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Fertilization and Supplementation Strategies for Steers Grazing Smooth Bromegrass Pastures

Andrea K. Watson
University of Nebraska at Lincoln, awatson3@unl.edu

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By

Andrea K. Watson

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Terry J. Klopfenstein and Galen E. Erickson

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Andrea K. Watson, M.S.

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Advisors: Terry J. Klopfenstein and Galen E. Erickson

Since 2004, fertilizer prices have doubled due to increases in energy prices for production and increased demand for N fertilizer due to high grain prices. This leads to questioning the cost effectiveness of increasing forage production with N fertilizer. At the same time, an increase in ethanol production creates an increase in the production of by-products of the ethanol industry, such as distillers grains. Distillers grains have been shown to be an excellent feed for ruminants both as a supplement while grazing and as part of a complete diet in the feedlot. Distillers grains provide protein, fat, and highly digestible fiber to the animal and are relatively inexpensive compared to other energy and protein sources. Feeding distillers grains as a supplement to backgrounding calves will increase N in their urine. If this excess N in the urine can be taken up by plants it may be more efficient to feed distillers grains as a supplement and fertilize the pastures with excess urinary N instead of inorganic N fertilizer.

Supplementing growing cattle with dried distillers grains increased ADG compared to non-supplemented cattle. Paddocks that received N fertilizer had the most forage production while paddocks with supplemented cattle had intermediate production and paddocks having non-supplemented cattle and receiving no N fertilizer had the least

forage production. This allowed paddocks that received fertilizer and paddocks with supplemented cattle to be stocked at the same rate, although cattle receiving supplement weighed 41 kg more at the end of the trial compared to both fertilized and non-fertilized treatments.

Profitability was increased for cattle receiving distillers grains supplement and not different between control and N fertilizer treatments. This was due to increased land costs for the control because of decreased forage production. Cost of gain and breakeven prices were lowest for supplemented cattle. In the future, the relationship between prices for land, N fertilizer, and protein supplements will affect the profitability of pasture based backgrounding systems.

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Introduction

Grazing ruminants have the amazing ability to turn low quality feeds, undesirable by-products, and forages into high quality protein sources for human consumption, typically either beef or milk. Approximately 90% of a ruminant's diet consists of forages that are essentially useless to humans, but can be turned into high quality proteins that are in demand throughout the world. In 2005, the average dairy cow in the United States produced 8898 kg milk per lactation period and the average person consumed 40.2 kg of beef per year. This comprises a large part of our diet as Americans and plays a key part in feeding a growing world population.

The changing landscape of agriculture requires cattle producers to consider different management strategies to be more efficient and to remain profitable. The option of backgrounding calves on grass pastures for 1-6 months before entering the feedlot gives smaller calves the chance to reach an ideal size before entering the feedlot. During this backgrounding phase, calves consume primarily forages and may be provided with a protein supplement to increase gains. Corn residue is readily available in Nebraska during the winter as approximately 3.70 million hectares were planted to corn in 2009. Nebraska also has extensive forages available during the summer months with Sandhills range in the western part of the state and primarily smooth bromegrass pastures in eastern locations. With the growth of the ethanol industry, distillers grains have become an inexpensive supplement for growing calves that is high in protein, energy, and phosphorous, and thus complements grazing situations. In addition, demand for distillers grains is lower demand during the summer months as cattle exit feedlots across Nebraska, leaving producers with a high-energy, low-cost supplement in the summer.

The response of cattle to distillers grains in both feedlot and grazing situations has been studied in depth in recent years. Many factors, including calf nutrient requirements, forage quality, quantity of supplement, and grazing behavior all affect the outcome of supplementing growing calves with distillers grains. Another important consideration is the response of pastures to being grazed by calves supplemented with distillers grains. The overall goal should be to implement sustainable and economically beneficial grazing systems that are favorable to both cattle and forage growth.

The purpose of this review is to examine the characteristics of smooth bromegrass pastures and their response to different grazing and supplementation strategies utilizing calves in a backgrounding operation.

Literature Review

Smooth Bromegrass Production and Quality

Plant Characteristics

Smooth bromegrass was first introduced to the United States in 1884 and is believed to have come from Hungary, where the seed was experimentally grown (Casler and Carlson, 1995). It first entered the country through California and made its way east to the Midwest by the late 1890s. After the dust bowl of the 1930s, smooth bromegrass emerged as one of the principal surviving species. It has now become widely distributed due to its ability to withstand drought and severe temperature fluctuations. It spreads through seed dispersion and strong, creeping rhizomes (Lamond et al., 1992).

Smooth bromegrass is well suited to eastern Nebraska as it prefers fertile, well drained silt or clay loam soils and temperate conditions with air temperatures between 18°C and 24 °C (Volesky, 2003). It can be grown under dryland or irrigated conditions and as a monoculture or in a mix with other grasses or legumes. When mature, smooth bromegrass plants are 46-122 cm tall and have erect leafy stems (Lamond et al., 1992).

Yields for smooth bromegrass typically average 4.0 Mg/ha in the spring with production declining during the summer months depending on rainfall and temperatures (Iwig, 2003). Total production yields over the season can range from 6.7 to 9.0 Mg/ha (Lamond et al., 1992). Schlueter (2004) found that smooth bromegrass grown in eastern Nebraska and fertilized with 90 kg N/ha produced 6.19 Mg/ha while smooth bromegrass receiving no fertilizer produced 4.58 Mg/ha. On similar locations, but with decreased rainfall, Baleseng (2006) reported DM production of 3.1 Mg/ha and 3.8 Mg/ha for pastures that received no fertilizer and pastures fertilized with 88 kg N/ha, respectively.

Continually grazing smooth bromegrass to less than 14 cm of stubble will negatively affect overall DM production and quality (Volesky, 2007). Fertilized smooth bromegrass under irrigation that was repeatedly clipped to a stubble height of 7 cm had a total DM production of 14.66 Mg/ha while grass clipped to a stubble height of 14 cm and 21 cm produced 18.63 Mg/ha and 21.79 Mg/ha, respectively. Clipping to 7 cm also decreased tiller density at the end of the growing season. In the same trial, smooth bromegrass IVDMD was greatest for the taller stubble heights.

Residual leaf area is important in order for the plants to remain productive. The canopy should not be grazed to less than 8 to 12 cm to ensure adequate carbohydrate storage for the winter (Casler and Carlson, 1995). If plants are left with inadequate cover through the winter, there will not be enough new growth to replace the approximately one-third of the root system that is damaged or lost each grazing season, causing a loss of production the following year (Ohlenbush and Watson, 1994). The timing of the first grazing in the spring can affect the entire season's yield and quality. Early grazing does not delay sward development if there are adequate rest periods after grazing. Starting a rotational grazing system when one fully collared leaf is present on each tiller does not affect grass yields or quality (Brueland et al., 2003).

Approximately 40-55% of the total seasonal growth for smooth bromegrass occurs by mid-May (Schlueter, 2004). With this fast, early growth in the spring, smooth bromegrass responds well to an intensive rotational grazing system with cattle being rotated through the pastures quickly during the first cycle. This keeps the grass from becoming stemmy and less palatable to the cattle (Baleseng, 2006). Rest periods should then be longer during the summer months due to slower growth. Fall regrowth can be grazed or stockpiled for use during the dormant season. Pastures that are grazed multiple times during the growing season have relatively high harvest efficiency. Plots that were grazed for three days, four times throughout the growing season had approximately 50% utilization (Schlueter, 2004). The grazing system should optimize both animal and forage production over a long-term period (Ohlenbusch and Watson, 1994).

Fertilizing smooth bromegrass improves both yields and nutrient quality of the grass. Without fertilization the grass may become sod bound which results in reduced productivity (Casler and Carlson, 1995). An application of 45 to 112 kg N/ha is recommended in order to optimize both forage yields and CP content. At least 50 to 80 kg N/ha should be applied in the early summer in order to avoid decreased yields due to summer slump (Casler and Carlson, 1995). Linear increases in forage production are seen with applications of N up to 100 to 504 kg N/ha. Schlueter (2004) found that plots not fertilized with nitrogen had 70-78% the total DM production of plots fertilized in mid-April with 90 kg N/ha. Greenquist (2008) reported that fertilizing smooth bromegrass with 90 kg N/ha increased forage yields 420 kg/ha compared to a non-fertilized control. The fertilizer also increased crude protein content of the smooth bromegrass from 15.21% to 17.25% of DM in early spring. Over the entire grazing season IVDMD was not affected by fertilizer treatment.

Common N sources used for fertilizing include liquid N, urea, ammonium nitrate, and anhydrous ammonia. If urea sources are applied to moist soils that are covered with grass residue the urea can be broken down into ammonia by urease and then lost to the air

(Lamond, 1992). This happens most commonly in moist conditions followed by warm temperatures. If there is rainfall after urea application, N volatilization is avoided and the urea moves into the soil.

Established stands of smooth bromegrass may also need phosphorus or potassium applications depending on the mineral content of the soil. Phosphorus application recommendations range from 0-56 kg/ha P_2O_5. Potassium application recommendations range from 0-56 kg/ha K_2O (Lamond, 1992).

Forage Quality

The nutrient content of smooth bromegrass is superior to many other cool-season grasses and is quite high in the spring and declines over the summer months as it matures (Casler and Carlson, 1995). Volesky and Anderson (2007) found that IVDMD of smooth bromegrass was higher than IVDMD of orchardgrass, creeping foxtail, and meadow bromegrass throughout the growing season. Schlueter (2004) found that CP content of fertilized bromegrass peaked in early May at 17.3% and declined to 14.6% by mid July. The same study found that NDF content increased from 54.4% to 66.6% during the same time period. The crude protein content of the leaf sheaths and stems was considerably lower than that of the leaves. Stems typically decrease in quality faster than leaves (Buxton, 1990). As grasses mature, the proportion of cell wall increases while the proportion of cell contents decreases leading to an overall decrease in digestibility (Minson, 1990). The digestibility of the stem portion is lower than the digestibility of the leaf before maturity, but with increasing maturity the stem declines in quality faster than the leaf and the proportion of stem to leaf increases (Terry and Tilley, 1964). All of these factors lead to a rapid decrease in forage quality as smooth bromegrass matures.

The digestibility of grasses is greatest in the vegetative stage (Bruinenberg, 2002) and declines rapidly after heading. The NDF content of smooth bromegrass hay harvested at the dough stage can be 5 percentage units higher in NDF content than hay harvested at an early heading stage (Lamond, 1992). New growth of smooth bromegrass in the fall is similar in quality to spring growth. Several trials evaluating the nutrient compostition of smooth bromegrass have been done in eastern Nebraska (Schlueter, Baleseng, Haugen, and MacDonald) on similar plots. Schlueter (2004) found that the CP concentration in smooth bromegrass was higher in May and September compared to June and July. Baleseng (2006) reported steadily decreasing IVDMD of smooth bromegrass throughout the growing season. However, CP content was higher in the spring and fall compared to the summer. Haugen (2004) found that IVDMD declined from 59.9% to 52.9%, while CP content of smooth bromegrass declined from 15.9% to 9.9% from June to July. MacDonald (2006) reported IVDMD decreasing from 69.5% to 51.3% and rebounding back to 54.0% when measured in mid-May, the first of June, and the first of July. During the same time period, CP content went from 25.3% to 13.3% and then back up to 20.4%. The CP content of smooth bromegrass can be affected by many factors including species type, maturity, soil fertility, and weather.

The UIP content of smooth bromegrass is relatively low and ranges from 11-18% of CP (Mitchell et al., 1997). The UIP content of smooth bromegrass varies slightly over the grazing season. Haugen (2006) found that smooth bromegrass samples from June and July had a UIP content of 1.82% DM and 1.71% of DM, respectively, and did not differ. However, total tract indigestible protein increased from 1.11% in June to 1.24% in July while digestibility of the UIP decreased from 38.6% in June to 27.1% in July. Samples of smooth bromegrass taken from Mead, NE in 2002-2004 had between 2.0% and 3.7% UIP on a DM basis (Benton et al., 2006). This UIP was 41.3% to 58.1% digestible. Diet samples of smooth bromegrass pastures in 2005 near Mead, NE at 8 different time points over the grazing season showed UIP concentrations ranging from 8.8% to 12.7% of CP (MacDonald, 2006). The UIP digestibility ranged from 40.7% to 50.1%. These values are all lower than the 80% constant digestibility assumed by the NRC (1996).

Available forage quality in a pasture can differ from the quality of the diet that cattle select. Decreased forage availability due to increased grazing pressure will alter the diet selection of cattle. Taylor et al. (1980) reported that higher competition for forage forced cattle to eat feedstuffs not generally consumed. They also reported an increase of forbs and browse in the animals' diet at the end of the grazing period when selection was limited.

Utilizing fistulated steers to determine diet quality is more accurate than taking grass clippings (Ullerich, 2001). Torell (1954) also found that clipped samples did not reflect the composition of the diet actually consumed by the animals. Rumen evacuations have been used in research extensively and require emptying the rumen contents, allowing the animal to graze, collecting the ingested sample, and returning the original rumen contents (Lesperance et al., 1960). One drawback to diet sampling with rumen evacuations is that the IVDMD of rumen samples can be decreased because of saliva contamination (Holecheck et al., 1982). However, this can be overcome by expressing the nutrient composition of the samples on an organic matter basis (Haugen, 2004).

Forage Protein

Degradable versus undegradable

The NRC (1996) has defined a metabolizable protein (MP) system that divides dietary crude protein (CP) into a fraction that is degraded in the rumen (DIP) and a fraction that escapes ruminal degradation (UIP). This MP system defines the protein requirements of ruminants for maintenance and growth in terms of absorbable amino acids available to the animal. Use of the MP system allows producers to more efficiently meet the true protein requirements of the animal (Haugen, 2004). The metabolizable protein flowing to the small intestine is primarily composed of microbial crude protein (MCP) that is synthesized in the rumen and UIP from the diet. However, not all of this protein is available to the animal. Microbial crude protein is assumed to be 80% true protein that is 80% digestible in the small intestine, which results in 64% of the MCP contributing to the MP (NRC, 1985). In the small intestine, UIP is also assumed to be 80% digestible; however, the digestibility of UIP from different feedstuffs does vary.

The amount of metabolizable protein that is available to the animal can vary due to many factors including the composition of the protein, protein degradation in the rumen, rate of passage, bacterial composition and yield, and postruminal digestibilities of the bacteria and UIP in the feed (Sniffen et al., 1992). The amount of DIP and UIP from a single feed source can even vary in different feeding situations (MacDonald, 2006).

The amount of MCP that is produced in the rumen depends on the amount of both N and energy that is available to the microorganisms in the rumen. Forage proteins are rapidly degraded by rumen microorganisms leaving little UIP from forages. The UIP that is left passes to the small intestine and is a source of protein to the host animal in addition to the MCP (Klopfenstein, 1996). Both excess DIP and excess UIP can be sent to the liver and metabolized into urea which is excreted in the urine. Excess MP may be used as an energy source for the animal, but excess DIP is an energy and protein sink for the animal because of the energy and protein expenses of the urea cycle (MacDonald, 2006). Urea recycling increases with increasing levels of NDF in the diet (Huntington et al., 1996).

Calves that are grown on a forage-based diet typically have sufficient DIP, but can be UIP deficient, which limits their performance (NRC, 1985). Growing forages have high DIP which, in combination with young growing cattle's high MP requirements, makes UIP their first-limiting nutrient (Creighton et al., 2003). Several studies have shown increased gains in growing calves in response to UIP supplementation (Karges et al., 1992; Klopfenstein, 1996; Creighton et al., 2003).

Creighton et al. (2003) studied the effects of UIP supplementation in combination with different wintering systems for spring born and summer born steers. This study used treated soybean meal and feather meal as a UIP source. Steers that were held to lower gains during the winter showed less response to UIP supplementation than steers with higher gains during the winter.

Lardy et al. (1999) studied the effects of UIP supplementation on nursing calves grazing subirrigated meadow grass using a blend of sulfite liquor treated soybean meal and feather meal as the UIP source. Supplemented calves had greater weight gains (0.88 vs. 0.66 kg/d) regardless of whether the calves were weaned September 1 or were allowed to nurse throughout the trial. While milk is an important source of MP for young calves, there is still an added response to UIP supplementation. Supplemented calves also had decreased forage intakes, but greater total intakes.

Hafley et al. (1993) reported the effect of supplemental UIP on steers grazing warm season grasses during the summer. The forage contained 10.5% to 12.2% CP and 5.1% to 6.2% UIP. Steers were supplemented with an energy supplement or an energy supplement plus 0.1 kg/hd/d or 0.2 kg/hd/d of UIP in order to determine if the response was due to the protein or energy. In this case the UIP source was a blend of blood meal and corn gluten meal. There was an increase in ADG when UIP was supplemented in addition to the energy supplement. Higher gains were also reported with the higher level of UIP supplementation.

Gustad (2006) supplemented calves on native Sandhills range with 2.27 kg/hd/d of DDG pellets. Using the NRC model (1996) she estimated that unsupplemented calves had an MP deficiency of -147 g/d and an energy allowable ADG of 0.77 kg. The supplemented calves had an MP excess of 145 g/d and an energy allowable ADG of 1.17 kg, which was very close to their actual gain of 1.14 kg/d. A third treatment with calves stocked at 2X the control and receiving no supplement showed no difference in ADG from the control, .48 and .45 kg/d, respectively. This illustrates that MP, and not energy, was the first limiting nutrient of these young, growing calves.

Calves grazing corn residue are protein deficient and at least 160 g/hd/d of UIP is recommended (Wilson et al, 2004). Gutierrez-Ornelas and Klopfenstein (1991) found that supplementing increasing levels of UIP, with constant CP, to calves grazing corn residue resulted in a linear response to the UIP.

Rumen Degradation of Protein

Some feeds can be treated in order to decrease ruminal degradation of the protein; this is typically done via the application of heat (Van Soest, 1994). Protection of the protein from ruminal degradation is typically caused by a Maillard reaction, which binds aldehyde groups of the sugar to free amino acid groups to create an amino-sugar complex (Orskov, 1982). The digestibility of the UIP in the small intestine is then dependent on the amount flowing to the small intestine and how digestible the protein source is. Cleale et al. (1987) found that steers consuming non-enzymatically browned soybean meal gained more than twice as much as steers consuming regular soybean meal, given the same N intake.

The 1996 NRC assumes a constant 80% true digestibility for UIP while the 2001 Dairy NRC assigns varying digestibility estimates for UIP from 50 to 100%. Frydrynch (1992) found the digestibility of UIP in concentrates to be approximately 88.2% and in forages to be 70.8%.

Intake

Measuring forage intake

Another factor with a key influence on forage quality and digestibility is intake. The digestibility of a feed has a large impact on passage rate of feed through an animal, which in turn is crucial in determining intake of feedstuffs. At the same time, intake influences passage rate and thus digestibility. In addition, forage intake of grazing animals is quite difficult to accurately measure. This is why voluntary forage intake of grazing animals is complex and not well understood.

The primary regulator of intake on a high forage diet is reticulo-rumen capacity and passage of forage out of this organ (Allison, 1985). A primary factor of reticulo-rumen capacity is body size. Other factors that affect intake include body condition and physiological status, which are closely related to the nutrient requirements of the animal. A shift in intake regulation occurs when ruminants are taken off forage diets and placed onto higher energy diets. On higher energy diets intake is no longer controlled by fill; instead intake appears to be primarily regulated by animals' energy demands and other metabolic factors (NRC, 1996).

Intake as a function of maintenance requirements can be accurately predicted for penned animals, but grazing animals can have maintenance requirements up to 30% higher than penned animals (Caton and Dhuyvetter, 1997). This additional energy is used by the muscles for eating, standing, and walking; which suggests that the size of the pasture and forage availability within the pasture have an influence on energy requirements. Stocking rate and weather conditions, such as drought, all have an impact on both forage availability and harvest efficiency. Harvest efficiency is increased in times of decreased forage availability. However, this leads to decreased selection and thus a decline in diet quality. Diet quality is a determining factor of passage rate. Forages that are high in digestibility spend less time in the rumen, allowing for greater intakes. In contrast, lower quality, bulky, high fiber forages have a slower passage rate, higher filling capacity, and lower intakes (Allen, 1996).

Forage intake of penned animals is measured as forage offered minus forage refused. Measuring forage intake of grazing animals can be much more complex. The NRC (1996) has developed several equations to predict intake based on energy maintenance requirements and the physiological status of animals. Other methods for measuring intake include determining forage removal via clipping quadrats before and after grazing (Macoon et al., 2003). However, this method can be misrepresentative due to inaccurate estimates of regrowth, trampling, weather losses, and consumption by insects and wildlife (Allison, 1985). Markers can also be used to estimate forage intake. Chromium is a common marker used, with continuous chromium releasing devices having been used in several studies (Lardy et al., 1999; Patterson et al., 2003). Markers appear to be an effective, but difficult and time consuming way of measuring intakes. Using markers may also affect the amount of time spent grazing which would bias intake measurements.

MacDonald and Klopfenstein (2004) estimated forage intakes of grazing cattle supplemented with DDGS using the 1996 NRC model. They estimated that unsupplemented cattle consumed 7.95 kg of smooth bromegrass per head per day. They also estimated that 0.45 kg of DDGS would replace 0.78 kg of forage.

An energetic model based on net energy equations of the NRC (1996) was developed by Morris et al. (2005) in order to predict forage intake. This model was developed by measuring forage intake and ADG of calves in an individually fed pen setting. Either low or high quality forage (brome hay or alfalfa hay with sorghum silage) was offered in combination with increasing levels of DDG. Net energy adjusters were then calculated in order to accurately predict ADG based on TDN of the diet.

MacDonald et al. (2006) then used this model to determine intakes of calves grazing smooth bromegrass pastures and supplemented with DDGS. The model predicted that every 0.45 kg of DDGS replaced 0.17 kg of forage. However, this replacement rate was not statistically different from 0.

Morris et al. (2006) also used the model to estimate forage intakes of steers grazing Sandhills range and supplemented with DDGS. The model showed that forage intakes decreased linearly as DDGS intakes increased from 0.26 to 0.51 to 0.77 to 1.03% of BW. This suggests that each 0.45 kg of DDGS was replacing 0.75 kg of forage. These results are consistent with the predictions of MacDonald and Klopfenstein (2004), but lower than replacement rates measured with hay by Morris et al. (2006) and Loy et al. (2003). This model appears to accurately predict forage intakes when high quality forage with a known TDN is grazed, and both DDGS intake and ADG are measured.

Intakes are affected differently by energy and protein supplements. Energy supplements tend to decrease forage intake (Loy, 2006) but the effects of protein supplementation are more varied (MacDonald, 2008). The effect of protein supplementation on intake is complex because of increasing rumen microbial activity in response to protein and variations in passage rate (Allison, 1985).

DGS effects on intake

There have been varying results of forage replacement when distillers grains are supplemented. This can be partially attributed to distillers grains being used as both a protein and energy supplement. Backgrounding operations tend to be more concerned with ADG performance of supplemented cattle than effects on forage intake, but cow-calf producers may be more interested in reducing forage intakes of cows than increasing body condition scores. A trial conducted by MacDonald et al. (2006) found that DDG supplemented at 2.5 to 7.5 g DM per kg BW decreased feed intake by approximately

50% of the supplement amount when an energetic model was used to predict intake. Creighton (2003) also found that DGS supplementation decreased forage intakes of summer Sandhills pasture that averaged 63.1% TDN and 10.5% CP.

In a trial conducted by Loy (2008), heifers supplemented with DRC or DDGS at 0.79% of BW had reduced hay DMI and increased total DMI compared to heifers supplemented at 0.21% of BW. Hay intake was decreased from 1.78% to 1.50% of BW for both treatments while overall intake increased from 2.06% to 2.38% of BW for the DRC supplemented heifers and from 2.05% to 2.28% of BW for DDGS supplemented heifers. The authors concluded that hay intake was depressed by the starch in the DRC supplement. Because there were no differences in forage DMI between supplements, forage DMI was also depressed for the DDGS supplement. This was most likely due to a negative associative effect between fat intake and fiber digestion. Fat intake for cattle on the high level of DDGS supplement was calculated to be 5.0% of the total diet compared to only 2.8% for the DRC supplementation. Average daily gain and feed efficiency were also increased at the higher level of supplementation for both the DRC and DDGS supplement with the response to the DDGS being greater than the response to DRC supplementation.

Gustad (2006) found that increasing levels of DDGS supplementation fed with a 58.8% IVDMD brome hay diet quadratically replaced forage in the diet. Calves supplemented at1.27% of BW of DDGS consumed approximately 27% less forage than calves supplemented at 0.29% of BW. This suggests that intake regulation was shifting from a fill-regulated mechanism to an energy regulation. However, this is a complex interaction and is affected by the age and type of calves, as well as the diet fed.

Forages are an excellent source of nutrients that can be utilized by ruminants. By taking all of these factors into account producers are better able to grow both forages and cattle in a sustainable system.

Calf Backgrounding

Systems

Backgrounding calves before placement in the feedlot has several advantages over the traditional method of placing weaned calves directly into the feedlot. Producers that background calves can better match forage resources to the needs of cattle. In times of drought calves can be moved into feedlots sooner in order to conserve forage resources for cow production. This flexibility allows producers to carry a consistent number of cows and vary the number of backgrounded animals. Backgrounding also allows flexibility in marketing fat cattle. By holding some calves back on a forage system they are able to market cattle in several different months, which may allow them to participate in fat cattle price rallies. Ethanol production has increased in recent years and is projected to continue increasing from 700,000 barrels produced per day in 2009 to 860,000 barrels in 2010. As this and other markets for corn grow, feeding cattle a corn based diet in the feedlot becomes more expensive. Backgrounding calves before placement in the feedlot decreases the number of days on feed and the amount of grain the cattle consume. Sorting animals into different management groups also benefits the cattle and allows them to reach their full potential. Some calves fit better into an intensively managed calf-fed program where they directly enter the feedlot after weaning; other calves benefit from a more extensively managed program where they are allowed to grow over the winter on a lower energy diet and then be placed into a feedlot the next spring or fall (Griffin, 2006). The genotype and phenotype of calves determines which system is more advantageous. Some studies have shown that backgrounding cattle can lead to heavier carcasses and the potential for increased income (Sainz and Vernazza Paganini, 2004; Kreihbel et al., 2000; Jordon, 2000).

Griffin (2006) found that cattle sorted after weaning into either a calf fed or a yearling fed group had different feedlot performance, carcass characteristics, and profitability. Calf feds were in the feedlot for more days and had greater overall feed intake, but were more efficient than yearlings. The yearling group had greater daily DMI, greater ADG, and fewer days on feed. Yearlings also had a heavier hot carcass weight (HCW) leading to more income than the calf feds. There was no difference in the percentage of carcasses grading choice or higher.

Winterholler et al. (2008) sorted weaned calves into either a calf fed or yearling fed group to follow through the feedlot. Calves put directly into the feedlot were on feed 169 days and started at 228 kg and finished at 518 kg. Backgrounded calves grazed wheat pastures for 164 days before being placed in the feedlot at 445 kg. Yearling fed steers finished at 605 kg after 88 days on feed, and had greater ADG, DMI, LM area, and 55 kg heavier HCW. Calf feds were more efficient and tended to be more profitable ($P = 0.09$). By including a backgrounding phase in the production system they were able to increase hot carcass weights by 17% without hurting carcass characteristics. The authors expect that corn prices will stay at levels higher than the $2.15/bushel they originally used in their analysis. So, they used a simple projection analysis with $3.76/bushel corn. This model predicted that with higher priced corn the yearling fed system becomes more profitable, with yearling steers making $34.31/hd more than calf feds. This is based on several years of data with an average of 73% corn in the diet.

Klopfenstein et al. (2000) concluded that a backgrounding program has little or no effect on carcass characteristics, based on yield grade and quality grade, if the cattle are fed to a common rib fat end point. The key is to match cattle type to the production system in order to avoid lightweight and overweight carcasses, and thus discounts at slaughter.

Feed sources

An important consideration when backgrounding cattle is the forage resource used to grow the cattle before placement into the feedlot. In Nebraska, crop residues are abundant and are an excellent winter feed for growing calves (Gustad, 2006; Geis et al., 2010; Wilken, 2009; Peterson, 2009). Common crop residues include cornstalks, sorghum residue, soybean stubble and wheat straw. All of these may be fed in the field as standing forage or harvested and fed in a mixed diet in a dry lot setting. They can also be enhanced by feeding with a supplement. Gustad (2006) found that ADG of calves on corn residue increased quadratically in response to increasing levels of DDGS from 0.68-2.95 kg/hd/d.

During the spring and summer months, grass can be utilized in a backgrounding system to further grow the cattle. Using the proper management system that optimizes both animal and forage production over the long-term is the objective in order to have a sustainable operation (Ohlenbusch and Watson, 1994). This involves using the proper stocking rate based on the forage production of the pasture and the animals' nutrient requirements. Supplement can also be provided during this phase to increase ADG of the cattle (Greenquist, 2008; Gustad, 2006; MacDonald, 2006; Morris, 2006). Typical supplements range from cereal grains to byproduct feeds from many different industries depending on the location of the operation. Some byproduct feeds found in Nebraska include beet pulp, potato waste, feathermeal, cottonseed meal, wheat midds, bloodmeal, SoyPass^{TM}, distillers grains, and corn gluten feed. With the increase in ethanol production in recent years the use of distillers grains as a supplement has also increased.

Distillers Grains

Dry Milling process

Distiller's grains are a by-product of the dry milling industry. The process is described in detail by Stock et al. (1990). In this process starch, typically from corn or sorghum, is converted into alcohol via yeast fermentation. The end result is approximately one-third ethanol, one-third carbon dioxide, and one-third distillers grains. After fermentation, the mixture is distilled in order to capture the alcohol. The remaining mixture is known as whole stillage (10% DM) and can be separated into wet distillers grains (WDG; 30 to 38% DM) and distillers solubles (4 to 10% DM) through centrifugation or a screening process. The grains portion can be sold as wet, modified, or dried distillers grains. The distillers solubles are evaporated to become condensed distillers solubles and either sold as feed, or added back to the distillers grains to form a product known as wet distillers grains plus solubles (WDGS) which can be sold as wet, modified, or dried distillers grains plus solubles. There is a large amount of variation between plants with different products being made, as well as differing composition of these products. In general, because starch comprises approximately one-third of the grain, and this starch is captured as alcohol, the nutrient composition of the distillers grains is three times greater than the nutrients found in the original grain. Distillers grains typically range from 29-31% CP, 11-13% fat, and 45-52% NDF (Loy, 2003). MacDonald (2006) found protein from DDG to be 55.7% UIP (% of CP) of which 90% was digestible in the small intestine. Distillers grains are also high in phosphorus, on average 0.70% to 1.00% of DM (Spiehs, 2002). Distillers grains may be a beneficial P supplement to cattle on high forage diets because inorganic P supplements can be quite expensive. The nutrient composition of distillers grains and the digestibility of those nutrients is also dependent on what type of grain is used in the fermentation process (Lodge et al., 1997; Waller et al., 1980).

Supplementing with DGS

The nutrient profile of distillers grains complements a summer grazing system. MacDonald (2006) found that DDGS supplemented to heifers grazing smooth bromegrass increased ADG linearly while Corn Gluten Meal increased ADG, but at only 39% of the response to DDG, and corn oil did not affect ADG. This suggests that the increase in ADG seen with DDG is due to the combined effect of the UIP and energy from fat found in the DDG. However, the increase in cattle performance seen with DDGS is even more than would be expected from its nutrient profile. This suggests that there is a positive associative effect taking place, although this has yet to be explained. Distillers grains are relatively high in methionine, which is the first limiting amino acid in forage diets. MacDonald et al. (2006) found that the methionine in DDGS is not solely responsible for the additional gains seen when using DDGS as a supplement to growing calves. Instead, the authors concluded that providing a variety of amino acids is more beneficial than providing a single amino acid.

Distillers grains are frequently used as an energy supplement. The nutrient content of distillers grains suggests that it would have an energy value approximately 18% higher than corn (Larson et al., 1993); however, many studies have shown the energy value to be even higher than this. Nuttleman (2009) found that WDGS had 130% the energy value of DRC when used in a high forage diet. Dried distillers grains may have slightly lower energy values than wet distillers grains due to heat damage during the drying process. However, DDGS is still considered to be a higher energy product than DRC, and the cost of transporting WDGS as well as faster spoilage and difficulty in feeding it may make DDGS more favorable in some situations. Loy (2008) reported an energy value for DDGS to be 27% higher than DRC in a high forage diet. When using distillers grains as an energy source for cattle the energy is coming from the highly digestible fiber and fat content of the distillers grains and not starch. Supplementing growing cattle with energy in the form of digestible fiber may overcome the negative associative effects associated with starch supplementation and high forage diets. Corn and other cereal grains contain large amounts of starch which lowers the overall response seen when using these as supplements to forage diets. This is due to the depressed ruminal pH that is observed due to rapid starch digestion and subsequent acid production. There can also be competition for nutrients when supplementing with grains because amylolytic microbial species can reduce nutrient availability to cellulolytic species (Kunkle et al., 1999). Bowman and Sanson (1996) suggest that providing grain-based supplements up to 0.25% of BW does not affect forage digestion, but supplementation levels over 0.25% of BW do decrease forage intake and(or) digestibility. Loy et al. (2004) found that cattle supplemented with distillers grains or corn at 0.4% of BW decreased forage intake while increasing overall intake. In contrast, protein supplements often increase intake and digestibility of low-quality forages (Horn and McCollum, 1987).

Horn et al. (1995) reported higher ADG for calves supplemented with high fiber (soy hulls and wheat middlings) than high starch (corn based) supplements; 1.07 vs. 1.00 kg/d, respectively. Sumner and Trenkle (1998) replaced 50% of either low or high quality forage in calves' diet with either DRC, DDG, or CGF. The DDG in combination with low quality forage increased NDF digestibility, while the DRC decreased digestibility. Similar results, but of a smaller magnitude were seen when high quality forage was replaced with supplement.

Loy et al. (2003) also found an increased response for DDGS supplementation compared to dry-rolled corn (DRC) and DRC fed with CGM. The calculated TDN content of the DDG was 18-30% greater than DRC.

Availability of distillers grains is a benefit to supplementing grazing animals with distillers grains during the summer months. In Nebraska, many feedlots are owned by farmer-feeders that place calves into the feedlot in the fall and market them as fat cattle in May-June. With all of these cattle coming off feed early in the summer there is a decreased demand for distillers grains, and thus a drop in prices during the summer months. In addition, recent increases in supply with ethanol production increasing from 523 million gallons in 2005 to 1.5 billion gallons in 2009 may make prices more favorable for cattle producers. This correlates with an increase in production of distillers grains from 1 million tons of DM produced in 1998 to 10 million tons in 2006 to a projected production of 16 million tons in 2010 (Weis et al., 2010).

Trials utilizing distillers grains as a supplement have been done in many different settings including winter pasture, native Sandhills range, smooth bromegrass, and crop residues. Gustad (2006) found that calves supplemented with 2.27 kg/hd/d of DDGS on Sandhills native range responded with a 0.675 kg/d increase in ADG while being stocked heavier than the unsupplemented calves. In another trial conducted on Sandhills range, cattle supplemented with 0 to 1.03% of BW in DDGS had a linear increase in ADG with increasing levels of DDGS (Morris, 2006).

Calves grazing corn residue and supplemented with increasing levels of DDGS from 0.68 to 2.95 kg/hd/d had a quadratic increase in ADG with increasing levels of supplement (Gustad, 2006). The lowest level of supplement corresponded with an ADG of 0.41 kg/d and the highest level of supplement with 0.82 kg/d. In a similar experiment, Gustad (2006) reported quadratically decreasing forage intakes when calves were supplemented increasing levels of DDGS from 0.68 to 2.95 kg/hd/d and fed a 70.9% brome hay diet. Average daily gain increased quadratically from 0.86 to 1.09 kg/d with increasing levels of DDGS supplement.

MacDonald (2006) supplemented heifers grazing smooth bromegrass with DDGS, corn bran and corn oil, or corn bran and corn gluten meal. Increasing levels of all three supplements led to increased ADG of the heifers. The DDGS supplement increased ADG 0.064 kg/d for every 0.10% BW increase in supplement and had the highest response compared to the other supplements. Greenquist (2008) supplemented steers grazing smooth bromegrass pastures with DDGS at 0.525% of BW and found an increase of 0.25 kg/d in ADG for supplemented cattle. Morris et al., (2005), supplemented heifers on either a high quality or low quality forage diet with DDGS from 0 to 2.73 kg/hd/d.

With both high and low quality forage diets, ADG increased with increasing levels of DDG and heifers consuming the higher quality forage gained more than those on the lower quality forage at all DDGS levels. Winterholler (2009) fed DDGS at 0.30 to 1.65% of BW to weaned calves with a prairie hay diet. Average daily gain increased linearly and G:F improved quadratically. In a trial with steers fed smooth bromegrass hay and increasing levels of DDGS from 0 to 1.2% of BW, total-tract OM and NDF digestibilities increased linearly while total-tract CP digestibility increased quadratically with increasing DDGS level (Leupp et al., 2009).

In summer forage grazing situations, average daily gain is not constant over the grazing season and a larger response from supplementation is expected when the forage is lower in quality; typically later in the growing season (Smith, 1981).

Supplementing cattle with distillers grains is a proven method for increasing cattle gains on pasture. Typically the price of distillers grains also declines during the summer months due to decreased demand. In recent years, the price of urea has risen dramatically making fertilizing pastures less profitable. Effectively incorporating distillers grains and N fertilizer into a grazing system can be important for both biological and economic reasons in order to have a viable and profitable operation.

The objective of this study was to examine steer and smooth bromegrass pasture performance under different fertilizer and supplementation strategies, as well as the economic impact these different management strategies had on the overall profitability of the system.

Literature Cited

Allen, M.S. 1996. Physical constraints on voluntary intake of forages by ruminants. J. Anim. Sci. 74: 3063-3075.

Allison, C.D. 1985. Factors affecting forage intake by range ruminants: a review. J. Range Manage. 38: 305-311.

Anderson, S.J., T.J. Klopfenstein, and V.A. Wilkerson. 1988. Escape protein supplementation of yearling steers grazing smooth brome pastures. J. Anim. Sci. 66: 237-242.

Baleseng, L.B. 2006. The quality of smooth bromegrass in monoculture pastures before and after grazing by yearling steers. Univ. Neb. MS Thesis.

Benton, J. R., J.C. MacDonald, G.E. Erickson, T.J. Klopfenstein, and D.C. Adams. 2006. Digestibility of undegradable intake proteins of feedstuffs. Nebraska beef cattle report. MP 88-A: 23-26.

Bowman, J.G.P., and D.W. Sanson. 1996. Starch or fiber based energy supplements for grazing ruminants. Proc. West. Sect. Am. Soc. Anim. Sci. 23: 833.

Brueland, B.A., Harmoney, K.R., Moore, K.J., George, J.R., Brummer, E.C. 2003. Developmental morphology of smooth bromegrass growth following spring grazing. Crop Science, 43: 1789-1796.

Bruinenberg, M.H., Valk, H., Korevaar, H., Struik, P.C. 2002. Factors affecting digestibility of temperate forages from seminatural grasslands: a review. Grass and Forage Science, 57: 292-301.

Buxton, D.R. 1990. Cell wall components in divergent germplasms of four perennial forage grass species. Crop Sci. 30: 402-408.

Casler, M.D. and I.T. Carlson. 1995. Smooth bromegrass, p. 313-324. *In*: R.F. Barnes, D.A. Miller, and C.J. Nelson (ed.), Forages: An introduction to grassland agriculture. Vol. 1. Iowa State University Press, Ames, IA.

Caton, J.S. and D.V. Dhuyvetter. 1997. Influence of energy supplementation on grazing ruminants: requirements and responses. J. Anim. Sci. 75: 533-542.

Cleale, R. M., R.A. Britton, T.J. Klopfenstein, M.L. Bauer, D.L. Harmon, and L.D. Satterlee. 1987a. Induced non-enzymatic browning of soybean meal. II. Ruminal escape and net portal absorption of soybean protein treated with xylose. J Anim Sci 65:1319-1326.

Cleale, R.M., T.J. Klopfenstein, R.A. Britton, L.D. Satterlee, and S.R. Lowry. 1987b. Induced non-enzymatic browning of soybean meal. I. Effects of factors controlling non-enzymatic browning on in vitro ammonia release. J Anim Sci 65: 1312-1318.

Cleale, R.M, T.J. Klopfenstein, R.A. Britton, L.D. Satterlee, and S.R. Lowry. 1987c. Induced non-enzymatic browning of soybean meal. III. Digestibility and efficiency of protein utilization by ruminants of soybean meal treated with xylose or glucose. J Anim Sci 65: 1327-1335.

Corrigan, M.E., T.J. Klopfenstein, G.E. Erickson, N.F. Meyer, K.J. Vander Pol, M.A. Greenquist, M.K. Luebbe, K.K. Karges and M.L. Gibson. 2009. Effects of level of condensed distillers solubles in corn dried distillers grains on intake, daily body weight gain, and digestibility in growing steers fed forage diets. J. Anim. Sci. 87: 4073-4081.

Creighton, K. W., C. B. Wilson, T. J. Klopfenstein, and D. C. Adams. 2003. Undegradable intake protein supplementation of compensating spring-born steers and summer-born steers during summer grazing. J Anim Sci 81:791-799.

Frydrynch, Z. 1992. Intestinal digestibility of rumen undegraded protein of various feeds as estimated by the mobile bag technique. Anim. Feed Sci. Technol. 37: 161-172.

Geis, J.R., A.K. Watson, G.E. Erickson, T.J. Klopfenstein, J.R. Benton, W.A. Griffin, R.B. Mitchell, J.F. Pedersen. 2010. Forage quality and grazing performance of beef cattle grazing brown midrib grain sorghum residue. Nebraska beef cattle report, MP 93-A: 40-41.

Greenquist, M.A. 2008. Effects of N fertilization or dried distillers grains supplementation on forage use and performance of yearling steers grazing smooth bromegrass pastures. Univ. Neb. PhD Dissertation.

Greenquist, M.A. 2009. Effects of nitrogen fertilization and dried distillers grains supplementation: Forage use and performance of yearling steers. J. Anim. Sci. 87: 3639-3646.

Griffin, W.A. 2006. The performance and economic effects of sorting long yearling steers by initial feedlot weight, the effects of optaflexx supplementation, and a performance and economic comparison of a long yearling and calf-fed productions system. Univ. Neb. PhD. Dissertation.

Griffin, W.A., V.R. Bremer, T.J. Klopfenstein, L.A. Stalker, L.W. Lomas, J.L. Moyer and G.E. Erickson. 2009. Summary of grazing trials using dried distillers grains supplementation. Nebraska beef cattle report, MP 92-A: 37-39.

Gustad, K.H., J.C. MacDonald, K.J. VanderPol, T.J. Klopfenstein, G.E. Erickson, and M.A. Greenquist. 2006. Dried distillers grains supplementation of calves grazing corn residue. Nebraska beef cattle report, MP 88-A: 36-37.

Gutierrez-Ornelas, E. and T.J. Klopfenstein. 1991. Diet composition and gains of escape protein-supplemented growing cattle grazing corn residues. J. Anim. Sci. 69: 2187-2195.

Hafley, J.L., B.E. Anderson and T.J. Klopfenstein. 1993. Supplementation of growing cattle grazing warm-season grass with proteins of various ruminal degradabilities. J. Anim. Sci. 71: 522-529.

Haugen, H.L., Ivan, S.K., Macdonald, J.C., Klopfenstein, T.J. 2006. Determination of undegradable intake protein digestibility of forages using the mobile nylon bag technique. J Anim Sci 84: 886-893.

Hart, R.H. 1983. Correcting for salivary contamination of esophageal fistula samples. J. Range Manage. 36(1).

Holecheck, J.L., M. Vavra, and R.D. Pieper. 1982. Methods for determining the nutritive quality of range ruminant diets: A review. J. Anim. Sci. 54: 363-376.

Horn, G.W. and F.T. McCollum. 1987. Energy supplementation of grazing ruminants. Page 125 in Proc. Graz. Nutr. Conf. Jackson Hole, WY.

Huntington, G., M. Poore, B. Hopkins, and J. Spears. 2001. Effect of ruminal protein degradability on growth and N metabolism in growing beef steers. J Anim Sci 79: 533-541.

Iwig, N.M. 2003. Forage yield, quality, and utilization of a smooth bromegrass and birdsfoot trefoil pasture mixture. Masters Thesis. University of Nebraska-Lincoln.

Jordon, D.J. 2000. Performance and slaughter breakeven analysis of calf and yearling systems and compensatory growth. PhD. Dissertation. University of Nebraska-Lincoln.

Karges, K.K., T.J. Klopfenstein, V.A. Wilkerson, and D.C. Clanton. 1992. Effects of ruminally degradable and escape protein supplements on steers grazing summer native range. J. Anim. Sci. 70: 1957-1964.

Klopfenstein, T. J., L. Lomas, D. Blasi, D. C. Adams, W. H. Schacht, S. E. Morris, K. H. Gustad, M. A. Greenquist, R. N. Funston, J. C. MacDonald, and M. Epp. 2007. Summary analysis of grazing yearling response to distillers grains. Nebraska Beef Rep. MP90:10-11.

Klopfenstein, T. J., R. A. Mass, K. W. Creighton, and H. H. Patterson. 2001. Estimating forage protein degradation in the rumen. J Anim Sci 79(E Suppl.):E208-217.

Klopfenstein, T.J., R. Cooper, D.J. Jordon, D. Shain, T. Milton, C. Calkins and C. Rossi. 2000. Effects of backgrounding and growing programs on beef carcass quality and yield. J. Anim. Sci. 77: 1-11.

Klopfenstein, T.J. 1996. Need for escape protein by grazing cattle. Anim. Feed Sci. Techno. 60: 191-199.

Krehbiel, C. R., C. L. Ferrell, and H. C. Freetly. 1998. Effects of frequency of supplementation on dry matter intake and net portal and hepatic flux on nutrients in mature ewes that consume low-quality forage. J Aniim Sci 76:2464-2473.

Kunkle, W.E., J.T. Johns, M.H. Poore, and D.B. Herd. 1999. Designing supplementation programs for beef cattle fed forage-based diets. Proc Am. Soc. Anim. Sci. Available at: http://www.asas.org/jas/symposia/proceedings/0912.pdf. Accessed March 24, 2010.

Lamond, R.E., J.O. Fritz, and P.D. Ohlenbusch. 1992. Smooth brome production and utilization. Kansas State University Agricultural Experiment Station and Cooperative Extension Services: C-402. Available at: htpp://www.oznet.ksu.edu.

Lardy, G.P., D.C. Adams, T.J. Klopfenstein, and R.T. Clark. 1999. First limiting nutrient for summer calving cows grazing autumn-winter range. J. Range Manage. 52: 317-326.

Larson, E.M., R.A. Stock, T.J. Klopfenstein, M.H. Sindt, and R.P. Huffman. 1993. Feeding value of wet distillers byproducts for finishing ruminants. J. Anim. Sci. 71: 2228-2236.

Lesperance, A.L., E.H. Jensen, V. R. Bohman, and R. A. Madsen. 1960. Measuring selective grazing with fistulated steers. J. Dairy Sci. 43: 1615-1622.

Leupp, J.L., G.P. Lardy, K.K. Karges, M.L. Gibson and J.S. Caton. 2009. Effects of increasing levels of corn distillers dried grains with solubles to steers offered moderate-quality forage. J. Anim. Sci. 87: 4064-4072.

Lodge, S.L., R.A. Stock, T.J. Klopfenstein, D.H. Shain, and D.W. Herold. 1997a. Evaluation of corn and sorghum distillers byproducts. J. Anim. Sci. 75: 37-43.

Loy, T. W., T. J. Klopfenstein, G. E. Erickson, C. N. Macken, and J. C. MacDonald. 2003. Supplemental type and frequency on intake, performance, and energy value of dry distillers grains in a high-forage diet. J Anim Sci 81(Suppl. 2):107. (Abstr.)

Loy, T.W., J.C. MacDonald, T.J. Klopfenstein, and G.E. Erickson. 2004. Effect of distillers grains or corn supplementation frequency on forage intake and digestibility. Nebraska beef cattle report MP 80-A: 22-24.

Loy, T.W., T.J. Klopfenstein, G.E. Erickson, C.N. Macken, and J.C. MacDonald. 2008. Effect of supplemental energy source and frequency on growing calf performance. J Anim Sci 86: 3504-3510.

MacDonald J.C. 2002. Sorting strategies in an extensive forage utilization beef production system. M.S. Thesis. University of Nebraska-Lincoln.

MacDonald, J. C. 2006. Use of dried distillers grains and nitrogen sources in high forage diets. Univ. Neb. Ph.D. Dissertation.

MacDonald, J.C., T.J. Klopfenstein, G.E. Erickson, W.A. Griffin. 2009. Effects of dried distillers grains and equivalent undegradable intake protein or ether extract on performance and forage intake of heifers grazing smooth bromegrass pastures. J. Anim. Sci. 87: 3639-3646.

MacDonald, J.C., G.E. Erickson and T.J. Klopfenstein. 2006. Effect of fat and undegradable intake protein in dried distillers grains on performance of cattle grazing smooth bromegrass pastures. Nebraska beef cattle report, MP 88-A: 27-29.

MacDonald, J.C. and T.J. Klopfenstein. 2004. Dried distillers grains as a grazed forage supplement. Nebraska beef cattle report. MP 80-A: 25-27.

Macoon, B., L.E. Sollenerger, J.E. Moore, C.R. Staples, J.H. Fike, and K.M. Portier. 2003. Comparison of three techniques for estimating the forage intake of lactating dairy cows on pasture. J. Anim. Sci. 81: 2357-2366.

McCurdy, M.P., G.W. Horn, J.J. Wagner, P.A. Lancaster and C.R. Krehbiel. 2010. Effects of winter growing programs on subsequent feedlot performance, carcass characteristics, body composition, and energy requirements of beef steers. J. Anim. Sci. 88: 1564-1576.

Minson, D.J. 1990. Forage in ruminant nutrition. Academic Press, Inc., San Diego, CA.

Mitchell, R.B., D.D. Redfearn, L.E. Moser, R.J. Grant, K.J. Moore, and B.H. Kirch. 1997. Relationships between insitu protein degradability and grass developmental morphology. J. Dairy Sci 80: 1143-1149.

Morris, S.E., J.C. MacDonald, D.C. Adams, T.J. Klopfenstein, R.L. Davis, and J.R. Teichert. 2006. Effects of supplementing dried distillers grains to steers grazing summer Sandhill range. Nebraska beef cattle report, MP 88-A: 30-32.

Morris, S.E., T.J. Klopfenstein, D.C. Adams, G.E. Erickson, and K.J. Vander Pol. 2005. The effects of dried distillers grains on heifers grazing low or high quality forage. Nebraska beef cattle report, MP 83-A: 18-20.

NRC. 1985. Ruminant Nitrogen Usage. National Academy Press, Washington, D.D.

NRC. 1996. Nutrient requirements of beef cattle. National Academy Press, Washington, D. C.

NRC. 2001. Nutrient requirements of dairy cattle. National Academy Press, Washington, D.C.

Nuttleman, B.L., M.K. Luebbe, J.R. Benton, T.J. Klopfenstein, L.A. Stalker, G.E. Erickson. 2009. Energy value of wet distillers grains in high forge diets. Nebraska beef cattle report, MP 92-A: 28-29.

Ohlenbush, P.D. and S.L. Watson. 1994. Stocking rate and grazing management. Kansas State University Agricultural Experiment Station and Cooperative Extension Services: MF-1118. Available at: htpp://www.oznet.ksu.edu.

Olson, K. C. 1991. Diet sample collection by esophageal fistula and rumen evacuation techniques. J. Range Manage. 44: 515-519.

Orskov, E. R. 1982. Protein Nutrition in Ruminants. Pages 40-84. Academic Press, New York, NY.

Patterson, H.H., D.C. Adams, T.J. Klopfenstein, R.T. Clark, and B. Teichert. 2003. Supplementation to meet metabolizable protein requirements of primiparous beef heifers: II. Pregnancy and economics. J. Anim. Sci. 81: 563-570.

Patterson, H.H., D.C. Adams, T.J. Klopfenstein, R.T. Clark, and B. Teichert. 2003. Supplementation to meet metabolizable protein requirements of primiparous beef heifers: I. Performance, forage intake, and nutrient balance. J. Anim. Sci. 81: 800-811.

Peterson, M.M., M.K. Luebbe, R.J. Rasby, T.J. Klopfenstein, G.E. Erickson and L.M. Kovarik. 2009. Level of wet distillers grains plus solubles and solubles ensiled with wheat straw for growing steers. Nebraska beef cattle report, MP 92-A: 35-36.

Sainz, R.D. and R.F. Vernazza Paganini. 2004. Effects of grazing and feeding periods on performance and carcass traits of beef steers. J. Anim. Sci. 82: 292-297.

Schlueter, K. R. 2004. Seasonal dry matter and crude protein removal by grazing from grass/legume mixtures. Univ. Neb. MS Thesis.

Smith, C.D., J.C. Whittier, D.N. Schutz, and D. Couch. 2001. Comparison of alfalfa hay and distillers dried grains with solubles, alone or in combination with cull beans, as protein sources for beef cows grazing native winter range. Professional Animal Scientist 17: 139-144.

Smith, E.F. 1981. Growing cattle on grass. . Kansas State University Agricultural Experiment Station and Cooperative Extension Services: 638. Available at: htpp://www.oznet.ksu.edu.

Sniffen, C. J., J. D. O'Connor, P.J. Van Soest, D. G. Fox, and J.B. Russell. 1992. A net carbohydrate and protein system for evaluating cattle diets: II. Carbohydrate and protein availability. J. Anim. Sci. 70: 3562-3577.

Spiehs, M.J., M.H. Whitney, and G.C. Shurson. 2002. Nutrient database for distiller's dried grains with solubles produced from new ethanol plants in Minnesota and South Dakota. J Anim Sci 80: 2639-2645.

Stock, R.A., J.M. Lewis, T.J. Klopfenstein, and C.T. Milton. 1999. Review of new information on the use of wet and dry milling feed by-products in feedlot diets. Proc. Am. Soc Anim. Sci. Available at: http://www.asas.org/JAS /symposia/proceedings/0924.pdf. Accessed Feb 19, 2010.

Sumner, P. and A. Trenkle. 1998. Effects of supplementing high or low quality forages with corn or corn processing co-products upon digestibility of dry matter and energy by steers. Iowa State University Beef Research Report. Available at: http://www/iowabeefcenter.org/Pages/ansci/beefreports/asl-1540.pdf. Accessed March 18, 2010.

Taylor, C.A., M.H. Ralphs and M.M. Kothmann. 1997. Technical note: Vegetation response to increasing stocking rate under rotational stocking. J. Range Manage. 50: 439-442.

Taylor, C.A., M.M. Kothmann, L.B. Merrill, and D. Elledge. 1980. Diet selection by cattle under high-intensity low-frequency, short duration, and Merrill grazing systems. J. Range Manage. 33: 428-434.

Terry, R.A. and Tilley, J.M.A. 1964. The digestibility of the leaves and stems of perennial ryegrass, cocksfoot, timothy, tall fescue, lucerne and sainfoin, as measured by an in vitro procedure. Journal of British Grassland Society, 19:363-372.

Torell, D. T. 1954. An esophageal fistula for animal nutrition studies. J. Anim. Sci. 13: 878-884.

Ullerich, M.D. 2001. Effects of forage quality on performance of beef steers grazing smooth brome pastures interseeded with legumes. Masters Thesis. University of Nebraska-Lincoln.

USDA. 2010. National Agricultural Statistics Service. Agricultural prices. Available at: http://www.nass.usda.gov/index.asp. Accessed on March 18, 2010.

Van Soest, P.J. 1994. Nutritional ecology of the ruminant. 2 ed. Cornell University Press, Ithaca, NY.

Van Soest, P.J., J.B., Robertson, and B.A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J Dairy Sci 74: 3583-3597.

Volesky, J.D., B.E. Anderson, J.T. Nichols. 2003. Perennial forages for irrigated pasture. NebGuide: G1502. University of Nebraska-Lincoln Extension, Institute of Agriculture and Natural Resources (IANR).

Volesky, J.D. and B.E. Anderson. 2007. Defoliation effects on production and nutritive value of four irrigated cool-season perennial grasses. J. Agron. 99: 494-500.

Waller, J., T.J. Klopfenstein, and M. Poos. 1980. Distillers feeds as protein sources for growing ruminants. J Anim Sci 51: 1154-1167.

Wilken, M.F., M.K. Luebbe, G.E. Erickson, T.J. Klopfenstein and J.R. Benton. 2009. Feeding corn distillers solubles or wet distillers grains plus solubles and cornstalks to growing calves. Nebraska beef cattle report, MP 92-A: 30-32.

Wilkerson, V. A., T. J. Klopfenstein, and W.W. Stroup. 1995. A collaborative study of in situ forage protein degradation. J. Anim. Sci. 73: 583-588.

Wilson, C.B., G.E. Erickson, T.J. Klopfenstein, R.J. Rasby, D.C. Adams and I.G. Rush. 2004. A review of corn stalk grazing on animal performance and crop yield. Nebraska beef cattle report. MP 80-A: 13-15.

Winterholler, S.J., D.L. Lalman, M.D. Hudson, C.E. Ward, C.R. Krehbiel, G.W. Horn. 2008. Performance, carcass characteristics, and economic analysis of calf-fed and wheat pasture yearling systems in the southern great plains. Prof. Anim. Sci. 24: 232-238.

Winterholler, S.J., B.P. Holland, C.P. McMurphy, C.R. Krehbiel, G.W. Horn, D.L. Lalman. 2009. Use of dried distillers grains in preconditioning programs for weaned beef calves and subsequent impact on wheat pasture, feedlot, and carcass performance. Prof. Anim. Sci. 25: 722-730.

Fertilization and Supplementation Strategies for Steers Grazing Smooth Bromegrass Pastures

A.K. Watson, T.J. Klopfenstein, W.H. Schacht, G.E. Erickson, M.K. Luebbe, W.A. Griffin, K.R. Brink, and M.A. Greenquist

Abstract

A 5-year study was conducted to evaluate the effects of different grazing and supplementation strategies on both cattle and pasture performance utilizing yearling steers grazing smooth bromegrass pastures. Forty-five steers were used each year for a total of 225 animals in a RCBD. The supplemented group received 0.6% of BW in dry distillers grains plus solubles (DDGS) pellets daily and were stocked at 9.9 AUM/ha (SUPP). Steers receiving no supplement but grazing pastures fertilized in the spring with 90 kg N/ha were also stocked at 9.9 AUM/ha (FERT). Non-supplemented cattle grazing non-fertilized pastures were stocked at 6.8 AUM/ha (CONT). Paddock was the experimental unit and was replicated 3 times per year. Paddocks were blocked by location and rotationally grazed. Put-and-take cattle were used to maintain similar grazing pressure among the different treatment paddocks. In-vitro DM digestibility of forage samples declined quadratically over the grazing season ($P < 0.01$) while CP content and forage production showed cubic responses ($P < 0.05$) over the grazing season. Forage production was greatest for the FERT paddocks, intermediate for SUPP paddocks, and least for CONT paddocks ($P < 0.01$). The UIP content averaged 2.03% of DM and varied between 2.89 and 1.55% of DM. There were no differences between fertilized and unfertilized samples ($P = 0.79$). Final BW was increased for SUPP steers compared to both FERT and CONT steers ($P < 0.01$). Over the grazing season, ADG declined as forage quality declined. As ADG declined, the extra gain of the SUPP steers over both FERT and CONT steers increased. Stocking rates were greater for SUPP pastures compared to non-fertilized pastures because of increased forage production and replacement of approximately 0.79 kg of forage for each 1 kg of supplement fed. Dried distillers grains can be used to increase yearling steer performance while grazing smooth bromegrass pastures.

Key words: Beef cattle, dried distillers grains, smooth bromegrass

Introduction

Linear increases in forage production of smooth bromegrass (*Bromus inermis* L.) in eastern Nebraska have been seen with fertilizer N applications up to 504 kg N/ha (Casler and Carlson, 1995), which may or may not be cost effective. Recent prices of N fertilizer have been up to $537/ 909 kg of urea, more than twice the price of urea in 2004 (USDA-NASS).

With recent increases in production of ethanol from grain sources, distillers grains have become a common, relatively inexpensive source of CP, energy, and P for cattle. The protein content of actively growing forages, like smooth bromegrass, is high in degradable intake protein (DIP). The protein in distillers grains is approximately 65% UIP, which would overcome any UIP deficiencies young, growing cattle may have while grazing forages. Several studies have shown increased gains in growing calves in response to UIP supplementation (Karges et al., 1992; Klopfenstein, 1996; Creighton et al., 2003). MacDonald (2006) found that DDG supplemented to heifers grazing smooth bromegrass increased ADG linearly while corn gluten meal increased ADG, but at only 39% of the response to DDG, and corn oil did not affect ADG. This suggests that the increase in ADG seen with DDG is due to the combined effect of the UIP and energy from fat found in the DDG. Loy (2003) also found an increased response for DDG supplementation compared to DRC and DRC fed with CGM. The calculated TDN content of the DDG was 18-30% greater than DRC. In addition to being used as a supplement for cattle, distillers grains also can be used as a fertilizer for pastures. When cattle are supplemented with approximately 2.27 kg of distillers grains daily they have excess N in their diet, part of which is excreted in the urine as urea. Distribution of urea application by cattle should improve as the intensity of the rotational grazing system increases. In addition to improving both cattle and pasture performance, distillers grains supplement can replace forage intake. Klopfenstein et al. (2007) summarized several grazing trials with distillers grains supplementation and found that every kg of distillers grains supplement can replace 0.27-0.79 kg of forage. The objective of this experiment was to determine both cattle and pasture performance under two different grazing management strategies, fertilizing with 90 kg N/ha or not fertilizing and supplementing the cattle with DDGS at 0.6% of BW.

Materials and Methods

This experiment was conducted at the University of Nebraska-Lincoln Agricultural Research and Development Center near Mead, NE. Temperatures in this area typically range between a low of -12.4°C in January to a high of 30.9°C in July. Annual precipitation for the 5 years of the study ranged between 60.63 cm of precipitation in 2005 to 102.62 cm in 2007 (NCDC, 2010). Soils of the study site are predominantly Sharpsburg silty clay loam. The pasture is composed of a monoculture of smooth bromegrass that has been fertilized in the past with 90 kg N/ha while being grazed heavily in the spring and fall.

Each year 45 crossbred steers (325 ± 22 kg) were used in a RCBD to evaluate the effects of N fertilization and DDGS supplementation. Data were collected in 5 consecutive years, from 2005 to 2009. Results from 2005 to 2007 have been previously reported by Greenquist et al. (2008) and will be added to the results from 2008 and 2009. Data were collected on steer performance, measured by ADG throughout the trial; diet quality, measured by diet samples taken with fistulated steers; and forage production, measured by hand clipping quadrats throughout the pastures. 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.

Treatments assigned in this trial were based on past research done on smooth bromegrass pastures. Schlueter (2004) reported that smooth bromegrass pastures fertilized with 90 kg N/ha can be stocked at 69% higher rates than pastures receiving no fertilizer. Additional research conducted by MacDonald et al. (2006) suggests that supplementing cattle with DDGS at 0 to 0.75% of BW will improve ADG by 0.064 kg for every 0.10% BW increase in DDGS supplementation. Due to the results from these past trials, 3 treatments were selected for the current study. Treatments included yearling steers stocked at 9.9 AUM/ha on smooth bromegrass pastures fertilized with 90 kg N/ha (FERT), non-fertilized smooth bromegrass pastures stocked at 6.8 AUM/ha (CONT), and non-fertilized smooth bromegrass pastures stocked at 9.9 AUM/ha and supplemented daily with 0.6% of BW in DDGS pellets (SUPP).

The pastures were divided into paddocks within three blocks with location being the blocking factor. Within each block, each treatment was assigned randomly a location at the start of the trial and treatments were maintained on the same locations for the duration. One replication of one treatment consisted of 6 paddocks that were approximately 0.33 ha for FERT and SUPP and 0.48 ha for CONT. These paddocks were rotationally grazed by the cattle with one full rotation through all 6 paddocks being a cycle that consisted of either 24 or 36 days. In cycle 1, cattle were rotated every 4 days for a total cycle length of 24 days. Cycles 2, 3, and 4 were 36 days in length with cattle being rotated every 6 days. Cycle 5 varied in length with cattle rotated every 4 or 6 days depending on rainfall and forage availability. Put-and take-cattle were also used to maintain similar grazing pressure on all treatments. Forage yield measurements and visual observations were used to determine if these extra cattle should be added or subtracted from treatments. Five tester animals were maintained at all times on every treatment. The put-and-take cattle were kept in an adjacent pasture with similar forage quality and availability. The put-and-take method allowed us to keep grazing pressure equal across all 3 treatments. The number of head days was calculated for each treatment by multiplying the number of tester steers by the number of days they grazed, plus the number of put-and-take cattle multiplied by the number of days grazed. The put-and-take cattle were not used in determining animal performance. Total gain for each treatment was calculated by ADG of the tester steers multiplied by the total number of head days.

Before trial initiation, steers were limit fed a common diet at approximately 1.75% of BW which consisted of 48% alfalfa hay, 48% wet corn gluten feed, and 4% supplement, all on a DM basis. Cattle were then weighed on 3 consecutive days to minimize the impact of variations in gut fill. Cattle were also weighed at the completion of each cycle. The first 3 years of the trial these were group weights taken with a mobile pen scale (MASM7-20EA, Norac Inc., Fridley, MN). The following 2 years individual animal BWs were measured. In all 5 years a 4% pencil shrink was assigned to BW. Cattle were checked daily and were provided with free choice trace mineral salt blocks and fresh water in portable water tanks that were rotated through the paddocks with the cattle. The SUPP treatment cattle also had portable feed bunks for the DDGS pellets that were rotated with the cattle. The paddocks were divided by a single strand of electric fence. Upon completion of the trial, cattle were again limit fed for 5 days followed by 3 days of BW data collected. Steers were fed for approximately 109 days in the feedlot, but data were not collected every year.

Diet quality data were collected on strips grazed in the 2nd, 4th, or 6th grazing period of each paddock, of each cycle, and in every block for the first 3 years of the trial. The last 2 years, measurements were taken only on one block due to all of the blocks being very similar in quality in the previous 3 years. Every year cattle were started in a different strip; so, diet samples were taken at different times throughout the 5 years of the study. Diet samples were taken at the midpoint of the grazing period (the morning of the

4th day of a 6 day rotation or the morning of the 3rd day of a 4 day rotation). Two ruminally fistulated steers were used to collect samples in each strip. These steers were kept in an adjacent pasture to the test pastures. The steers were locked out of feed for 12 h prior to the sampling date but had access to water. Rumen evacuations were performed and then the steers were hauled to the sampling site and allowed to graze for approximately 30 minutes. Three sites were measured on each sampling date so 6 steers were utilized with steers being assigned randomly to sample treatments throughout the trial. After grazing, samples were pulled from the rumen and put on ice. The rumen contents were then replaced. After being transported to the lab, samples were freeze dried and ground through a Wiley mill (Thomas Scientific, Swedesboro, NJ) with a 5.08 cm screen. A sub sample was ground through a 2.54 cm screen.

Diet samples were used to determine the cattle's diet quality, including IVDMD and CP. In vitro DM disappearance was measured using the Tilley and Terry method (Tilley and Terry, 1963) with the addition of 1 g/L of urea to the McDougall's buffer (Weis, 1994). Rumen fluid for this procedure was collected from 2 ruminally fistulated steers that had ad libitum access to smooth bromegrass hay and water. All IVDMD runs had 5 feed standards of varying quality and known in vivo DM digestibility included. The IVDMD values of these standards were then regressed on their known digestibilities in order to develop regression equations for each run to calculate total tract DM digestibility (TTDMD). This method was developed by Geisert et al. (2006). Crude protein was measured using a combustion N analyzer (Leco FP-528, St. Joseph, MI).

Diet samples were also used to determine UIP content of the steers' diet. Two ruminally fistulated crossbred steers were used for incubation of the samples to determine UIP. The animals were individually penned and had ad libitum access to brome hay and water. Dacron bags (Ankom, Fairport, NY) that were 5 by 10 cm with a pore size of 50 µm were used. Samples were composited by year, cycle, and fertilized or unfertilized paddocks, and then ground through a 2 mm screen. The 1.25 g of sample were weighed into each Dacron bag. Dacron bags were placed inside mesh bags and then placed inside the rumen at 3 different time points that corresponded with IVDMD of the samples. Samples of lower quality were incubated for a longer time in order to ensure adequate degradation in the rumen. The time points were chosen based on calculation of rate of passage with the following equation: $K_p = 0.07 * \text{IVDMD} (\%) – 0.20$ (Klopfenstein, et al., 2001), followed by determination of 75% total mean retention time (TMRT) with the following equation: $((1/k_p) + 10) * 0.75$. The bags were inserted into the rumen sequentially starting with the highest incubation point and finished with the least incubation point so that all of the bags were removed at the same time. The mesh bags were then removed and Dacron bags were machine-washed (Whittet et al., 2003). Washing consisted of 5 rinse cycles with each having 2 minutes of spin and 1 min of agitation. Half of the bags were then bulk refluxed in neutral detergent solution to remove microbial contamination and dried at 60°C for 48 h. The remaining bags were inserted into duodenally fistulated steers at a rate of one bag every 5 minutes with 12 bags inserted into one steer per day. The following day bags were collected out of the feces and frozen. These bags were washed similar to rumen incubation. Microorganisms were removed by refluxing the bags in neutral detergent solution (Klopfenstein et al., 2001). All bags were weighed after being dried, allowed to air equilibrate for 3 h and then weighed again. Samples were taken from the bags to determine N concentration of the residue to determine Neutral Detergent Insoluble Nitrogen (NDIN).

In 2005 to 2008 available forage was measured before and after cattle grazed paddocks. This was done with a drop disk method where 50 disc (0.26 m^2) measurements were taken at randomly selected locations and correlated to actual clip data from quadrats (0.38 m^2) that were clipped at every 8^{th} disc location. At each disk location, the disk was released from a 1-m height and the resting height of the disc on the grass tillers was recorded. This was done for pre and post grazing to determine DM removed by the cattle. This method is described in more detail by Baleseng et al. (2006). In 2009, total forage production was measured in two paddocks of each treatment of each block. This was done by putting up 8 cages, approximately 1m^2, in each paddock that was measured. Quadrats (0.38 m^2) were then clipped within these cages where the cattle could not graze. This was done twice per year, in late June and early October to account for both spring growth and any regrowth in the fall. These cages were put up after the FERT treatment received fertilizer in March. Forage growth due to urine spots from previous years, but not the current year, would be accounted for within these cages.

Statistics for this trial were done with the mixed procedures of SAS (SAS Inst., Inc, Cary, NC) as a RCBD with block being considered as a random effect and paddock being the experimental unit. Model effects included year, treatment, year x treatment interactions, cycle, and cycle x treatment interactions. Differences in means were considered significant at $P < 0.05$.

Results and Discussion

Across years there were differences in weather patterns with temperature and rainfall (Table 1) being the easiest variables to measure. This resulted in different forage production within the different years, which directly affected animal performance. In a typical year, smooth bromegrass will have rapid growth in the spring, be fairly dormant during the hot dry months of summer, and have some regrowth in the fall, dependent on temperature and rainfall. In 2007 and 2009, August was an exceptionally wet month causing an increase in forage production compared to other years. In vitro DM digestibility also increases when there is new regrowth and so, IVDMD was higher in Cycle 5 of 2007 and 2009 than other years. Other studies done on pastures close to this location have reported a quadratic decline in IVDMD ($P < 0.01$) over the summer months accompanied by a cubic relationship ($P < 0.01$) between CP content and time in the grazing season (Schlueter, 2004; Baleseng, 2006; MacDonald, 2006; Greenquist, 2008). For the current study, over all 5 years, both IVDMD and CP content were highest for all treatments in Cycle 1 and declined over time with some rebound in cycles 4 or 5 (Table 2).

Diet quality characteristics are presented in Tables 2 and 3. Across treatment IVDMD values started at almost 71% in cycle 1 and fell to a low of 47% in cycle 5. There were no statistical differences between treatments for IVDMD. Over time there was a quadratic relationship for IVDMD ($P < 0.05$). Crude protein levels were highest in cycle 1 at 18.6% DM. In cycle 1, CP content was highest for the FERT treatment ($P < 0.01$). In cycles 3, 4, and 5 there were no differences in CP content between treatments.

There was a cubic response of CP content over time ($P < 0.05$). The CP content of smooth bromegrass can be affected by many factors including maturity, soil fertility, and weather.

The UIP content of smooth bromegrass dry matter varied slightly over the grazing season. Haugen et al. (2006) stated that the constant digestibilities used by the NRC system may be overestimated for forages. The digestibility of the UIP in smooth bromegrass in the current study would support that finding with digestibilities ranging from 39-55%. These values are considerably lower than the assumed 80% for all forages in the 1996 NRC. Undegradable intake protein (% DM), digestibility of undegradable protein, and intestinal disappearance of undegradable intake protein (IDUIP) of smooth bromegrass are shown in Tables 5, 6, and 7. The intestinal disappearance of UIP (DUIP) is measured by subtracting total tract indigestible protein (TTIDP) from the total UIP content of a sample. This is then equal to the amount of UIP that is absorbed in the intestine. As forage quality declined over the grazing season the quantity of UIP also declined with digestibility declining from a high of 55% in cycle 1 to a low of 39% in cycle 5. However, total UIP content of the samples declined with the summer slump and then rebounded in the fall. There were no interactions between fertilized and unfertilized treatments ($P = 0.79$) for total UIP content. Cycle 1 is the only time point where there was a difference in CP content between fertilized and unfertilized samples ($P < 0.01$).

Approximately 40-55% of the total seasonal growth for smooth bromegrass occurs by mid-May (Schlueter, 2004). With this fast, early growth in the spring, smooth bromegrass responds well to an intensive rotational grazing system with cattle being rotated through the pastures quickly during the first cycle. This keeps the grass from becoming stemmy and less palatable to cattle (Baleseng, 2006). Rest periods should then be longer during the summer months due to slower growth. Having multiple grazing periods throughout the growing season also increases harvest efficiency.

In 2005 to 2008 standing crop was measured before and after grazing for all treatments to estimate forage availability and forage utilization in each cycle. There was a cubic response for forage availability with peak production reached in cycle 2 for all treatments (Table 2). Over the entire grazing season forage availability per ha was greatest for FERT, intermediate for SUPP, and lowest for CONT (Table 3). In 2009 total forage production was measured by clipping cages in June and October. This data illustrates forage production after 4 years of these treatments being applied to these pastures. The FERT pastures (9429 kg/ha) had the greatest forage production per hectare overall, while CONT pastures (6565 kg/ha) had the lowest yields and SUPP pastures (7300 kg/ha) were intermediate (Table 8). Clipped samples were classified as either smooth bromegrass or "other", mostly weedy species. In 2009, the CONT pastures had a greater production of these weedy species compared to the other two treatments indicating that this treatment may not be sustainable in the long run. Because the CONT pastures produced less per ha but were originally stocked at only 69% of the FERT treatment forage availability 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 grazing ($P = 0.81$). If CONT cattle did not have enough extra land to compensate for decreased forage production on those pastures, their performance would have suffered. Average forage intake for CONT cattle was estimated using NRC equations and was 8.46 kg/d. Using this and total forage production, cattle utilization of available forage was 42.17%. Applying this utilization rate to the SUPP cattle shows forage intake to be 6.52 kg/day in addition to approximately 2.45 kg/d of DDGS supplement. Each kg of DDGS fed replaced approximately 0.79 kg of forage.

Grazing pressure was adjusted each cycle using put-and-take cattle to account for changes in forage production. The goal was to use the available forage, down to 8-10 cm, by the end of the grazing season. Extra put-and-take cattle were added in cycle 5, if necessary, to remove any stockpiled forage from earlier in the grazing season. Actual stocking rates used over the five years, adjusted for put-and-take animals and BW of cattle were 8.53, 12.88, and 13.27 AUM/ha for the CONT, FERT, and SUPP treatments, respectively. Actual stocking rates used for CONT pastures were 66% of FERT and 64% of SUPP pastures over the five years.

Cattle performance was identical between the CONT and FERT treatments ($P = 0.81$) with CONT cattle stocked at only 69% of FERT. This resulted in weight gain per ha to be greater for FERT than CONT (Table 4). Total weight gained per ha was highest for the SUPP pastures as cattle were stocked at the same rate as the FERT cattle, but also gained 41 kg more over the entire grazing season due to the daily supplement they received. This increase in weight gain can be attributed to the extra energy from the fat and undegradable intake protein content of the supplement because pasture IVDMD did not differ between treatments ($P > 0.05$). This suggests that DDGS supplementation is an effective way to increase the efficient use of a single piece of land.

Interim weights taken between cycles show that the increased response to DDGS is not constant throughout the season. Pasture IVDMD was also not constant across the grazing season with higher quality forage in cycles 1 and 2 and a decline in IVDMD through cycles 3, 4, and 5 (Table 2). As IVDMD declined through the grazing season, ADG of the cattle also declined (Figure 2). The response of the SUPP cattle to the DDGS is defined as their increased gain over the gain of the unsupplemented cattle. As IVDMD and ADG of the cattle declined, the cattle's response to the DDGS actually increased (Figure 3). In cycles 1 and 2, the supplemented steers' ADG response was 0.15 kg/day. In cycles 3, 4, and 5, IVDMD of the smooth bromegrass declined and ADG response increased to 0.34 kg/day. 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 see benefits of supplementation by capitalizing on the additional benefits of supplementation later in the grazing period.

Measuring or predicting cattle intakes on pastures is difficult. Using the NRC model, we were able to estimate that CONT cattle on the current study had a forage intake of 8.59 kg/day of bromegrass. Assuming that the DDGS supplement had a TDN value of 108% (Loy, 2003), the SUPP steers had an intake of 5.82 kg/day of bromegrass plus 2.32 kg/day of DDGS. The 2.32 kg of supplement was replacing 2.77 kg of bromegrass for a replacement rate of approximately 1 to 1. To further support this, the CONT cattle were stocked at 69% of the SUPP cattle and the SUPP cattle had 68% the forage intake of CONT cattle. In 2004, MacDonald and Klopfenstein also estimated forage intakes of grazing cattle supplemented with DDGS using the 1996 NRC model. They estimated that unsupplemented cattle consumed 7.95 kg of smooth bromegrass per head per day. They also estimated that 0.45 kg of DDGS would replace 0.78 kg of forage.

Implications

Utilizing dried distillers grains as a supplement to steers grazing smooth bromegrass pastures did improve cattle performance. Over all 5 years, total gain per ha was increased by 219 kg for supplemented cattle and 103 kg for cattle grazing fertilized pastures compared to non-supplemented cattle grazing non-fertilized pastures. Supplemented cattle were successfully stocked at the same rate as pastures fertilized in the spring with 90 kg N/ha. Thus, distillers grains improved pasture performance by increasing forage production and replacing approximately 1 kg of forage for every 1 kg of DDGS consumed. Supplementing cattle is most valuable when forage quality is low suggesting that supplementing cattle at key points during the growing season would be beneficial.

Literature Cited

Baleseng, L.B. 2006. The quality of smooth bromegrass in monoculture pastures before and after grazing by yearling steers. Univ. Neb. MS Thesis.

Benton, J. R., J.C. MacDonald, G.E. Erickson, T.J. Klopfenstein, and D.C. Adams. 2006. Digestibility of undegradable intake proteins of feedstuffs. Nebraska beef cattle report. MP 88-A: 23-26.

Casler, M.D. and I.T. Carlson. 1995. Smooth bromegrass, p. 313-324. *In*: R.F. Barnes, D.A. Miller, and C.J. Nelson (ed.), Forages: An introduction to grassland agriculture. Vol. 1. Iowa State University Press, Ames, IA.

Creighton, K. W., C. B. Wilson, T. J. Klopfenstein, and D. C. Adams. 2003. Undegradable intake protein supplementation of compensating spring-born steers and summer-born steers during summer grazing. J Anim Sci 81:791-799.

Geisert, B.G., T.J. Klopfenstein, D.C. Adams, and J.C. MacDonald. 2006. Comparison of in vivo digestibility to in vitro digestibility of five forages fed to steers. J. Anim. Sci. 84 (Suppl. 2): 104. (Abstr.)

Greenquist, M.A. 2008. Effects of N fertilization or dried distillers grains supplementation on forage use and performance of yearling steers grazing smooth bromegrass pastures. Univ. Neb. PhD Dissertation.

Haugen, H.L., Ivan, S.K., Macdonald, J.C., Klopfenstein, T.J. 2006. Determination of undegradable intake protein digestibility of forages using the mobile nylon bag technique. J Anim Sci 84: 886-893.

Karges, K.K., T.J. Klopfenstein, V.A. Wilkerson, and D.C. Clanton. 1992. Effects of ruminally degradable and escape protein supplements on steers grazing summer native range. J. Anim. Sci. 70: 1957-1964.

Klopfenstein, T. J., L. Lomas, D. Blasi, D. C. Adams, W. H. Schacht, S. E. Morris, K. H. Gustad, M. A. Greenquist, R. N. Funston, J. C. MacDonald, and M. Epp. 2007. Summary analysis of grazing yearling response to distillers grains. Nebraska Beef Rep. MP90:10-11.

Klopfenstein, T. J., R. A. Mass, K. W. Creighton, and H. H. Patterson. 2001. Estimating forage protein degradation in the rumen. J Anim Sci 79(E Suppl.):E208-217.

Klopfenstein, T.J. 1996. Need for escape protein by grazing cattle. Anim. Feed Sci. Techno. 60: 191-199.

Loy, T. W., T. J. Klopfenstein, G. E. Erickson, C. N. Macken, and J. C. MacDonald. 2003. Supplemental type and frequency on intake, performance, and energy value of dry distillers grains in a high-forage diet. J Anim Sci 81(Suppl. 2):107. (Abstr.)

Loy, T.W., T.J. Klopfenstein, G.E. Erickson, C.N. Macken, and J.C. MacDonald. 2008. Effect of supplemental energy source and frequency on growing calf performance. J Anim Sci 86: 3504-3510.

MacDonald, J.C., G.E. Erickson and T.J. Klopfenstein. 2006. Effect of fat and undegradable intake protein in dried distillers grains on performance of cattle grazing smooth bromegrass pastures. Nebraska beef cattle report, MP 88-A: 27-29.

MacDonald, J.C., T.J. Klopfenstein, G.E. Erickson, W.A. Griffin. 2009. Effects of dried distillers grains and equivalent undegradable intake protein or ether extract on performance and forage intake of heifers grazing smooth bromegrass pastures. J. Anim. Sci. 87: 3639-3646.

MacDonald, J.C. and T.J. Klopfenstein. 2004. Dried distillers grains as a grazed forage supplement. Nebraska beef cattle report. MP 80-A: 25-27.

Mitchell, R.B., D.D. Redfearn, L.E. Moser, R.J. Grant, K.J. Moore, and B.H. Kirch. 1997. Relationships between insitu protein degradability and grass developmental morphology. J. Dairy Sci 80: 1143-1149.

NCDC, National Climatic Data Center (Asheville, NC) for Mead, NE. Available at http://cdo.ncdc.noaa.gov/ancsum/ACS. Accessed on 28 June 2010.

NRC. 1996. Nutrient requirements of beef cattle. National Academy Press, Washington, D. C.

Schlueter, K. R. 2004. Seasonal dry matter and crude protein removal by grazing from grass/legume mixtures. Univ. Neb. MS Thesis.

Tilley, J.M.A. and R.A. Terry. 1963. A two stage technique for in vitro digestion of forage crops. J Brit Grassl Soc 18: 104-110.

USDA. 2010. National Agricultural Statistics Service. Agricultural prices. Available at: http://www.nass.usda.gov/index.asp. Accessed on March 18, 2010.

Weiss, W.P. 1994. Estimation of digestibility of forages by laboratory methods. Page 644 in Forage Quality, Evaluation and Utilization. G.C. Fahey, Jr., ed. Am. Soc. Agronomy, Crop Sci. Soc. America, Soil Sci Soc America, Madison, WI.

Whittet, K., Creighton, K., Vander Pol, K., Erickson, G., Klopfenstein, T. 2003. Influence of rinsing technique and sample size on in situ protein degradation. Nebraska beef cattle report. MP 80-A: 86-8

Table 1. Rainfall during the growing season in 2005-2009 (mm).

	2005	**2006**	**2007**	**2008**	**2009**
April	91.7	106.7	118.1	117.9	41.4
May	69.6	35.1	174.5	151.4	30.5
June	88.1	24.6	62.2	251.2	164.8
July	100.8	77.0	41.9	94.7	66.5
August	19.6	156.0	257.8	25.7	184.7
September	25.2	159.0	75.9	110.0	39.4
Total Annual Precipitation	606.3	770.6	1027.2	987.0	731.8

National Climatic Data Center (Asheville, NC) for Mead, NE.
Available at http://cdo.ncdc.noaa.gov/ancsum/ACS. Accessed on 28 June 2010.

Table 2. Main effects of time (cycle) on diet sample characteristics and standing crop measurements of smooth bromegrass pastures grazed by yearling steers.

	Cycle						Probabilities[1]		
	1	2	3	4	5	SEM	Linear	Quad	Cubic
Time of year	May	June	July	August	September				
In vitro DMD[2], %	70.54	61.12	56.43	48.76	47.01	1.23	<0.01	<0.01	0.64
CP, %	18.62	15.32	14.35	14.58	16.08	0.42	0.85	<0.01	<0.05
Standing Crop, kg/ha[3]	2414	3714	2387	772	1565	224	<0.01	<0.01	<0.01

[1] Probabilities of linear, quadratic, and cubic trends determined with orthogonal polynomial contrasts.
[2] In vitro DM digestibility (IVDMD) was determined by including five hay samples of varying qualities with known total tract in vivo digestibilities. The IVDMD values for these standards were regressed on their known digestibilities to develop an equation to calculate TTDMD within each in vitro run.
[3] Standing crop was measured as forage available each cycle before grazing in years 1 to 4.

Table 3. Main effects of dried distillers grains (DDGS) supplementation and N fertilization on diet sample characteristics and standing crop measurements of smooth bromegrass pastures.

	Treatment[1]				
	CONT	FERT	SUPP	SEM	P-value
In-vitro DMD[2], %	60.40	59.74	59.85	0.74	0.82
CP, %	14.47[a]	17.04[b]	15.79[a]	0.58	<0.05
Standing crop[3], kg/ha	2195[c]	2537[d]	2379[e]	109	<0.01

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

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

[3] Standing crop was measured as forage available each cycle before grazing in years 1 to 4.

[a,b] Means in a row without a common superscript differ ($P < 0.05$)

[c,d,e] Means in a row without a common superscript differ ($P < 0.01$).

Table 4. Main effects of grazing management supplementation strategies on steer performance when grazing smooth bromegrass pastures, averaged over five years.

	Treatment[1]				
	CONT	FERT	SUPP	SEM	P-value
Head days[2]	868	912	898	-	-
Area, ha	2.90	2.01	2.01	-	-
Initial BW, kg	326	325	324	5.81	0.96
Ending BW, kg	436[a]	434[a]	475[b]	7.01	<0.01
BW gain, kg	110[a]	109[a]	151[b]	3.12	<0.01
Gain per ha, kg[3]	210[a]	313[b]	429[c]	7.74	<0.01
ADG, kg	0.70[a]	0.69[a]	0.96[b]	0.07	<0.01

[1] Treatments consisted of non-fertilized pastures (CONT), fertilized with 90 kg/ha N (FERT), or non-fertilized and steers were supplemented daily with 0.6% BW (DM) of DDGS (SUPP).
[2] Head days calculated as the number of tester steers plus the number of put and take cattle within the grazing period multiplied by the number of days in the grazing period.
[3] Calculated by multiplying ADG by the total number of head days, then dividing by the number of ha.
[a,b,c] Means in a row without common superscript differ ($P < 0.01$).

Table 5. Protein characteristics of smooth bromegrass pastures throughout the grazing season.

Cycle	Treatment[6]	CP, % DM	UIP[1], % DM	TT IDP[2], % DM	TT IDP[3], % CP	Digestibility of UIP[4], %	DUIP[5], % DM
1	FERT	21.7	2.89	1.30	5.94	55.2	1.58
1	UNFERT	15.6	2.39	1.35	8.84	44.8	1.04
2	FERT	14.4	1.63	0.91	6.35	44.3	0.73
2	UNFERT	12.9	1.55	0.73	5.63	52.8	0.82
3	FERT	14.9	1.70	0.89	5.93	45.4	0.81
3	UNFERT	12.5	1.86	0.99	8.12	45.8	0.87
4	FERT	15.2	1.99	1.12	7.37	44.7	0.87
4	UNFERT	15.3	2.00	1.20	7.87	39.2	0.81
5	FERT	16.4	2.20	1.34	8.42	39.0	0.86
5	UNFERT	14.6	2.08	1.25	8.82	39.1	0.82

[1] Undegradable Intake Protein (UIP, % DM) = (NDIN at 75% total mean retention time * 6.25) / sample DM
[2] Total tract indigestible protein (TT IDP, % DM) = (fecal NDIN * 6.25) / sample DM
[3] Total tract indigestible protein (TT IDP, % CP) = (fecal NDIN * 6.25) / (sample DM * % CP)
[4] Digestibility of UIP = 1- (TT IDP / UIP)
[5] Intestinal Disappearance of UIP (DUIP, % DM) = (UIP – TT IDP)
[6] Treatments consisted of FERT, pastures that were fertilized in the spring with 90 kg N/ha and UNFERT, a composite of CONT and SUPP treatments where the pastures received no fertilizer in the spring.

Table 6. Differences in protein characteristics of fertilized and unfertilized diet samples of smooth bromegrass pastures over the grazing season.

	FERT				UNFERT			
Cycle	UIP[1], % DM	TT IDP[2], % DM	Digestibility of UIP[3], %	DUIP[4], % DM	UIP, % DM	TT IDP, % DM	Digestibility of UIP, %	DUIP, % DM
1	2.89	1.30	55.2	1.58	2.39	1.35	44.8	1.04
2	1.63	0.91	44.3	0.73	1.55	0.73	52.8	0.82
3	1.70	0.89	45.4	0.81	1.86	0.99	45.8	0.87
4	1.99	1.12	44.7	0.87	2.00	1.20	39.2	0.81
5	2.20	1.34	39.0	0.86	2.08	1.25	39.1	0.82

[1] Undegradable Intake Protein (UIP, % DM) = (NDIN at 75% total mean retention time * 6.25) / sample DM
[2] Total tract indigestible protein (TT IDP, % DM) = (fecal NDIN * 6.25) / sample DM
[3] Digestibility of UIP = 1- (TT IDP / UIP)
[4] Intestinal Disappearance of UIP (DUIP, % DM) = (UIP-TT IDP)

Table 7. Seasonal changes in protein characteristics of smooth bromegrass pastures.

	Cycle						Probabilities[5]		
	1	2	3	4	5	SEM	Linear	Quad	Cubic
Time of year	May	June	July	August	September				
UIP[1], % DM	2.64	1.59	1.78	2.00	2.14	0.08	0.33	<0.01	0.04
TT IDP[2], % DM	1.33	0.82	0.94	1.16	1.30	0.55	0.42	<0.01	0.05
Digestibility of UIP[3], %	50.0	48.55	45.60	41.95	39.05	2.10	<0.01	0.76	0.83
DUIP[4], % DM	1.31	0.78	0.84	0.84	0.84	0.43	0.02	0.04	0.13

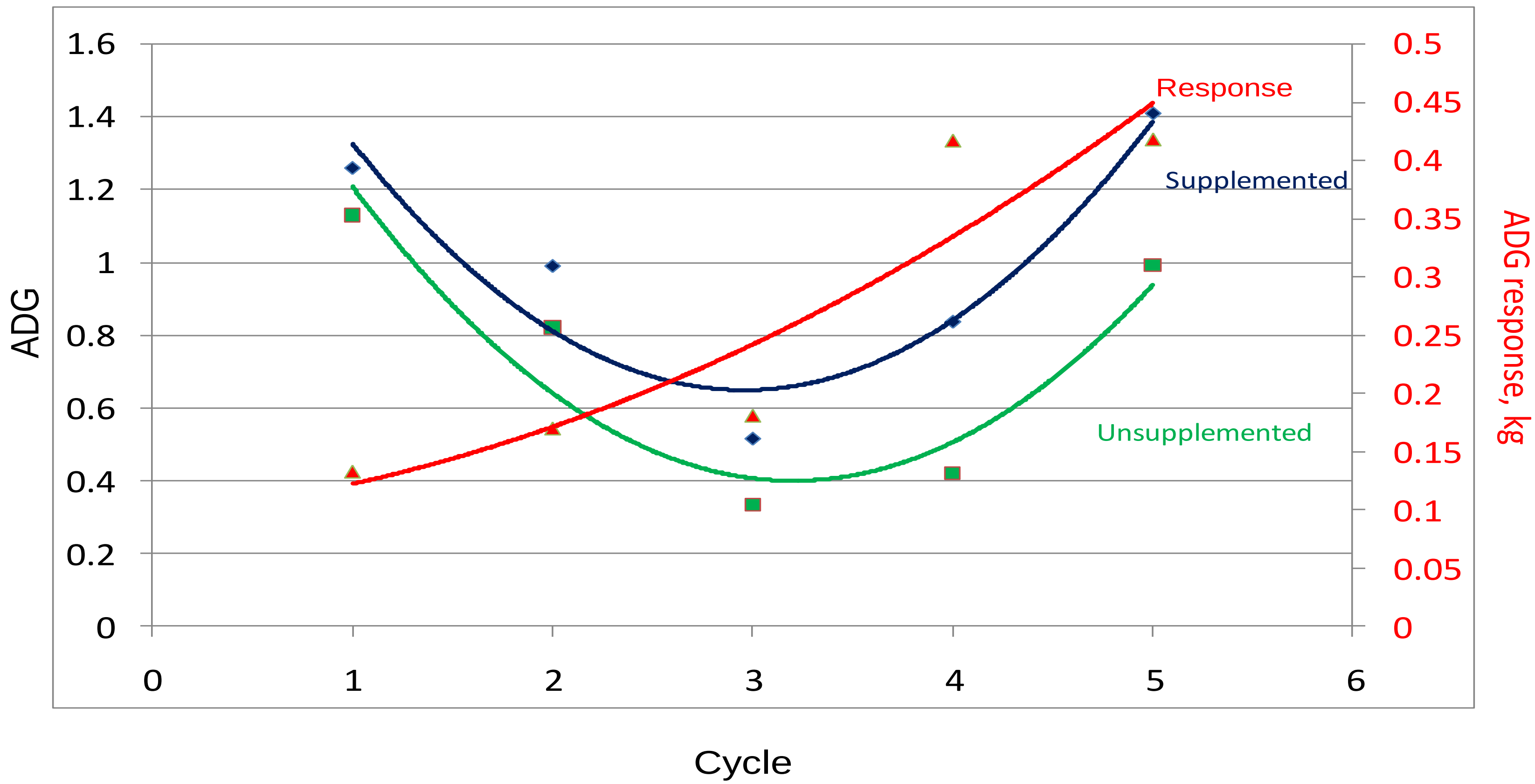
[1] Undegradable Intake Protein (UIP, % DM) = (NDIN at 75% total mean retention time * 6.25) / sample DM
[2] Total tract indigestible protein (TT IDP, % DM) = (fecal NDIN * 6.25) / sample DM
[3] Digestibility of UIP = 1- (TT IDP / UIP)
[4] Intestinal Disappearance of UIP (DUIP, % DM) = (UIP – TT IDP)
[5] Probabilities of linear and quadratic trends determined with orthogonal polynomial contrasts.

Table 8. Total forage production (kg/ha) in 2009 after 4 years of treatments being applied to pastures.

	CONT	FERT	SUPP	SEM	P-Value
June	4124^{b}	6142^{a}	4483^{b}	165.35	<0.05
October	2441^{c}	3287^{a}	2817^{b}	114.89	<0.05
Total	6565^{c}	9429^{a}	7300^{b}	252.40	<0.05
Other[1]	197^{a}	7^{b}	49^{b}	16.29	<0.05

[1] "Other" includes all species besides smooth bromegrass found in the pastures: buffalo burr, Russian thistle, Kentucky bluegrass, etc.
[a,b,c] Means in a row without common superscript differ ($P < 0.05$).

Figure 1. Average daily gain and average daily gain response of steers grazing smooth bromegrass pastures with or without 0.6% of BW daily in distillers grains supplement. As ADG of the steers declines over the grazing period the supplemented steers ADG response increases. There was a quadratic effect ($P < 0.01$) of ADG for all steers.



1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
ADG
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ADG response, kg
Response
Supplemented
Unsupplemented
0
1
2
3
4
5
6
Cycle

Figure 2. Average daily gain of steers grazing smooth bromegrass pastures in relation to the in-vitro dry matter digestibility of diet samples taken over the grazing season in cycles 1 and 2 compared to cycles 3, 4, and 5. Higher IVDMD values are correlated with higher ADG values (R^2 = 0.504).

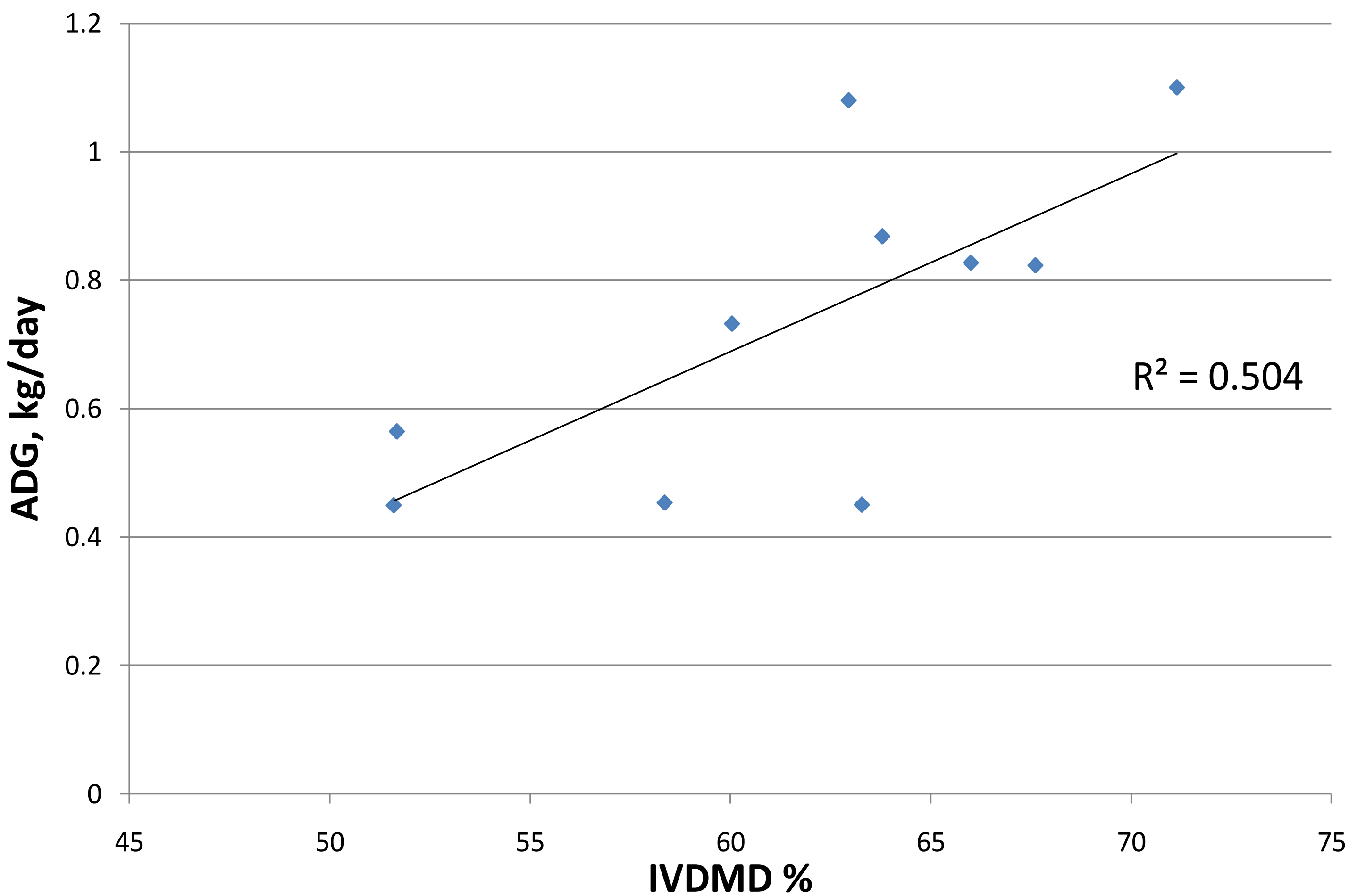
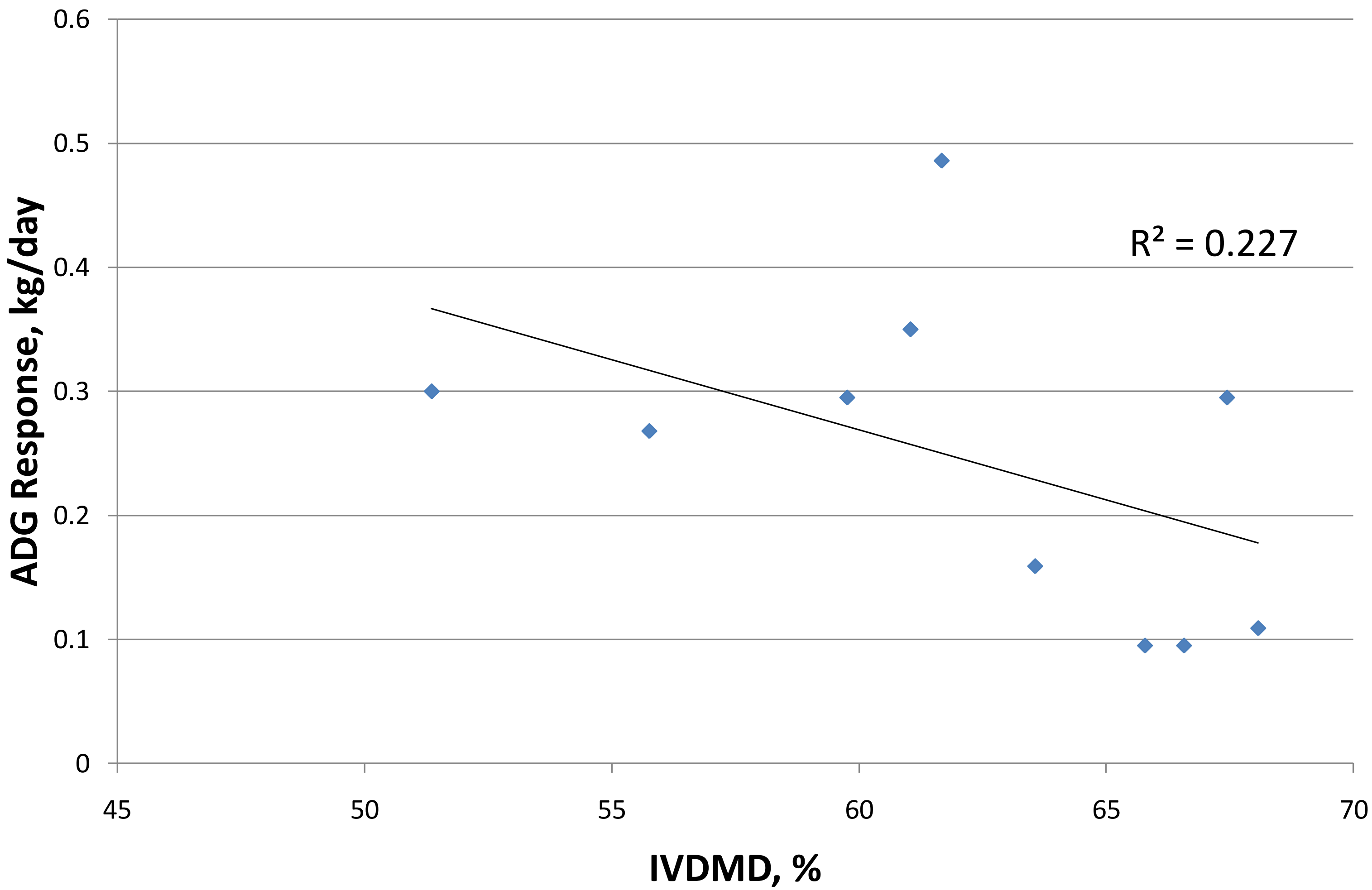

ADG, kg/day
1.2
1
0.8
0.6
0.4
0.2
0
45
50
55
60
65
70
75
IVDMD %
R² = 0.504

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



0.6
0.5
0.4
0.3
0.2
0.1
0
ADG Response, kg/day
R² = 0.227
45
50
55
60
65
70
IVDMD, %

Figure 4. Average variable stocking rate of all three treatments over the grazing season from 2005-2009. Cycles 1, 2, 3, 4, and 5 roughly match up with May, June, July, August, and September.

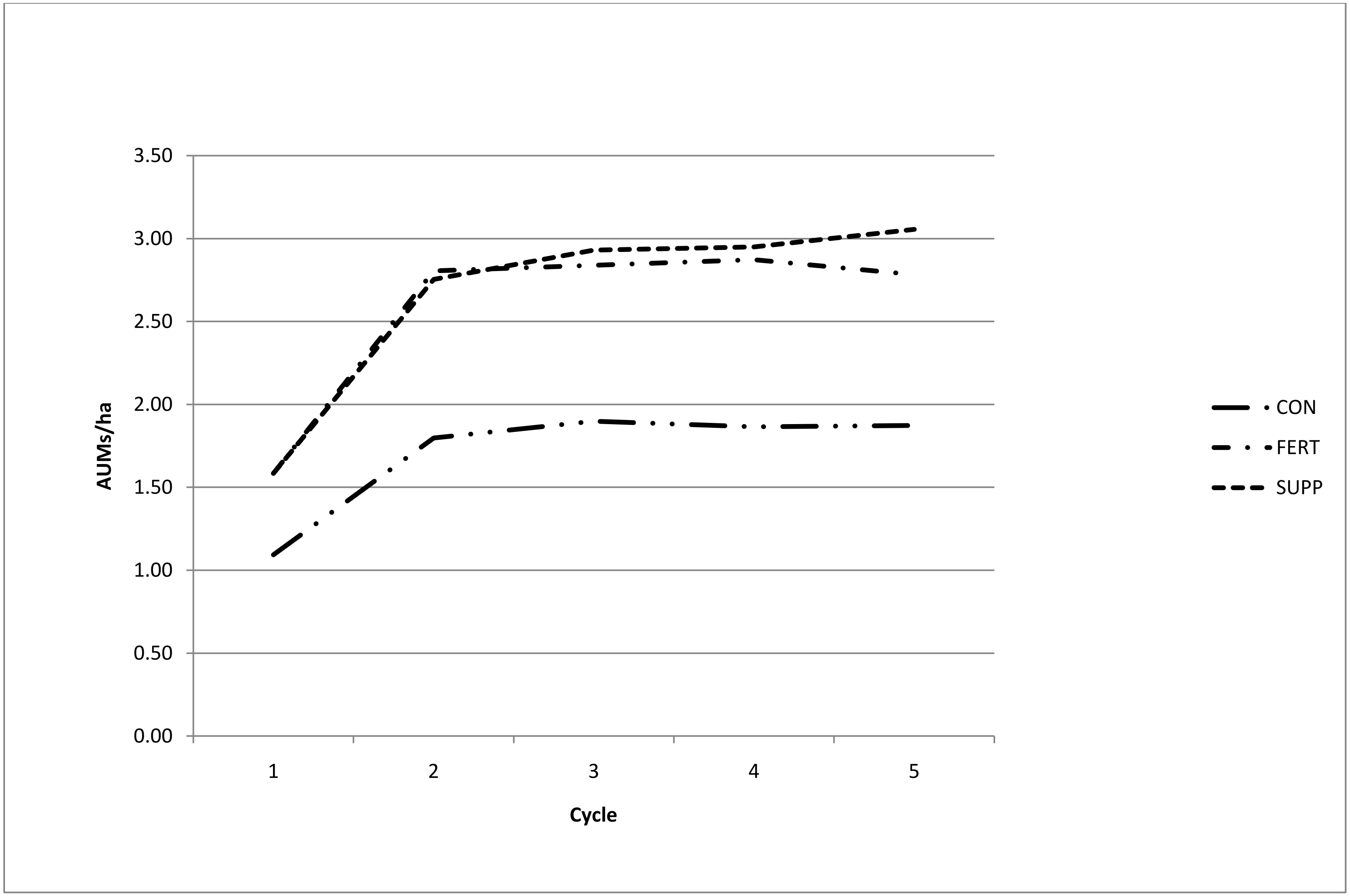
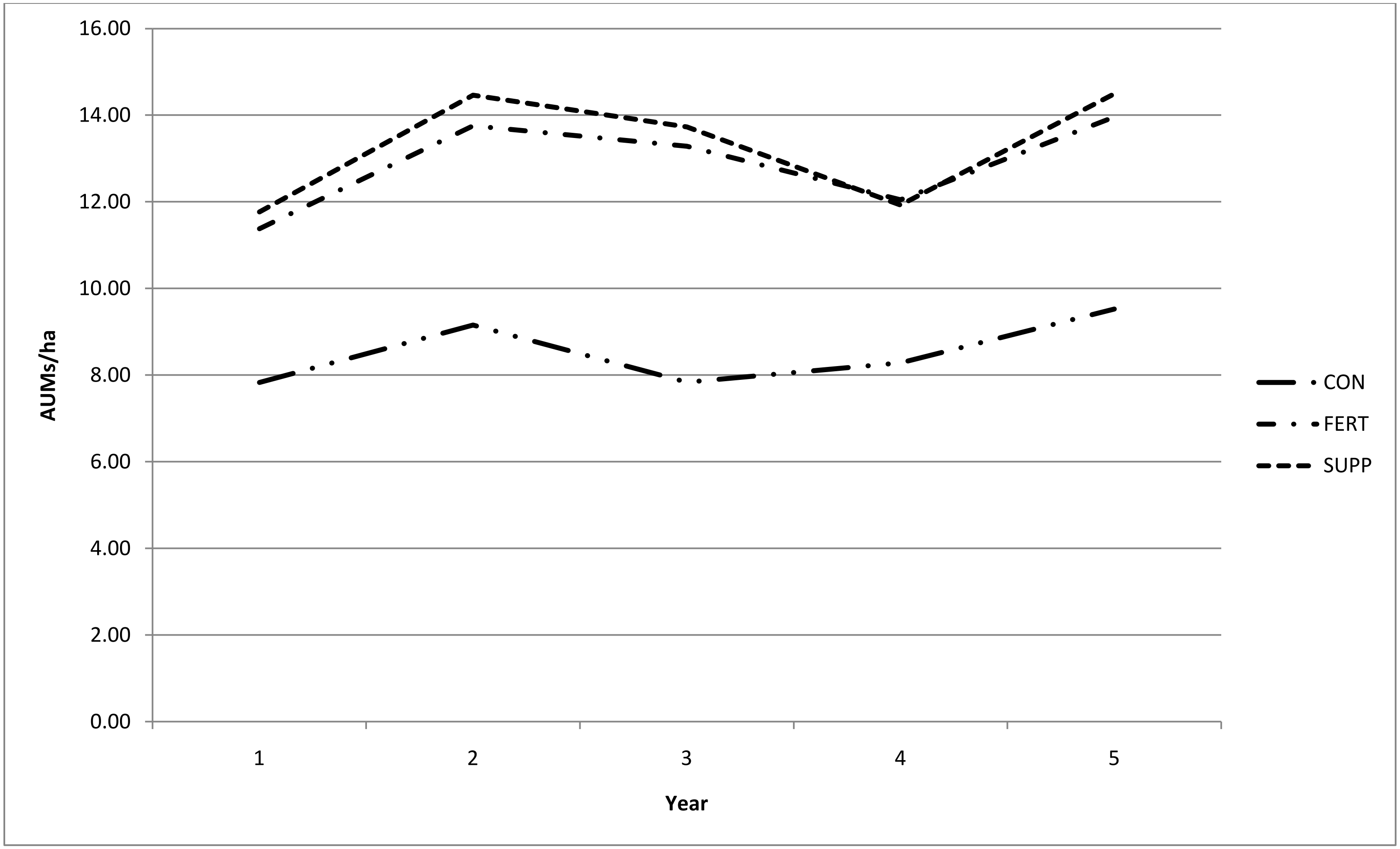

3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
AUMs/ha
1
2
3
4
5
Cycle
CON
FERT
SUPP

Figure 5. Variable stocking rate of all three treatments over the 5 years of the trial (2005 to 2009).


16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
AUMs/ha
1
2
3
4
5
Year
CON
FERT
SUPP

Economic Analysis of Smooth Bromegrass Pasture Beef Growing Systems

A.K. Watson, T.J. Klopfenstein, W.H. Schacht, G.E. Erickson, D.R. Mark

Abstract

A five-year study from 2005-2009 was conducted to evaluate production and biological differences in three grazing management strategies for backgrounding calves on smooth bromegrass pastures. An economic budget analysis was then conducted to estimate the relative differences in profitability for the 3 treatments. Two-hundred and twenty-five steers (325 ± 22 kg) were used in a randomized complete block design and the trial lasted for an average of 158 days each year. Treatments included pastures fertilized in the spring with 90 kg N/ha (FERT), non-fertilized pastures with calves supplemented daily with dried distillers grains plus solubles (DDGS) at 0.6% of their BW (SUPP), and control (CONT) pastures that had no fertilizer or supplementation applied. Both FERT and SUPP pastures were initially stocked at 9.9 AUM/ha while CONT was stocked at only 6.8 AUM/ha. Put and take cattle were used to maintain similar grazing pressure on all treatments. SUPP steers came off pasture 41 kg heavier than either the FERT or CONT steers, which resulted in an increased revenue of $49.38/hd for the SUPP treatment ($P = 0.03$). This is true even though the heavier calves were worth less per kg than the lighter calves due to the typical feeder cattle price slide. The SUPP treatment also had increased costs of $59.14/hd for the DDGS supplement, but the FERT treatment also included $35.48/hd expense for fertilizer application in the spring. Land costs were decreased by $35.50/hd for both the FERT and SUPP treatments relative to the CONT treatment due to their increased stocking rate. Profit was greatest for SUPP at $22.79/hd (P = 0.02), while both the CONT and FERT treatments lost money at -$6.20 and -$8.71/hd, respectively. Cost of gain and breakeven prices were lowest for SUPP and not different between the FERT and CONT treatments (P < 0.01). In recent years, prices for N fertilizer have increased dramatically making the FERT treatment less profitable. In the future, the relationship between prices for land, N fertilizer, and DDGS will affect the profitability of all three treatments.

Key words: Beef cattle, dried distillers grains, smooth bromegrass

Introduction

Cattle producers have faced increasing input costs in past years. In order to remain profitable, many producers have had to make changes to their operations. With increasing grain costs, growing cattle on pasture before placement in the feedlot may become more favorable. Nitrogen fertilizer can be used to increase forage yields of pastures in order to increase stocking rates. In eastern Nebraska, many studies have observed an increase in DM yields of forage in relation to N fertilization. Rehm et al. (1971) showed increased DM yields of 1100, 3571, and 5076 kg/ha for N fertilizer rates of 0, 45, and 90 kg/ha, respectively. Schlueter et al. (2004) reported increased yields from 3234 to 4694 kg/ha with an increase of N fertilizer from 0 to 90 kg/ha. Nitrogen fertilizer prices are increasing due to increased energy prices for production as well as increased demand for N fertilizer due to high grain prices. Another source of N fertilizer for pastures is from the grazing cattle. Cattle with excess N in their diet will excrete a majority of the excess N in the form of urea in the urine. The breakdown of the urea by urease enzymes is believed to be complete within a matter of hours or days (Haynes and Williams, 1993). Supplementing grazing cattle with dry distiller's grains with solubles (DDGS) supplies the cattle with excess N in their diet as well as increasing ADG of the cattle. Dry distiller's grains are typically 32% CP, 65% of which is UIP, and 12% fat. It is the combination of UIP and fat in the DDGS that leads to the increased ADG of the cattle (MacDonald et al., 2007). Typically, demand for DDGS is lower during the summer months due to decreased cattle on feed numbers. This results in lower prices during the summer months, ideal for producers supplementing DDGS to grazing cattle during the summer. Greenquist et al. (2008) has shown that cattle supplemented with DDGS on non-fertilized smooth bromegrass pastures can be stocked at the same rate as non-supplemented cattle on fertilized smooth bromegrass pastures. Both of these treatments can be stocked at 69% higher rates than non-fertilized, non-supplemented pastures. The objective of this paper is to examine the relationship between input costs and the effects of different grazing management strategies on the profitability of backgrounding calves on smooth bromegrass pastures.

Materials and Methods

Five years of pasture and cattle performance data were gathered from 2005 to 2009 at Mead, Nebraska on smooth bromegrass pastures. Pasture and animal management are described in detail by Watson, et al. (2010). Briefly, 225 crossbred steers (325 ± 22 kg) were used in a randomized complete block design. Steers were managed in accordance with the protocols approved by the Animal Care and Use Committee at the University of Nebraska. Treatments included CONT, SUPP, and FERT. For the supplemented treatment (SUPP), calves received 0.67% of their BW in 90% DM DDGS pellets daily. Cattle weights were collected every 24 or 36 days and the amount of supplement offered was adjusted. Pastures in the SUPP treatment received no fertilizer. For the fertilized treatment (FERT), pastures received 90 kg N/ha in the spring. The FERT calves received no DDGS supplement. The CONT treatment had no supplementation or fertilizer applied. The CONT calves were initially stocked at 6.8 AUM/ha whereas both the SUPP and FERT treatments were initially stocked at 9.9 AUM/ha. Actual stocking rates used over all 5 years due to put and take animals were 8.53, 12.88, and 13.27 AUM/ha for the CONT, FERT, and SUPP treatments, respectively. All of the calves grazed from approximately mid-April through September. All treatments were rotationally grazed within 6 paddocks and variable stocking rates were used to maintain similar grazing pressure on all treatments. Beginning and ending BW of the steers were obtained after a 5 day limit feeding period and BW was collected on 3 consecutive days to minimize variations in gut fill.

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 320-340 kg steers. Yardage was included at

$0.10/hd/d to account for labor in building and maintaining fences as well as daily checking of animals and watering. An $8.33/hd 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 National Agricultural Statistics Service (NASS). Fertilizer prices of $419.20/909 kg were based on urea prices in April plus a $4.00/909 kg application fee and were also compiled by NASS. DDGS prices in Nebraska from April through September were reported by USDA-AMS and averaged $116.80/909 kg on a 90% DM basis, plus a $24/909 kg delivery and handling fee was added. Agricultural operating loan interest rates averaged 7.6% and were obtained from the Federal Reserve Bank of Kansas City. Prices for feeder calves in October at Nebraska sale barns were used to determine final live value of the calves. Because of the price slide associated with feeder calves, different values were used for the CONT and FERT calves versus the SUPP calves because the SUPP calves gained more weight over the grazing season. Costs of gain over the grazing period were calculated by dividing total costs, minus initial steer cost and interest, by the total weight gained by the animal during the grazing season. Breakeven prices were calculated by dividing total costs by the final shrunk body weight 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.

Results and Discussion

Initial BW of the steers was 325 kg and did not differ by treatment ($P = .96$) (Table 1), but ending BW was 39 kg heavier for the SUPP steers compared to CONT or 41 kg heavier than FERT steers ($P < 0.01$). Total weight gained for the SUPP steers was 151 kg over the entire grazing period compared to 110 kg by CONT and 109 kg by FERT steers (Table 1). Initial cost of the calves was not different by treatment ($P < 0.01$) and averaged $794.69/hd. Steer cost was calculated by multiplying initial BW by $2.44/kg ($111.07/cwt), the average Nebraska price for 320-340 kg feeder steers in April from 2005 to 2009. Interest rates averaged 7.6% and simple interest was charged on initial steer cost for the entire grazing period plus cash rent cost for one half of the grazing period. Nebraska feeder calves are sold with a price slide so that heavier calves sell for fewer dollars per kg while lighter calves bring a higher price per kg. The average Nebraska price in October from 2005-2009 for 432-455 kg steers was $2.17/kg ($98.81/cwt) while the price for 455-477 kg steers was $2.09/kg ($95.01/cwt). With these prices the FERT and CONT calves had a final live value of $942.43/hd and $947.77/hd, respectively, which was less than the SUPP steers final live value of $994.48/hd ($P = 0.03$). Yardage was charged for all treatments at $0.10/hd/day or $15.84/hd over the grazing season. Health and processing fees of $8.33/hd were also charged on all treatments. A death loss of 0.5% for all treatments resulted in a $3.97/hd fee. The SUPP treatment also had the added cost of buying, transporting and handling the DDGS that was fed to the calves daily. DDGS prices from April through September from 2005-2009 averaged $116.80/909 kg on a 90% DM basis. A $24/909 kg charge was added to this price for transportation and handling. Steers consumed an average of 2.4 kg/hd/d, resulting in a cost of $59.14/hd over the grazing season. Instead of increased feed costs, the FERT treatment had increased costs due to 90 kg N/ha being applied in the spring. Average urea prices in April for this period were $419.20/909 kg of urea plus a $4.00/909 kg charge for application resulting in a cost of $35.48/hd. Cash rent values for land were different between treatments because of the different stocking rates used. The CONT calves were stocked at 8.53 AUM/ha over the entire 5 years. Multiplying this by the average Nebraska cash rent price of $23.86/AUM results in a 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 calf for each treatment. This was $105.71 for CONT, $69.65 for FERT, and $70.78 for SUPP.

Total costs were $953.97/hd on CONT, $951.14/hd on FERT, $971.69/hd on SUPP and were not different (P = 0.56). Total revenue was $947.77/hd on CONT, $942.43/hd on FERT, and $994.48/hd on SUPP, with the SUPP calves having more income than either of the other two treatments (P = 0.03). Profits were also highest for the SUPP calves at $22.79/hd while both the FERT and CONT calves lost money at -$8.71/hd and -$6.20/hd for the FERT and CONT treatments, respectively (P = 0.02). 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 = 0.49) and was decreased for the SUPP treatment to $1.05/kg ($47.93/cwt) (P < 0.01). Breakeven was $2.19/kg

($99.72/cwt) of ending wt for FERT, $2.18/kg ($99.46/cwt) for CONT, and $2.04/kg ($92.89/cwt) for SUPP ($P < 0.01$).

In Tables 2 and 3 all prices, including cattle prices when purchasing and selling cattle, are held constant while pasture cash rent, fertilizer, and DDGS prices vary, showing the resulting effect on COG for the different treatments. In Table 2, as land and fertilizer prices increase, COG also increases. In order to at least breakeven (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 profitable COGs, less than $1.18/kg, while prices below and to the right of the dividing line represent COGs where producers would lose money (i.e., COG higher than $1.18/kg). Table 3 presents a similar comparison but with DDGS and land prices varying while all other prices are held constant. In order to breakeven 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 make money, while prices below and to the right of the dividing line represent scenarios where producers would lose money. 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 will still be able to make money if they are able to purchase DDGS for less than $150/909 kg. The outcomes of these scenarios are variable and depend on cattle prices, gains, and other expenses.

Implications

Profitability of a backgrounding operation can be increased by either fertilizing pastures or supplementing the 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 simultaneously improving cattle performance with better gains throughout the summer. Using fertilizer or supplement does increase 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 to 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 out of the same amount of land.

Literature Cited

Greenquist, M.A. 2008. Effects of N fertilization or dried distillers grains supplementation on forage use and performance of yearling steers grazing smooth bromegrass pastures. Univ. Neb. PhD Dissertation.

Haynes, R. J. and P. H. Williams. 1993. Nutrient cycling and soil fertility in the grazed pasture ecosystem. Adv Agron 49:119-199.

Klopfenstein, T.J., L. Lomas, D. Blasi, D.C. Adams, W.H. Schacht, S.E. Morris, K.H. Gustad, M.A. Greenquist, R.N. Funston, J.C. MacDonald, and M. Epp. 2007. Summary analysis of grazing yearling response to distillers grains. Neb Beef Cattle Rep MP 90: 10-11.

Loy, T.W., T.J. Klopfentstein, G.E. Erickson, C.N. Macken, and J.C. MacDonald. 2003. Supplemental type and frequency on intake, performance, and energy value of dry distillers grains in a high-forage diet. J Anim Sci 81 (Supp. 2): 107. (Abst.).

MacDonald, J.C., T.J. Klopfenstein, G.E. Erickson, and W.A. Griffin. 2007. Effects of dried distillers grains and equivalent undegradable intake protein or ether extract on performance and forage intake of heifers grazing smooth bromegrass pastures. J Anim Sci 85: 2614-2624.

Rehm, G. W., W. J. Moline, E. J. Schwartz, R. S. Moomaw. 1971. The effect of fertilization and management on the production of bromegrass in northeastern Nebraska. University of Nebraska-Lincoln, Res Stn Bull 247:3-27.

Schlueter, K. R. 2004. Seasonal dry matter and crude protein removal by grazing from grass/legume mixtures. Univ. Neb. MS Thesis.

USDA. 2010. National Agricultural Statistics Service. Agricultural prices. Available at: http://www.nass.usda.gov/index.asp. Accessed on March 18, 2010.

Watson, A.K., Klopfenstein, T.J., Schacht, W.H., Erickson, G.E., Luebbe, M.K., Griffin, W.A., Brink, K.R., and Greenquist, M.A. 2010. Fertilization and supplementation strategies for steers grazing smooth bromegrass pastures. Professional Animal Scientist. (Submitted).

Table 1. Economic evaluation of grazing management and supplementation strategies for steers grazing smooth bromegrass.

	Treatment				
	CON	FERT	SUPP	SEM	P-value
Initial BW, kg	326	325	324	5.81	0.96
Ending BW, kg	436	434	475	7.01	<0.01
Head days	868	912	898	19.24	0.26
Initial Cost, $/hd	796.95	795.63	791.50	14.20	0.96
DDGS, $/hd			59.14		
Fertilizer, $/hd		35.48			
Land Cash Rent, $/hd	105.71	69.65	70.78		
Yardage, $/hd	15.84	15.84	15.84		
Health and Processing, $/hd	8.33	8.33	8.33		
Death Loss, $/hd	3.98	3.98	3.96		
Interest, $/hd	23.16	22.23	22.4		
Total Cost, $/hd	953.97	951.14	971.69	14.63	0.56
Total Revenue, $/hd	947.77[a]	942.43[a]	994.48[b]	14.97	0.03
Profit, $/hd	-6.20[a]	-8.71[a]	22.79[b]	8.11	0.02
COG, $/kg weight 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).

Table 2. Effects of varying N fertilizer and land prices on costs of gain ($/ kg) for steers grazing fertilized smooth bromegrass in Eastern Nebraska. In this scenario, in order to breakeven producers need to keep COG at or below $1.18/kg ($0.53/lb), values above and to the left of the dividing line represent profitable COGs while values below and to the right of the dividing line represent COGs where producers would lose money.

Fertilizer prices, $/kg N	Land Prices, $/AUM										
	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

Table 3. Effects of varying DDGS and land prices on costs of gain ($/kg) for steers supplemented with DDGS while grazing smooth bromegrass in Eastern Nebraska. In this scenario, in order to breakeven producers need to keep COG at or below $1.20/kg ($0.54/lb), values above and to the left of the dividing line represent profitable COGs while values below and to the right of the dividing line represent COGs where producers would lose money.

DDGS prices, $ / 909 kg	Land Prices, $/AUM										
	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