture, plus the number of put-and-take cattle multiplied by the number of stocking days on the pasture. Total gain for each treatment was calculated by ADG of the tester steers multiplied by the total number of head days. The CONT pastures were initially stocked at 6.8 AUM (1 AUM is equal to 308 kg of forage on a 100% DM basis)/ha, whereas both the SUPP and FERT treatments were initially stocked at 9.9 AUM/ha. Actual stocking rates changed from year to year due to put-and-take animals. Averaged over the 5 yr, stocking rates were 8.53, 12.88, and 13.27 AUM/ha for the CONT, FERT, and SUPP treatments, respectively (Figure 1).

Before trial initiation and at trial completion, steers were limit fed on a common diet for 5 d at approximately 1.75% of BW. Diet consisted of 48% alfalfa hay, 48% wet corn gluten feed, and 4% supplement (DM basis). Cattle were then weighed on 3 consecutive days to obtain initial and final BW. Cattle were also weighed at the start of each cycle. These interim weights were taken on the morning of the first day of cycles 2, 3, 4, and 5 and assigned a 4% pencil shrink.

Data were collected on steer performance, measured by ADG throughout the trial; diet quality, measured by diet samples taken with fistulated steers; and forage mass available at the beginning of each cycle, measured by hand clipping quadrats throughout the pastures each cycle before grazing, were described in detail by Greenquist et al. (2009). In 2009, total forage mass, without grazing, was measured in exclosures within 2 paddocks of each treatment of each block to evaluate pasture response to 4 yr of treatments being applied. Eight 1-m^2 exclosures were randomly located in each pasture before the beginning of the growing season (early April), after N fertilization of FERT pastures. All standing vegetation was clipped at ground level in a quadrat (0.38 m^2) placed in each exclosure. Clipping

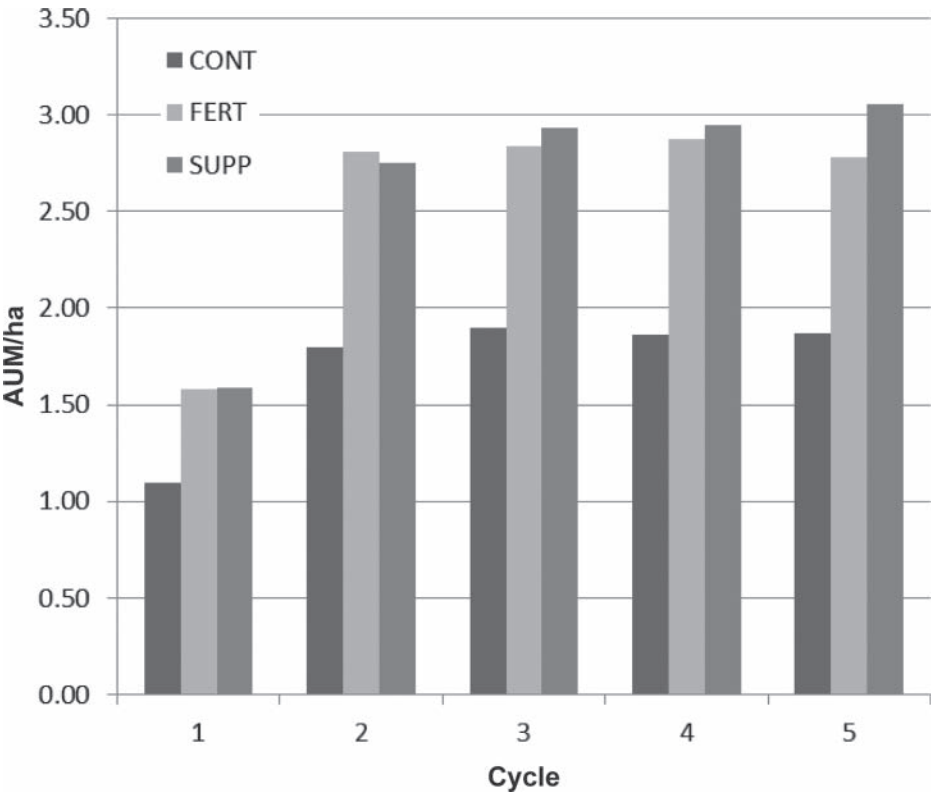

Figure 1. Average variable stocking rate of all 3 treatments over the grazing season from 2005 to 2009. Cycles 1, 2, 3, 4, and 5 roughly match up with May, June, July, August, and September. Treatments consisted of pastures nonfertilized (CONT), fertilized with 90 kg/ha N (FERT), or nonfertilized grazed by steers supplemented daily with 0.6% BW (DM) of DDGS (SUPP). One AUM is equal to 308 kg of forage on a 100% DM basis.

was conducted in late June and early October to account for both early season production (which commonly accounts for about 75% of annual production of smooth bromegrass) and regrowth that occurs later in the season.

Economic Analysis

For the economic analysis, all prices were based on averages from 2005 to 2009. Total costs for each system included initial steer price plus interest, yardage, health and processing fees, death loss, cash rent plus interest, and fertilizer or DDGS cost for the FERT and SUPP treatments. Initial steer cost was based on average Nebraska sale barn prices in April from 2005 to 2009 for 320 to 340 kg steers. Yardage was included at \$0.10/d per steer to account for labor in building and maintaining fences as well as daily checking of animals and watering. An \$8.33/steer health and processing fee was charged over the grazing period. Death loss of 0.5% was charged, based on initial steer cost. Cash rent for pastures was based on \$23.86/AUM, from Nebraska averages compiled by the USDA-NASS for 2005–2009 (USDA-NASS, 2010). Fertilizer prices of \$0.46/kg urea (\$419.20/ton urea) were based on urea prices in April plus a \$0.004/kg urea (\$4.00/ton urea) application fee and were also compiled by USDA-NASS. Prices for DDGS in Nebraska from April through September were reported by USDA-AMS (2010) and averaged \$0.13/kg (\$116.80/ton) on a 90% DM basis, plus a \$0.03/kg (\$24/ton) delivery and handling fee. Agricultural operating loan interest rates averaged 7.6% and were obtained from the Federal Reserve Bank of Kansas City (2005–2009). At the end of the grazing season, cattle were marketed to a feedlot. Prices for feeder cattle in October at Nebraska sale barns were used to determine final live value of the CONT and FERT steers, \$2.17/kg (\$98.81/cwt). Because of the price slide associated with feeder steers, different values were used for the CONT and FERT steers versus the SUPP steers because SUPP steers gained more BW over the grazing season. Value of the SUPP steers was based on data from Rolfe et al. (2012) in which breakeven prices were calculated for both supplemented and unsupplemented calves entering a feedlot. Cattle supplemented with distillers grains weighed approximately 40 kg more than unsupplemented cattle and were discounted \$0.09/kg (\$4.24/cwt) when sold to enter feedlots.

Costs of gain (**COG**) over the grazing period were calculated by dividing total costs, minus initial steer cost and interest, by the total BW gained by the animal during the grazing season. Breakeven prices were calculated by dividing total costs by the final shrunk BW of the animal at the end of the grazing season. Profitability was calculated as total live value of the animal in October minus total costs during the grazing season, including the purchase price of the steers.

Statistical analysis used mixed procedures of SAS (SAS Institute Inc., Cary, NC). Year was considered a random effect, and paddock was the experimental unit within a randomized complete block design. Model effects included block, treatment, cycle, and cycle × treatment interactions. Differences in means were considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

Cattle Performance

Initial BW was 317 kg for the 2-yr analysis (2008 to 2009) and 325 kg for the 5-yr analysis (2005 to 2009; Table 1). Ending BW was heavier for SUPP steers compared with FERT or CONT steers in both the 2- and 5-yr analysis ($P < 0.01$). Total BW gained was 151 kg over the entire grazing period for SUPP steers compared with 110 kg by

Table 1. Main effects of grazing management strategies on yearling steer performance when grazing smooth bromegrass pastures

Item	Treatment[1]			SEM	*P*-value
	CONT	FERT	SUPP		
Pasture area, ha	2.90	2.01	2.01	—	—
2008–2009					
Initial BW, kg	319	318	315	4.44	0.70
Ending BW, kg	429[a]	426[a]	471[b]	6.47	<0.01
BW gain, kg	110[a]	108[a]	156[b]	5.44	<0.01
ADG, kg	0.68[a]	0.67[a]	0.96[b]	0.03	<0.01
Head days	902	927	912	—	—
Gain per ha, kg	211[a]	307[b]	435[c]	14.62	<0.01
2005–2009					
Initial BW, kg	326	325	324	1.97	0.51
Ending BW, kg	436[a]	434[a]	475[b]	4.15	<0.01
BW gain, kg	110[a]	109[a]	151[b]	3.12	<0.01
ADG, kg	0.68[a]	0.67[a]	0.94[b]	0.07	<0.01
Head days	861	909	895	—	—
Gain per ha, kg	202[a]	303[b]	419[c]	9.74	<0.01

[a–c]Means within a row without a common superscript differ ($P < 0.01$).

[1]Treatments consisted of pastures nonfertilized (CONT), fertilized with 90 kg/ha N (FERT), or nonfertilized grazed by steers supplemented daily with 0.6% BW (DM) of DDGS (SUPP).

[2]Head days = (tester animals × days in grazing period) + (no. of put and take cattle × days on pasture).

[3]Gain per ha = (ADG × head days)/pasture area.

CONT and 109 kg by FERT steers. Over all 5 yr, ADG was greatest for SUPP steers ($P < 0.01$) at 0.94 kg/d, and not different ($P = 0.81$) between CONT and FERT steers at 0.68 and 0.67 kg/d, respectively.

Stocking rates used for CONT paddocks were 66% of FERT and 64% of SUPP pastures over the 5 yr (Figure 1). Ending BW for steers on the CONT and FERT treatments did not differ ($P = 0.81$) with CONT cattle stocked at only 66% of FERT. This resulted in weight gain per hectare being greater for FERT than CONT ($P < 0.01$; Table 1). Total weight gained per hectare was greatest for the SUPP pastures because cattle were stocked at the same rate as the FERT cattle, but gained 41 kg more over the entire grazing season due to the daily supplement they received. The supplemental efficiency of the DDGS was 9.4 kg of supplement per kilogram of increased gain per hectare compared with CONT cattle. Horn et al. (2005) reported supplement conversions (kg of supplement per kg of increased gain per ha) ranging from 5.0 to 10.3. This increase in weight gain can be attributed to the undegradable intake protein (**UIP**) and additional energy, from both fat and digestible fiber, provided by the DDGS because pasture in vitro DM digestibility (**IVDMDig**) did not differ among treatments ($P = 0.71$; Table 2). This would agree with MacDonald et al. (2007) who found that heifers grazing pasture had increased gains when supplemented with distillers grains compared with heifers supplemented with either corn gluten meal or corn oil. Morris et al. (2005) reported increased gains of 0.20 kg/d for each kilogram of DDGS supplemented to heifers on a 65% TDN forage diet. This is a greater response than the current study would suggest at 0.11 kg/d for each kg of DDGS supplemented. In a summary of 8 grazing trials, Klopfenstein et al. (2007) found that ADG increased by 0.13 kg/d for each kg of DDGS supplemented.

Steer weights taken between cycles show that the increased BW gain response to DDGS was not constant throughout the season. Pasture IVDMDig also was not constant across the grazing season with higher quality forage in cycles 1 and 2 and a decline in IVDMDig through cycles 3, 4, and 5 (Table 3). As IVDMDig declined through the grazing season, ADG of the cattle declined (Figure 2). The response of the SUPP cattle to the DDGS is defined as their increased gain over the gain of the nonsupplemented cattle. As IVDMDig of the forage and ADG of the cattle declined, the SUPP cattle's response to the DDGS increased (Figure 3). In cycles 1 and 2, the SUPP steers' ADG response to DDGS was 0.15 kg/d. In cycles 3, 4, and 5, IVDMDig of the smooth bromegrass declined and ADG response increased to 0.34 kg/d. This suggests that supplementing grazing cattle at key points in the grazing season may be beneficial. Producers may be able to save time and money by not supplementing early in the grazing season when forage quality is quite high, and then still realize the benefits of supplementation by capitalizing on the additional benefits of supplementation later in the grazing period. However, in pasture supplementation systems focused on increasing stocking rates through N cycling and forage replacement, it is important to supplement cattle daily.

Forage Analysis

Forage quality was very similar between treatments in 2008 and 2009. There were no differences in IVDMDig among treatments ($P = 0.71$; Table 2). Over time, IVDMDig declined linearly ($P < 0.01$; Table 3) from a high of 68.58% in cycle 1 to a low of 51.43% in cycle 5. Over the entire grazing season, CP was highest for FERT pastures compared with SUPP and CONT pastures ($P < 0.01$). This is due to differences in CP in the first cycle, following N fertilization in the spring. In cycles 2 through 5, there were no differences in CP content between treatments (P

Table 2. Main effects of dried distillers grains (DDGS) supplementation and N fertilization on diet sample characteristics and forage mass of smooth bromegrass pastures grazed by yearling steers 2008–2009

Item	Treatment[1] CONT	FERT	SUPP	SEM	*P*-value
IVDMDig,[2] %	57.99	59.34	57.99	1.33	0.71
CP, %	13.34[a]	17.92[b]	14.95[a]	0.70	<0.01
Forage mass[3]—2009					
June, kg/ha	4,124[b]	6,142[a]	4,483[b]	165.35	<0.01
October, kg/ha	2,442[b]	3,287[a]	2,817[b]	114.89	<0.01
Total, kg/ha	6,565[c]	9,429[a]	7,300[b]	222.96	<0.01
Other,[4] kg/ha	197[a]	7[b]	49[b]	16.29	<0.01

[a–c]Means within a row without a common superscript differ ($P < 0.05$).

[1]Treatments consisted of pastures nonfertilized (CONT), fertilized with 90 kg/ha N (FERT), or nonfertilized grazed by steers supplemented daily with 0.6% BW (DM) of DDGS (SUPP).

[2]In vitro DM digestibility (IVDMDig) was determined by including 5 hay samples of varying qualities with known total tract in vivo digestibilities. The IVDMDig values for these standards were regressed on their known digestibilities to develop an equation to calculate total tract DM digestibility within each in vitro run.

[3]Forage mass measured in 2009 after 4 yr of treatments being applied by hand clipping exclosures within pastures in late June and early October to account for total growing season forage production.

[4]"Other" includes all species besides smooth bromegrass found in the pastures: buffalo burr, Russian thistle, Kentucky bluegrass, and so on.

= 0.07) and no differences between cycles ($P = 0.43$).

In 2009, total above ground forage mass was estimated by clipping within exclosures in June and October. These data illustrate the response of above ground production to application of treatments for 4 yr. The FERT paddocks (9,429 kg/ha) had the greatest forage mass per hectare overall, whereas CONT paddocks (6,565 kg/ha) had the lowest mass and SUPP paddocks (7,300 kg/ha) were intermediate ($P < 0.01$; Table 2). Clipped samples were classified as either smooth bromegrass or other, mostly weedy species. In 2009, the CONT paddocks had a greater ($P < 0.01$) production of these weedy species compared with the other 2 treatments indicating that stands of smooth bromegrass were declining in the CONT paddocks. The added nutrients in the FERT and SUPP appear to be important in maintaining the vigor and productivity of smooth bromegrass. Because CONT paddocks produced about 70% of FERT paddocks and were originally stocked at only 69% of the FERT treatment, forage mass per head was similar between the FERT and CONT cattle. This is supported by cattle performance with FERT and CONT cattle weighing 434 and 436 kg, respectively, at the end of the grazing season ($P = 0.81$; Table 1). If CONT cattle did not have enough extra land to compensate for decreased forage production on those pastures, forage intake would have been limited, resulting in decreased animal performance.

Average forage intake for CONT cattle was estimated using NRC (1996) equations and was 8.46 kg/d. Using this and total forage mass, cattle utilization of forage mass was 42.17%. Taking this utilization rate multiplied by forage mass on the SUPP paddocks and divided by head days shows forage intake to be 6.52 kg/d in addition to approximately 2.45 kg/d of DDGS supplement for the SUPP cattle. Each kilogram of DDGS fed replaced approximately 0.79 kg of forage. Morris et al. (2005) reported a linear decrease in forage intake as DDGS supplement level was increased from 0 to 2.7 kg/d. When fed at approximately 0.6% BW, the

Table 3. Main effects of time (cycle) on diet sample characteristics of smooth bromegrass grazed by yearling steers 2008–2009

	Cycle 1	2	3	4	5		Probabilities[1]		
Item	May	June	July	August	September	SEM	Linear	Quadratic	Cubic
IVDMDig,[2] %	68.58	60.18	57.39	55.82	51.43	1.35	<0.01	0.08	0.05
CP, %	18.37	13.84	16.02	14.44	14.49	0.93	0.02	0.15	0.06

[1]Probabilities of linear, quadratic, and cubic trends determined with orthogonal polynomial contrasts.

[2]In vitro DM digestibility (IVDMDig) was determined by including 5 hay samples of varying qualities with known total tract in vivo digestibilities. The IVDMDig values for these standards were regressed on their known digestibilities to develop an equation to calculate total tract DM digestibility within each in vitro run.

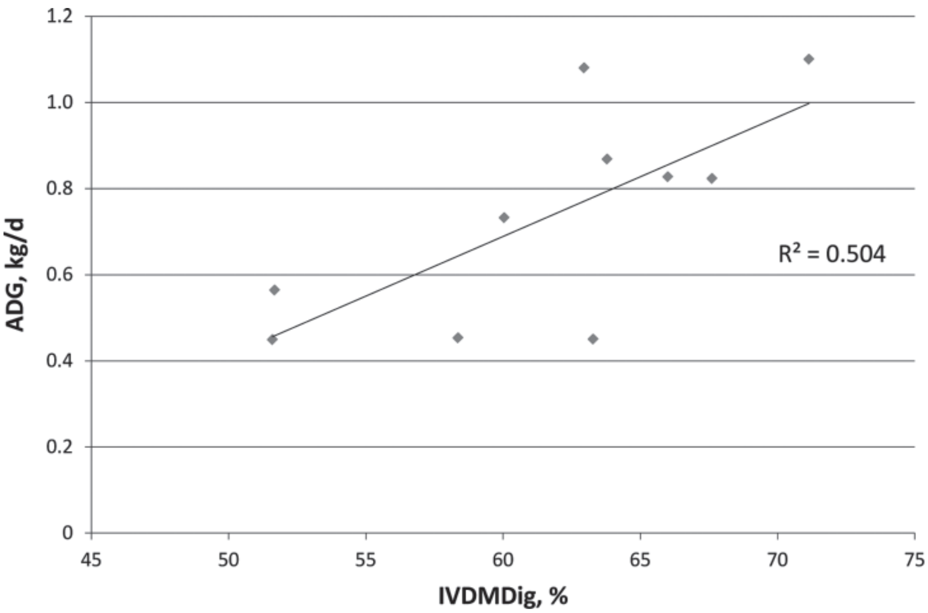

Figure 2. Average daily gain of steers grazing smooth bromegrass nonfertilized pastures and pastures fertilized with 90 kg/ha N in relation to the in vitro DM digestibility (IVDMDig) of diet samples taken over the grazing season in cycles 1 and 2 compared with cycles 3, 4, and 5. Higher IVDMDig values are correlated with higher ADG values ($R^2 = 0.504$).

DDGS supplement reduced high quality (65% TDN) forage intake by 18.6% and low quality (53% TDN) forage intake by 16.1%. Horn and McCollum (1987) also concluded that with increasing forage digestibility, supplements have a greater substitution effect on intake. Klopfenstein et al. (2007) summarized 6 grazing trials with distillers grain supplementation and concluded that for yearlings grazing pasture, similar to this trial, a reduction in forage intake of 0.6 to 0.7 kg for each kilogram of supplement would be expected.

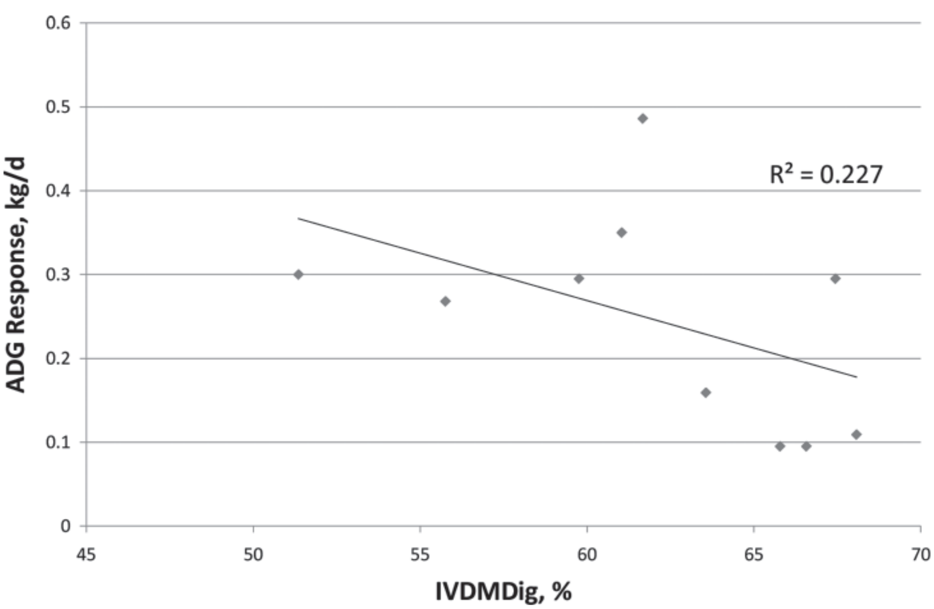

Figure 3. Average daily gain response of steers grazing smooth bromegrass pastures and supplemented daily with 0.6% of BW in dried distillers grains in relation to the in vitro DM digestibility (IVDMDig) of diet samples of these pastures in cycles 1 and 2 compared with cycles 3, 4, and 5. The ADG response of the supplemented steers is their increased gain over the gain of the nonsupplemented cattle. As IVDMDig declined, ADG also declined, but ADG response increased ($R^2 = 0.227$).

Nonsupplemented cattle had an estimated intake (NRC, 1996) of 8.46 kg/d of smooth bromegrass, which averaged 15.8% CP and met the overall CP requirement of steers. However, the UIP content of smooth bromegrass averaged 1.32% of DM, which is below the requirement of growing steers of 1.64% of DM (NRC, 1996). This left the nonsupplemented cattle with a 99 g/d MP deficiency. Adding approximately 2.45 kg/d of DDGS, which was 32% CP, of which 65% was UIP, to the diet, increased both CP and UIP above steers' requirements. This apparent response to MP and the additional energy suggest that DDGS supplementation is an effective way to increase the total live animal weight gain per unit land area in a beef production system.

Economic Analysis

Initial cost of the calves was not different by treatment ($P = 0.51$; Table 4) and averaged $794.69/steer. The FERT and CONT calves had a final live value of $942.43/steer and $947.77/steer, respectively, which was less than the SUPP steers final live value of $989.24/steer ($P < 0.01$). According to Arthington et al. (2007) differences in income due to changes in cattle markets is the largest factor influencing the ability of ranches to invest in annual inputs such as fertilizer and supplemental feed. Our objective was to determine the effect of biological differences on economics, rather than the year-to-year effect of price variation. Yardage, health and processing, and death loss fees were $28.14/steer for all treatments over the grazing season. The SUPP treatment also had the added cost of buying, transporting, and handling the DDGS that was fed to the calves daily. Steers consumed an average of 2.4 kg/steer daily, resulting in a cost of $59.14/steer over the grazing season. The cost of applying N fertilizer in the spring to FERT pastures was $35.48/steer. Cash rent values for land were different among treatments because of the different stocking rates. The CONT calves were stocked at 8.53 AUM/ha over the entire 5 yr. Multiplying AUM used by the average Nebraska cash rent price of $23.86/AUM results in a baseline price of $203.53/ha for all treatments. Multiplying this by the number of hectares, then dividing by the number of head days, and then multiplying by the average number of grazing days gives the cost of land per steer for each treatment. This was $105.71 for CONT, $69.65 for FERT, and $70.78 for SUPP.

Total costs of $953.97/steer for CONT and $951.14/steer for FERT were not different ($P = 0.57$) and were less than total costs for the SUPP treatment at $971.69/steer ($P < 0.01$). Gross return was $947.77/steer on CONT, $942.43/steer on FERT, and $989.24/steer on SUPP, with the SUPP steers having greater gross returns than either of the other 2 treatments ($P < 0.01$). Net return was also highest for the SUPP steers at $17.55/steer, whereas both the FERT and CONT steers had negative net returns at −$8.71/steer and −$6.20/steer, respectively ($P < 0.01$). Cost of gain was not different between the FERT and CONT treatments at $1.23/kg ($56.86/cwt) and $1.24/kg ($56.48/cwt), respectively ($P = 0.89$), and was less for the SUPP treatment at $1.05/kg ($47.93/cwt; $P < 0.01$). Breakeven was $2.19/kg ($99.72/cwt) of ending BW for FERT, $2.18/kg ($99.46/cwt) for CONT, and $2.04/kg ($92.89/cwt) for SUPP ($P < 0.01$).

In a study completed in Florida, Arthington et al. (2007) concluded that stocking rates, up to 0.58 ha/cow, and ranch income are directly linked, with a 1% decrease in stocking rate resulting in a 1% decrease in revenue. The current study would support the idea that stocking rate and income are closely related, although in Nebraska this may not be a 1:1 ratio. Beck et al. (2008) supplemented soybean hulls to growing calves on Bermudagrass pasture interseeded with wheat in Arkansas. Stocking rates were increased by 33% for supplemented cattle. Supplementing cattle at 0.5% BW increased net returns by $42/ha, and supplementing at 0.75% BW increased net returns by $45/ha. Horn et al. (2005) provided an energy supplement to growing cattle on wheat pasture at 0.91 to 1.36 kg/d. Supplementing increased ADG by 0.22 kg, which in turn increased net returns by $15 to $31/steer. Input prices for fertilizer or supplemental feed are variable and highly dependent on location. Increased stocking rates or cattle performance may or may not overcome these additional costs.

In Tables 5 and 6 all prices, including cattle prices when purchasing and selling cattle, are held constant whereas pasture cash rent, fertilizer, and DDGS prices vary, showing the resulting effect on COG for the different treatments. In Table 5, as land and fertilizer prices increase, COG also increases. To at least break even (revenue equal to costs), producers need to keep COG at or below $1.18/kg ($0.53/lb) for FERT. All prices above and to the left of the dividing line represent COG with positive net returns, less than $1.18/kg, whereas prices below and to the right of the dividing line represent COG with negative net returns (i.e., COG higher than $1.18/kg). Table 6 presents a similar comparison but with DDGS and land prices varying, whereas all other prices are held constant. To break even in this situation, producers need to keep COG at or below $1.20/kg ($0.54/lb). Again, prices above and to the left of the dividing line represent price scenarios where producers would have positive net returns, whereas prices below and to the right of the dividing line represent scenarios where producers would have negative net returns. These tables suggest that with land prices below $26/AUM and fertilizer prices below $1.22/kg N, producers have an incentive to fertilize pastures. With the supplemented treatment, land prices can be above $30/AUM and producers would still have positive net returns if they were able to purchase DDGS for less than $0.17/kg ($150/ton). The outcomes of these scenarios are variable and depend on cattle prices, gains, and other expenses.

Table 4. Economic evaluation of grazing management and supplementation strategies for steers grazing smooth bromegrass

	Treatment[2]				
Item[1]	CONT	FERT	SUPP	SEM	*P*-value
Initial cost, $/steer	796.95	795.63	791.50	4.82	0.51
DDGS, $/steer			59.14		
Fertilizer, $/steer		35.48			
Land cash rent, $/steer	105.71	69.65	70.78		
Yardage, $/steer	15.84	15.84	15.84		
Health and processing, $/steer	8.33	8.33	8.33		
Death loss, $/steer	3.98	3.98	3.96		
Interest, $/steer	23.16	22.23	22.40		
Total cost, $/steer	953.97[a]	951.14[a]	971.69[b]	4.97	<0.01
Total revenue, $/steer	947.77[a]	942.43[a]	989.24[b]	8.76	<0.01
Net return, $/steer	−6.20[a]	−8.71[a]	17.55[b]	7.35	<0.01
COG, $/kg BW gained	1.24[a]	1.25[a]	1.05[b]	0.02	<0.01
Breakeven, $/kg final BW	2.19[a]	2.19[a]	2.04[b]	0.01	<0.01

[a,b]Means within a row with unlike superscripts differ ($P < 0.05$).

[1]DDGS = dried distillers grains plus solubles; COG = costs of gain.

[2]Treatments consisted of pastures nonfertilized (CONT), fertilized with 90 kg/ha N (FERT), or nonfertilized grazed by steers supplemented daily with 0.6% BW (DM) of DDGS (SUPP).

Table 5. Effects of varying N fertilizer and land prices on costs of gain ($/kg) for steers grazing fertilized smooth bromegrass in eastern Nebraska[1]

Fertilizer prices, $/kg N	Land price, $/AUM[2]										
	20	21	22	23	24	25	26	27	28	29	30
0.66	0.99	1.01	1.03	1.08	1.10	1.12	1.14	1.19*	1.21*	1.23*	1.25*
0.77	1.01	1.06	1.08	1.10	1.12	1.17	1.21*	1.21*	1.23*	1.28*	1.30*
0.88	1.06	1.08	1.10	1.14	1.17	1.19*	1.25*	1.25*	1.28*	1.30*	1.32*
0.99	1.08	1.12	1.14	1.17	1.19*	1.23*	1.28*	1.28*	1.30*	1.32*	1.36*
1.10	1.12	1.14	1.17	1.21*	1.23*	1.25*	1.30*	1.30*	1.34*	1.36*	1.39*
1.21	1.14	1.19*	1.21*	1.23*	1.25*	1.28*	1.34*	1.34*	1.36*	1.39*	1.43*
1.32	1.19*	1.21*	1.23*	1.25*	1.30*	1.32*	1.36*	1.36*	1.41*	1.43*	1.45*
1.43	1.21*	1.23*	1.28*	1.30*	1.32*	1.34*	1.41*	1.41*	1.43*	1.45*	1.47*
1.54	1.25*	1.28*	1.30*	1.32*	1.36*	1.39*	1.45*	1.43*	1.45*	1.50*	1.52*
1.65	1.28*	1.30*	1.34*	1.36*	1.39*	1.41*	1.47*	1.47*	1.50*	1.52*	1.54*
1.76	1.32*	1.34*	1.36*	1.39*	1.41*	1.45*	1.50*	1.50*	1.52*	1.56*	1.58*
1.87	1.34*	1.36*	1.39*	1.43*	1.45*	1.47*	1.54*	1.54*	1.56*	1.58*	1.61*
1.98	1.36*	1.41*	1.43*	1.45*	1.47*	1.52*	1.56*	1.56*	1.58*	1.61*	1.65*

[1]To break even in this scenario, producers need to keep costs of gain (COG) at or below $1.18/kg ($0.53/lb); values without asterisks (*) represent profitable COG, whereas values with asterisks represent COG where producers would have negative net returns.

[2]1 AUM is equal to 308 kg of forage on a 100% DM basis.

IMPLICATIONS

Pasture forage production, cattle performance, and profitability of a backgrounding operation can be increased by supplementing growing cattle with DDGS. Fertilizing the pastures can be used to increase stocking rate, but has no effect on cattle performance. Supplementing the cattle with DDGS is also a viable way of increasing stocking rate, while

Table 6. Effects of varying dried distillers grains plus solubles (DDGS) and land prices on costs of gain ($/kg) for steers supplemented with DDGS while grazing smooth bromegrass in eastern Nebraska[1]

DDGS prices, $/909 kg (ton)	Land price, $/AUM[2]										
	20	21	22	23	24	25	26	27	28	29	30
50	0.70	0.73	0.75	0.77	0.79	0.81	0.84	0.84	0.86	0.88	0.90
60	0.75	0.75	0.77	0.79	0.81	0.84	0.86	0.88	0.90	0.90	0.92
70	0.77	0.79	0.81	0.81	0.84	0.86	0.88	0.90	0.92	0.95	0.97
80	0.79	0.81	0.84	0.86	0.88	0.88	0.90	0.92	0.95	0.97	0.99
90	0.81	0.84	0.86	0.88	0.90	0.92	0.95	0.95	0.97	0.99	1.01
100	0.86	0.86	0.90	0.90	0.92	0.95	0.97	0.99	1.01	1.01	1.03
110	0.88	0.90	0.92	0.92	0.95	0.97	0.99	1.01	1.03	1.06	1.08
120	0.90	0.92	0.95	0.97	0.99	0.99	1.01	1.03	1.06	1.08	1.10
130	0.92	0.95	0.97	0.99	1.01	1.03	1.06	1.08	1.08	1.10	1.12
140	0.97	0.99	0.99	1.01	1.03	1.06	1.08	1.10	1.12	1.14	1.14
150	0.99	1.01	1.03	1.06	1.06	1.08	1.10	1.12	1.14	1.17	1.19
160	1.01	1.03	1.06	1.08	1.10	1.12	1.12	1.14	1.17	1.19	1.21*
170	1.03	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.19	1.21*	1.23*
180	1.08	1.10	1.10	1.12	1.14	1.17	1.19	1.21*	1.23*	1.25*	1.25*
190	1.10	1.12	1.14	1.17	1.17	1.19	1.21*	1.23*	1.25*	1.28*	1.30*
200	1.12	1.14	1.17	1.19	1.21*	1.23*	1.23*	1.25*	1.28*	1.30*	1.32*

[1]To break even in this scenario, producers need to keep costs of gain (COG) at or below $1.20/kg ($0.54/lb); values without asterisks (*) represent profitable COG, whereas values with asterisks represent COG where producers would have negative net returns.

[2]1 AUM is equal to 308 kg of forage on a 100% DM basis.

simultaneously improving cattle performance. Using fertilizer or supplement increases costs, but the returns to the operation may outweigh the costs. The input costs for backgrounding operations, especially fertilizer, supplement, and land prices, can vary quite dramatically over time and will affect the profitability of each treatment. Looking at breakpoints for costs of gain can help producers make appropriate decisions about which system would be the most profitable for their operation. As land prices increase, the benefit of either fertilizing or supplementing will be more evident as producers need to get more use from the same amount of land.

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