EXECUTIVE SUMMARY

Our objectives were to determine the impacts of grazing intensity and advancing season on: 1. Chemical composition, intake, and total nutrient digestion of forage grazed by beef cattle, 2. Ruminal fermentation, passage rate, and in situ rates and extent of nutrient digestion, 3. Relationships between intake, digestion, and animal body weight changes associated with advancing season. In summary, our data are interpreted to indicate that seasonal factors are a more important driver of steer dietary chemical composition, performance, intake, ruminal fermentation, and digestion than grazing intensity; however, supplemental protein (DDGS) may have mitigated the impact of grazing pressure.

To date, this effort has resulted in four publications, one proceedings paper in the Western Section of American Society of Animal Science, and three abstracts in the Grazing Livestock Nutrition Conference. These publications are included at the end of this report.

BACKGROUND AND JUSTIFICATION

Animal agriculture faces immense challenges in the near future. Global reports from Food and Agriculture Organization of the United Nations indicate that livestock contribute 15% of total food energy, 25% of dietary protein, and provide essential micronutrients not easily obtained from plant food products (Elliot, 2013). Currently, livestock contributes 40% of the global value of agricultural products and supports the livelihoods and food security of almost 1 billion people. However, to meet the projected requirements of the growing population the world needs to significantly increase its animal agriculture output by 2050 (Elliot, 2013). Ruminant animals have and will continue to play a unique and essential role in the human-animal-plant interface because of their diversity, adaptability, and ability to consume feedstuffs that humans cannot use for food. These feedstuffs are abundant and include forages, crop residues, native grasslands, browse, and other feed resources. In the future, the world population is expected to reach nearly 9.6 billion by 2050 (United Nations, 2015). The majority of the projected population growth is expected to occur in regions of low food security where the recent trends are for increased per capita consumption of animal products. Consequently, the demand for more efficient and effective production of high-quality animal products will increase. Ruminants, because of their unique ability to convert non-edible products into high quality, nutrient dense foods for human consumption are expected to fill an increasingly significant and sustainable role. From a global food supply perspective, effective management of rangeland and agroecosystems is essential from both a human food and resource preservation perspective. Increased knowledge of the forage-animal interface can contribute to improved nutritional status and production efficiency of livestock, improved economic efficiency within in forage-based livestock production systems, and improved sustainability in ranching enterprises and rural communities.

Forage intake and digestion are key drivers of livestock production from grasslands. Intake, nutrient composition, and digestion of grazed forage change with advancing forage maturity. Modulating cattle stocking rates on pasture is a common management tool used to achieve goals of optimizing forage use, livestock production, and agroecosystem sustainability. Unfortunately, information regarding the impact of grazing intensity on forage intake and digestion by cattle grazing mixed grass prairie is lacking. New information in this regard will have direct impact on decision making in both livestock and forage management practices.
Long-term grazing intensity research was initiated in central North Dakota in 1989 (Patton and Nyren, 2014). The study site (Central Grasslands Research Extension Center in Kidder County northwest of Streeter, N.D.) was divided into 12 pastures of approximately 12 hectares each. Established grazing intensities were light, moderate, heavy and extreme. Grazing began annually in mid-May, with cattle removal occurring when forage utilization on half of the pastures had reached targeted grazing intensities (approximately mid-October). Overtime, this research has produced interesting data in terms of above ground biomass, total forage production, and plant species changes. However, grazing cattle select diets that are different from those of clipped samples; therefore, work with grazing livestock to assess nutrient intake and digestion will provide more applicable results for making informed management decisions.

**SPECIFIC RESEARCH OBJECTIVES**

To determine the impacts of grazing intensity and advancing season on: 1. Chemical composition, intake, and total nutrient digestion of forage grazed by beef cattle, 2. Ruminal fermentation, passage rate, and in situ rates and extent of nutrient digestion, 3. Relationships between intake, digestion, and animal body weight changes associated with advancing season.

**MATERIALS AND METHODS**

The grazing portion of this experiment was successfully conducted from May through September of 2015. The grazing trial was conducted at the Central Grasslands Research and Extension Center (CGREC) located on the Missouri Coteau in south-central North Dakota directly on the pastures established for long-term grazing intensity research (Patton et al., 2002; Patton and Nyren, 2014). Vegetation, soils, and topography of the study site has been previously described (Patton et al., 2002). Cattle (described below) grazed from May 15 to September 11 on 12 native grass pastures. Major pasture grasses are Kentucky bluegrass (Poa pratensis), needle and thread (Stipa cornata), western wheatgrass (Agropyron smithii), and blue grama (Bouteloua gracilis). Fringed sage (Artemisia frigida), rigid goldenrod (Solidago rigida), and cudweed sagewort (Artemisia ludouiciana) are the primary forbs. Western snowberry (Symphoricarpos occidentalis) is the only shrub species.

Experimental methodologies included both ruminal cannulated and non-cannulated cattle that co-grazed one of 12 pastures. All animal procedures were approved by the institutional animal care and use committee. Twelve ruminal cannulated steers (one per pasture) co-grazed with the intact animals in each pasture. The intact animals were used to establish grazing intensity. Steers were stocked at densities so that at the end of the grazing season (September 11), 65% (lightly grazed), 50% (moderately grazed), 35% (heavily grazed), and 20% (extremely grazed) of the long-term average annual forage production was remaining. Each treatment had been assigned 3 pastures. Cattle were allowed to freely graze and had free access to water and salt based trace mineral supplements. In addition, all cattle were hand fed known amounts of dried distiller’s grains on a daily basis (0.3% of body weight). Five 10-day collection periods were conducted in May, June, July, August, and September. During each collection period, individual animal measurements were taken to accomplish specific objectives. On day 1 of each collection period, grazed masticate forage was collected on each study pasture using ruminal cannulated animals and the ruminal evacuation technique. Grazed forage masticates were used for dietary chemical composition and rates and extent of in situ nutrient digestion. On days 6 to 10 of each collection period, samples were taken for measuring ruminal fermentation and passage, in situ and in vitro digestibilities, and for determining fecal output, which will be used in equations to estimate forage intake. Samples were handled by approved and published procedures and stored until transported to the laboratory for analyses. All samples were analyzed in the laboratory and then statistically to determine differences between grazing intensity and advancing season.
RESULTS

Grazing treatment × sampling period interactions were not present (P ≥ 0.29) for dietary composition variables measured except IVOMD (P < 0.01). There were no main effects of grazing treatment for dietary NDF, ADF, total N, soluble N (SN), insoluble N (IN), and ADIN. Responses to grazing season were evaluated with linear, quadratic, and cubic contrasts. Neutral detergent fiber increased linearly (P < 0.01) and cubically (P = 0.01), while ADF tended (P = 0.17) to increase linearly with advancing season. Dietary N decreased linearly (P < 0.01), quadratically (P = 0.01), and cubically (P = 0.01). Soluble N and IN expressed a linear (P < 0.001) and quadratic (P = 0.03) decrease across advancing season, while IN also showed a cubic response (P < 0.001). Acid detergent insoluble N did not change as season advanced (P > 0.14). In vitro OM digestibility decreased from May to September (P < 0.01) in all sampling periods, but did not show any trends across treatments (P = 0.82). However, IVOMD did show a treatment × period interaction (P < 0.01).

Total DMI and ruminal DM fill (g/kg of BW) increased linearly (P ≤ 0.01) from May to September (17.9 to 23.0 ± 1.2 g/kg of BW and 11.2 to 21.8 ± 1.1 g/kg of BW, respectively). Fecal output (g/kg of BW) increased linearly (P < 0.01) across season from 6.5 to 11.6 ± 0.4. Organic matter and CP digestibility decreased linearly (P ≤ 0.01) and quadratically (P ≤ 0.05) with advancing season (61.7 to 50.8 ± 2.6 % and 71.2 to 38 ± 3.2 %, respectively). Neutral detergent fiber digestibility demonstrated a quadratic and cubic decrease with advancing season (P ≤ 0.01), while ADF digestibility had linear, quadratic, and cubic (P ≤ 0.05) decreases.

Rate of DM disappearance was not affected (P = 0.50) by grazing intensity, but decreased (linear, P = 0.001; quadratic, P < 0.001) with advancing season (11.7, 9.7, 9.1, 7.1, and 8.5 ± 0.75 %/h for periods 1, 2, 3, 4, and 5, respectively). Rate of NDF disappearance was not affected by grazing intensity or advancing season (P ≥ 0.18) and averaged 4.6 ± 0.34 %/h. Rapidly, slowly, and non-degradable CP fractions were not affected by grazing intensity (P ≥ 0.34). Rapidly and slowly degradable CP fractions decreased (linear, quadratic, and cubic; P ≤ 0.02; 37.6 and 58.8, 43.7 and 48.1, 37.7 and 51.1, 29.0 and 57.2, and 25.9 and 32.3 ± 2.2 and 2.6 %, respectively for rapidly and slowly degraded CP fractions during seasonal periods of 1, 2, 3, 4, and 5) while non-degradable CP increased cubically (P < 0.001) with advancing season. Rate of CP disappearance was not affected by grazing intensity or advancing season and averaged 5.4 ± 0.53 %/h across both grazing intensity and advancing season.

Grazing treatment × season interactions were not present (P = 0.19) for ruminal pH and present (P ≤ 0.02 for ruminal ammonia (AMM), total VFA, acetate, propionate, butyrate, and acetate:propionate (AP). Ruminal pH was not impacted by grazing treatment, and increased (linear, P ≤ 0.01) with advancing season (6.3 to 6.6 ± 0.05 from May to September, respectively). Observed interactions for ruminal VFA and AMM data were being driven predominately by advancing season and not grazing intensity. Ruminal AMM and total VFA increased (quadratic, P ≤ 0.001) with advancing season consistently across grazing treatments and ranged from 3.4 to 8.2 ± 0.31 mM and 137 to 183 ± 4.5 mM, respectively. Acetate proportions increased (linear, P ≤ 0.001), while butyrate decreased (linear, P ≤ 0.001) with advancing season across grazing intensity treatments. Propionate decreased (quadratic, P ≤ 0.001) with advancing season. The AP increased (linear, P ≤ 0.001) with advancing season and ranged from 2.3 to 2.9 from May to September, respectively.

In summary, these data indicate increases in dietary NDF and decreases in N, SN, IN, and IVOMD with advancing season. These data suggest seasonal factors are a more important driver of grazed masticate forage nutrient composition than the grazing intensities evaluated in this study. Grazing season and not intensity had impacts on forage intake, digestion, ruminal fermentation, and rates of digestion by grazing beef steers. These data are interpreted to indicate that seasonal factors are a more important driver of steer performance, intake, ruminal fermentation, and digestion than grazing intensity; however, supplemental protein (DDGS) may have mitigated the impact of grazing pressure.
LITERATURE CITED


Elliot, I. 2013. Feedstuffs. Accessed 1/15/2013:


Patton, B. and A. Nyren. 2014. Central Grasslands Research and Extension Center, Annual Report:

ABSTRACT: A study was conducted to evaluate the influence of advancing season and grazing intensity on dietary chemical composition and in vitro organic matter disappearance (IVOMD) in beef steers grazing mixed-grass prairie in the Missouri Coteau of south central North Dakota. Five sampling periods were conducted from mid-May to early September 2015. Twelve ruminal cannulated crossbred steers were used to collect diets while 188 crossbred steers were used to maintain specific grazing intensities on 12 pastures. Treatments were light (LT), moderate (MOD), heavy (HVY), and extreme (EXT) grazing intensities. Each treatment was assigned to 3 pastures. Grazing treatment × sampling period interactions were not present (P > 0.29) for all variables measured except IVOMD (P < 0.01). There were no main effects of grazing treatment for NDF, ADF, total N, soluble N (SN), insoluble N (IN), and ADIN. Responses to grazing season were evaluated with linear, quadratic, and cubic contrasts. Neutral detergent fiber increased linearly (P < 0.01) and cubically (P = 0.01), while ADF tended (P = 0.17) to increase linearly with advancing season. Dietary N decreased linearly (P < 0.01), quadratically (P = 0.01), and cubically (P = 0.01). Soluble N and IN expressed a linear (P < 0.001) and quadratic (P = 0.03) decrease across advancing season, while IN also showed a cubic response (P < 0.001). Acid detergent insoluble N did not change as season advanced (P > 0.14). In vitro OM digestibility decreased from May to September (P < 0.01) in all sampling periods, but did not show any trends across treatments (P = 0.82). However, IVOMD did show a treatment × period interaction (P < 0.01). In summary, these data indicate increases (P < 0.001) in dietary NDF and decreases (P < 0.001) in N, SN, IN, and IVOMD with advancing season. These data suggest seasonal factors are a more important driver of grazed masticate forage nutrient composition than the grazing intensities evaluated in this study.

Key words: dietary nutrient composition, grazing intensity, season

INTRODUCTION

Dietary chemical composition of grazed forage, when coupled with forage intake and digestion are important factors in rangeland based cattle production systems. We know that as forage maturity increases, dietary CP, digestibility, and intake often decline, while dietary fiber usually increases (Olson et al., 1994; Johnson et al., 1998; McCollum et al., 1985; Adams et al., 1987; Cline et al., 2009). Bryant et al. (1970) found that if grazing pressure is intense enough to causes a low availability of herbage, quality of herbage ingested decreases due to the reduced opportunity for selective grazing. Furthermore, as grazing intensity increases, diet quality decreases (Cook et al., 1953; Pieper et al., 1959).

It is common for beef cattle operations to maintain herds on native grass to reduce input costs of harvested and purchased feeds. Therefore, modulating cattle stocking rates on pasture is a common management tool used to achieve long-term goals of optimizing forage use, livestock production, and agroecosystem sustainability (Derner et al., 2008; Biondini et al., 1998; Hart et al., 1988). However, information regarding the impact of grazing intensity on forage intake and digestion by cattle grazing mixed-grass prairie is lacking. Hence, our objectives were to evaluate the effects of advancing season and grazing intensity on diet chemical composition and in vitro OM digestibility (IVOMD) by steers grazing mixed-grass prairie in the Missouri Coteau of south central North Dakota.

MATERIALS AND METHODS

Animals

Protocols described herein were approved by the North Dakota State University Institutional Animal Care and Use Committee. Angus cross beef steers (n = 188; 320 ± 35.2 kg initial BW) were used to establish grazing pressure, and 12 ruminal cannulated steers (272 ± 33.6 kg) co-grazed with the non-cannulated animals. All steers had free access to water and trace mineral salt blocks (salt 95.5 to 98.5%, zinc 3,500 mg/kg, iron 2,000 mg/kg, manganese 1,800 mg/kg, copper 280 to 420 mg/kg, iodine 100 mg/kg, and cobalt 60 mg/kg; American Stockman Hi-Salt with EDDI; North American Salt Company, Overland Park, KS). Steers were fed dried distillers grains with solubles (DDGS) daily at sunrise at 0.3% of their BW. All animals were weighed every 28 d to determine gains as the grazing season progressed as well as used to adjust DDGS fed. All steers were implanted with Revalor-G (40 mg of trenbolone acetate and 8 mg estradiol; Intervet Inc., Millsboro, DE) 1 d before being turned out on pasture.

Experimental Design and Treatments
The grazing trial was conducted at the Central Grasslands Research Extension Center (CGREC) located on the Missouri Coteau in south-central North Dakota. The study site had been divided into 12 pastures of approximately 12.9 ha each in 1989. Cattle grazed from May 15 to September 11 of 2015. Patton and Nyren (2014) reported the botanical composition of the plant communities at the study site the year before this study. The most common grasses in 2014 were Kentucky bluegrass (Poa pratensis L.), western wheatgrass (Pascopyrum smithii A.), sun sedge (Carex inops), green needlegrass (Nassella viridula), obtuse sedge (Carex obtusata Lilj.), and blue grama (Bouteloua gracilis). Common forbs were heath aster (Symphyotrichum ericoides), common dandelion (Taraxacum officinale), and western yarrow (Achillea millefolium L.). Buckbrush (Symphoricarpos occidentalis) was the only common shrub. Steers were stocked at 25 LL, 35 (HVY), and 20% (EXT) of an average annual above ground biomass remained at the end of the grazing season. Each of the cannulated steers was assigned to a pasture at random, each treatment having 3 pastures. Animals were removed at the end of the grazing season when forage utilization on half of the pastures had reached desired grazing intensity.

Five, 10 d collection periods were conducted for May, June, July, August, and September. Sampling periods began with collection of diet samples. At sunrise, cannulated steers were restrained and subjected to total ruminal evacuation. Ruminal digesta was physically removed from each cannulated steer and the rumen was then double rinsed with water to assure complete removal of contents. Steers were then allowed to graze on their assigned pastures for 30 to 45 min. Then ruminal masticate samples were removed, labeled, and immediately placed on ice. Previously collected ruminal contents were placed back in the animal. All samples were then frozen at -20°C for later analysis.

Masticate samples were lyophilized (Genesis 25LL, Virtis, Gardiner, NY). Dry matter, ash, and CP were determined using AOAC (1990). Neutral detergent fiber and ADF of diet samples were determined using ANKOM procedures (ANKOM, Macedon, NY). Acid detergent insoluble N was calculated as N remaining in the ADF residue. Soluble N was extracted with 0.15 M NaCl according to the procedure of Waldo and Goering (1979). In vitro OM digestibilities (Tilley and Terry, 1963) were conducted to determine IVOMD. Masticate forage and ruminal fluid collected from each animal was used for in vitro determinations.

Statistical Analysis

Chemical composition and IVOMD were analyzed as a repeated measures design using a mixed model approach in SAS (SAS Inst. Inc., Cary, NY). Effects for sampling period, grazing treatment, and period × treatment interactions were included in the model. In the absence of interactions, orthogonal contrasts were used to determine linear, quadratic, and cubic, responses across the grazing season (sampling period). Sampling period × grazing treatment interactions (P ≤ 0.05) were detected for IVOMD; therefore, the simple effect means were separated using the LSMEANS statement in SAS. The procedures of SAS were used for all statistical analysis and P-values ≤ 0.05 were considered different.

RESULTS AND DISCUSSION

Diet Analyses

No treatment × period interactions (P > 0.05) were observed, with the exception of interactions of IVOMD which will be discussed later in the Results and Discussion. Therefore, main effect means are reported for grazing intensity treatment and grazing period (Table 1). Organic matter, NDF, and ADF of cattle diets were not affected (P > 0.05) by grazing intensity. Crude protein, total N, soluble N (SN), insoluble N (IN), and ADIN also did not differ between grazing intensity treatments (P > 0.05).

Table 1 shows the effects of grazing intensity and advancing season on chemical composition of diet as well as IVOMD. Neutral detergent fiber and ADF changed with advancing season (P < 0.01). These results coincided with Olson et al. (1994) for south central North Dakota, Johnson et al. (1998) for western North Dakota, and McCollum et al. (1985) for south central New Mexico. Neutral detergent fiber increased with advancing season (P < 0.01 and P = 0.01, respectively for a linear and cubic response) and ADF tended (P = 0.17; linear) to increase as season advanced. These responses are supported by previous data from south central North Dakota (Olson et al., 1994), western North Dakota (Johnson et al., 1998), as well as south central New Mexico (McCollum et al., 1985) who observed similar responses.

Nitrogen (% of OM) decreased linearly (P < 0.01), quadratically (P < 0.01), and cubically (P < 0.01) as season advanced. Typically, forage masticate N concentration declines with increasing forage maturity associated with advancing season. Such was the case in our study and the work of others within the region (Olson et al., 1994; Johnson et al., 1998; Cline et al., 2009). Soluble N decreased (P < 0.01) in a linear fashion, whereas, IN data were represented by declining linear, quadratic, and cubic responses (P < 0.01). McCollum et al. (1985) also found that N, SN, and IN decreased with advancing grazing season. In the present study, ADIN was not impacted by advancing season. However, Cline et al. (2009) observed an increase in ADIN from late June to mid-November.

IVOMD

There was a sampling period × grazing intensity interaction (P = 0.01; Table 1); therefore, interactive means are discussed (data not shown). In vitro OM digestibility decreased from May to September (P < 0.05) in all grazing intensities. In May, IVOMD was similar across all grazing intensities (P > 0.05). In June, LT and MOD had greater (P < 0.05) IVOMD compared with HVY, while EXT was
similar to all grazing intensities (75.7, 73.4, 62.9, and 69.1 ± 2.8 %, respectively). In July, LT had the lowest and HVY the greatest IVOMD (P < 0.05). In August, LT had similar (P > 0.05) IVOMD compared with all other grazing intensities, while MOD was lower (P < 0.05) than HVY. In September, IVOMD was 52.5, 44.9, 50.3, and 42.8 ± 5.1 %; (P > 0.05) for LT, MOD, HVY, and EXT grazing intensities.

**IMPLICATIONS**

The results of this study demonstrate that grazed forage by beef cattle in the Missouri Coteau increase in fiber and decrease in N as season advances. Grazing intensity had little impact on grazed forage nutrient composition. Consequently, previously observed differences in livestock production due to grazing intensity in the Missouri Coteau must be driven by changes in dietary intake or in vivo digestion. Additional research assessing changes in intake and rates of digestion are needed.

**LITERATURE CITED**


Table 1. Effects of grazing intensity and advancing season on dietary chemical composition, and in vitro OM digestibility (IVOMD) in steers grazing mixed-grass prairie

<table>
<thead>
<tr>
<th>Item</th>
<th>Grazing Intensity (TRT)</th>
<th>Grazing Period (PD)</th>
<th>P-value³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LT MOD HVY EXT SEM¹</td>
<td>1 2 3 4 5 SEM²</td>
<td>TRT PD TRT × PD L Q C</td>
</tr>
<tr>
<td>No. of Observations</td>
<td>15 15 15 15 -</td>
<td>12 12 12 12 12 -</td>
<td>- - - - - - - - -</td>
</tr>
<tr>
<td>OM, %</td>
<td>81.3 82.2 80.6 82.3 1.49</td>
<td>74.6 82.4 83.9 83.7 83.2</td>
<td>3.08</td>
</tr>
<tr>
<td>NDF</td>
<td>67.5 69.6 70.7 65.6 2.05</td>
<td>58.4 69.9 67.5 70.7 75.2</td>
<td>3.81</td>
</tr>
<tr>
<td>ADF</td>
<td>38.5 40.2 41.5 36.1 1.85</td>
<td>37.2 38.5 37.1 39.5 43.1</td>
<td>4.05</td>
</tr>
<tr>
<td>CP</td>
<td>18.7 17.7 17.8 19.6 0.63</td>
<td>29.9 18.3 16.9 14.9 12.3</td>
<td>0.86</td>
</tr>
<tr>
<td>N</td>
<td>2.99 2.84 2.85 3.14 0.10</td>
<td>4.78 2.92 2.70 2.38 1.97</td>
<td>0.14</td>
</tr>
<tr>
<td>Soluble N</td>
<td>0.70 0.73 0.69 0.82 0.06</td>
<td>1.08 0.81 0.66 0.57 0.55</td>
<td>0.09</td>
</tr>
<tr>
<td>Insoluble N</td>
<td>2.28 2.11 2.16 2.32 0.08</td>
<td>3.70 2.11 2.05 1.81 1.42</td>
<td>0.12</td>
</tr>
<tr>
<td>ADIN</td>
<td>0.48 0.42 0.44 0.47 0.04</td>
<td>0.52 0.37 0.47 0.44 0.45</td>
<td>0.06</td>
</tr>
<tr>
<td>IVOMD</td>
<td>60.4 62.6 63.4 60.6 2.62</td>
<td>75.9 70.3 62.1 52.8 47.6</td>
<td>3.35</td>
</tr>
</tbody>
</table>

¹LT = light, MOD = moderate, HVY = heavy, and EXT = extreme grazing intensities.
²Grazing period collections were 1 (May 11 to 22), 2 (June 10 to 19), 3 (July 8 to 17), 4 (August 5 to 14), and 5 (September 2 to 11).
³Significance level of the F-test for treatment (TRT), period (PD), treatment by period (TRT × PD), linear (L), quadratic (Q), and cubic (C) effects for items.
⁴Standard error of mean for grazing intensity, n = 15. Most conservative standard error mean values were used.
⁵Standard error of mean for grazing period, n = 12. Most conservative standard error mean values were used.
Effects of grazing intensity and advancing season on performance and intake in steers supplemented with distillers dried grains with solubles grazing northern Great Plains rangelands

K. E. Chilcoat*, B. W. Neville†, M. S. Crouse*, and J. S. Caton*

*Department of Animal Science, North Dakota State University, Fargo 58108
†Central Grasslands Research Extension Center, Streeter ND 58483

A study was conducted to evaluate the influence of grazing intensity and advancing season on performance, intake, and digestion by beef steers grazing mixed-grass prairie in the Missouri Coteau of south central North Dakota. Steers were supplemented with distillers dried grains with solubles (DDGS) at 0.3% BW. Treatments were light, moderate, heavy, and extreme grazing intensities, leaving behind targets of 65, 50, 35, and 20%, respectively, of average annual forage production. Five data collection periods were conducted in May 13 to 22, June 10 to 19, July 8 to 17, August 5 to 14, and September 2 to 11 of 2015. Twelve ruminally cannulated crossbred steers (271 ± 20.0 kg initial BW) were used to collect diet masticate samples, and 188 crossbred steers (320 ± 30.2 kg initial BW) were used to maintain specific grazing intensities over 12 pastures. Each treatment was assigned to 3 pastures. Ruminal contents and masticate samples were collected via ruminal evacuation techniques on d 0 of each collection period. Chromic oxide (8 g ± .02) was dosed twice daily via the ruminal cannula for use as an indigestible marker. No main effects of grazing treatment ($P \geq 0.05$) or treatment × advancing season interactions ($P \geq 0.05$) were observed. Total DMI and ruminal DM fill (g/kg of BW) increased linearly ($P \leq 0.01$) from May to September (17.9 to 23.0 ± 1.2 g/kg of BW and 11.2 to 21.8 ± 1.1 g/kg of BW, respectively). Fecal output (g/kg of BW) increased linearly ($P < 0.01$) across season from 6.5 to 11.6 ± 0.4. Organic matter and CP digestibility decreased linearly ($P \leq 0.01$) and quadratically ($P \leq 0.05$) with advancing season (61.7 to 50.8 ± 2.6 % and 71.2 to 38 ± 3.2 %, respectively). Neutral detergent fiber digestibility demonstrated a quadratic and cubic decrease with advancing season ($P \leq 0.01$), while ADF digestibility had linear, quadratic, and cubic ($P \leq 0.05$) decreases. These data are interpreted to suggest seasonal factors are a more important driver of steer performance and intake than grazing intensity; however, supplemental protein (DDGS) may have mitigated the impact of grazing pressure.

Key words: advancing season, grazing intensity, intake
Effects of grazing intensity and advancing season on in situ forage disappearance in steers supplemented with distillers dried grains with solubles grazing northern Great Plains rangelands

B. W. Neville†, K. E. Chilcoat*, M. S. Crouse*, and J. S. Caton*

*Departments of Animal Science, North Dakota State University, Fargo 58108
†Central Grasslands Research Extension Center, Streeter ND 58483

Twelve ruminally cannulated steers (272 ± 33.6 kg initial BW) were used to assess the impacts of grazing intensity and advancing season on in situ forage disappearance. Steers grazed northern Great Plains rangelands and were supplemented with distillers dried grains with solubles (DDGS) at 0.3% BW. Cannulated steers co-grazed with intact animals to achieve targeted grazing intensities. Grazing intensity targets were leaving 65 (light), 50 (moderate), 35 (heavy), and 20% (extreme) of average annual forage production. Data collection periods across advancing season were 1 (May 11 to 22), 2 (June 10 to 19), 3 (July 8 to 17), 4 (August 5 to 14), and 5 (September 2 to 11) of 2015. Forage masticate samples were collected via ruminal evacuation techniques on d 0 of each collection period. Masticate samples were dried, ground, allocated into in situ bags, and subsequently placed into the original cannulated steer. No grazing intensity treatment × advancing season interactions were present (P ≥ 0.25). Rate of DM disappearance was not affected (P = 0.50) by grazing intensity, but decreased (linear, P = 0.001; quadratic, P < 0.001) with advancing season (11.7, 9.7, 9.1, 7.1, and 8.5 ± 0.75 %/h for periods 1, 2, 3, 4, and 5, respectively). Rate of NDF disappearance was not affected by grazing intensity or advancing season (P ≥ 0.18) and averaged 4.6 ± 0.34 %/h. Rapidly, slowly, and non-degradable CP fractions were not affected by grazing intensity (P ≥ 0.34). Rapidly and slowly degradable CP fractions decreased (linear, quadratic, and cubic; P ≤ 0.02; 37.6 and 58.8, 43.7 and 48.1, 37.7 and 51.1, 29.0 and 57.2, and 25.9 and 32.3 ± 2.2 and 2.6 %, respectively for rapidly and slowly degraded CP fractions during seasonal periods of 1, 2, 3, 4, and 5) while non-degradable CP increased cubically (P < 0.001) with advancing season. Rate of CP disappearance was not affected by grazing intensity or advancing season and averaged 5.4 ± 0.53 %/h across both grazing intensity and advancing season. Grazing intensity did not, and advancing grazing season did, alter in situ forage disappearance. Supplemental protein (DDGS) may have mitigated the impact of grazing intensity on in situ forage disappearance.

Key words: advancing season, grazing intensity, rate of digestion
Effects of grazing intensity and advancing season on ruminal fermentation in steers supplemented with distillers dried grains with solubles grazing northern Great Plains rangelands

K. E. Chilcoat*, B. W. Neville†, M. S. Crouse*, and J. S. Caton*

*Department of Animal Science, North Dakota State University, Fargo, ND 58108
†Central Grasslands Research Extension Center, Streeter, ND 58483

A study was conducted to evaluate the influence of grazing intensity and advancing season on ruminal fermentation by beef steers grazing mixed-grass prairie in the Missouri Coteau of south central North Dakota. Steers were supplemented with distillers dried grains with solubles (DDGS) at 0.3% BW. Five data collection periods were conducted in May 13 to 22, June 10 to 19, July 8 to 17, August 5 to 14, and September 2 to 11 of 2015. Twelve ruminally cannulated crossbred steers (271 ± 20.0 kg initial BW) were used to assess ruminal fermentation, and 188 crossbred steers (320 ± 30.2 kg initial BW) were used to maintain specific grazing intensities over 12 pastures. Treatments were light, moderate, heavy, and extreme grazing intensities, leaving behind targets of 65, 50, 35, and 20%, respectively, of average annual forage production. Each treatment was assigned to 3 pastures. Ruminal samples were collected at -2, 0, 2, 4, 8, 12, and 24, h after supplementation on d 6 during 5 distinct seasonal sampling periods. Daily sampling times were of little interest and data were analyzed for effects of grazing treatment, advancing season and the interaction. Grazing treatment × season interactions were not present (P = 0.19) for ruminal pH and present (P ≤ 0.02 for ruminal ammonia (AMM), total VFA, acetate, propionate, butyrate, and acetate:propionate (AP). Ruminal pH was not impacted by grazing treatment, and increased (linear, P ≤ 0.01) with advancing season (6.3 to 6.6 ± 0.05 from May to September, respectively). Observed interactions for ruminal VFA and AMM data were being driven predominately by advancing season and not grazing intensity. Ruminal AMM and total VFA increased (quadratic, P ≤ 0.001) with advancing season consistently across grazing treatments and ranged from 3.4 to 8.2 ± 0.31 mM and 137 to 183 ± 4.5 mM, respectively. Acetate proportions increased (linear, P ≤ 0.001), while butyrate decreased (linear, P ≤ 0.001) with advancing season across grazing intensity treatments. Propionate decreased (quadratic, P ≤ 0.001) with advancing season. The AP increased (linear, P ≤ 0.001) with advancing season and ranged from 2.3 to 2.9 from May to September, respectively. These data are interpreted to suggest that, within study conditions, seasonal factors are a more important driver of ruminal fermentation characteristics than grazing intensity; however, supplemental protein (DDGS) may have mitigated the impact of grazing pressure.

Key words: advancing season, grazing intensity, ruminal fermentation