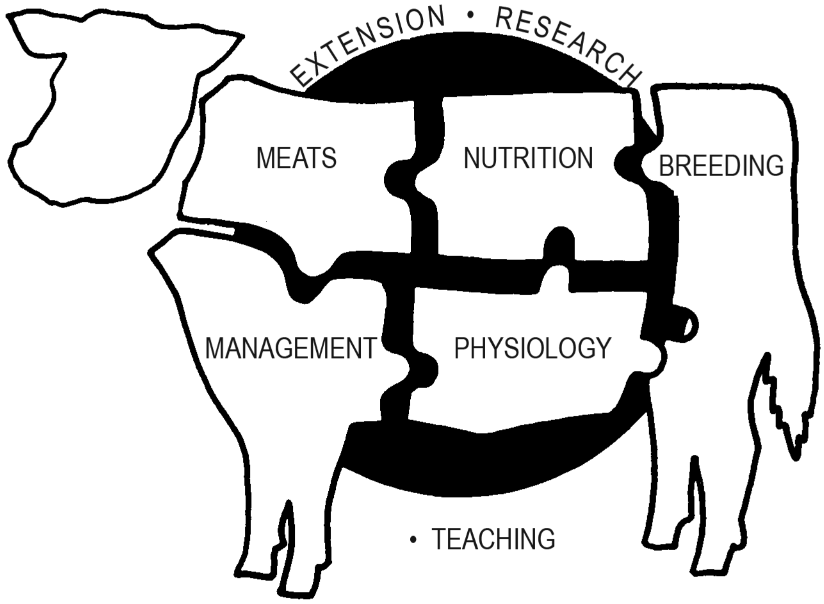
NEBRASKA

EXTENSION

MP118



Agricultural Research Division
University of Nebraska Extension
Institute of Agriculture and Natural Resources
University of Nebraska–Lincoln

2024 Beef Cattle Report

University of Nebraska Lincoln

Table of Contents 2024 Nebraska Beef Cattle Report

Cow-calf Nutrition, Reproduction, and Management

Growing Calf and Yearling Management

Forage Evaluation

Mitigating Greenhouse Gases

Finishing Phase Nutrition and Management

Technology Applications in the Beef Industry

Impact of Increasing Level of Milk Production on Cow-Calf Performance in Nebraska Sandhills

Selby L. Boerman
Jacki A. Musgrave
Kathryn J. Hanford
Mitchell B. Stephenson
J. Travis Mulliniks

Summary with Implications

In a 2-yr study, data were collected on 118 crossbred cow-calf pairs from March- and May-calving herds. On approximately 30, 60, 90, 120, and 210 d postpartum, individual cow 24-h milk yield was estimated through weigh-suckle-weigh techniques. Cow body weight (BW) and body condition score (BCS) were collected weekly through breeding. Calf BW was recorded at each milking. Individual cow milk area under the curve (AUC) values were calculated and data were analyzed using linear regression analysis. Results from this study illustrate that increasing total milk produced throughout the lactation period had minimal influence on the cow production parameters assessed in the Nebraska Sandhills forage environment. However, the lack of differences found in this study may be due to years of selecting for low milk production genetics and the cowherd may not represent the US average for milk production.

Introduction

Genetic selection and cow-calf management practices must be tailored to each unique environment to optimize forage resource utilization and animal productivity. Increased efforts to improve output-related traits, such as calf weaning weight, have been observed in the last 30 years. With increased selection for calf growth by increasing dam milk production, mixed results have been observed, which may be due to differences in calf forage intake. This may be due to the value of the added milk production not being fully captured due to environmental conditions. Previous research has shown offspring from high-milking cows have decreased postweaning growth and feed efficiency, due to increased maintenance requirements. Therefore, the objective of this study was to evaluate the effects of increasing total milk yield on cow BW, cow BCS, cow reproductive performance, calf BW, and calf gain in beef cattle grazing Nebraska Sandhills native range.

Procedure

In a 2-yr study, data were collected on 118 crossbred mature cow-calf pairs from March- and May-calving herds. At the initiation of the study, cows were selected at ~30 d post-calving based on initial milk production estimated using a traditional weigh-suckle-weigh technique to include a range of cows with low to high milk production. Cows and calves were separated at 1000 h, paired and allowed to nurse at 1630 h, then separated again until the following morning at 0700 h. Beginning at 0700 h, calves were weighed, paired with their dam and allowed to nurse, then weighed again. Milk production was estimated by calf pre- and post-suckle body weight difference and extrapolated to 24-h yield based on duration of separation. Cows were stratified by cow age, body weight (BW), body condition score (BCS), calving date, calf sex, calf age, and calf birth BW. At approximately d 60, 90, 120, and 210 postpartum, milk production was measured using a modified weigh-suckle-weigh technique utilizing a milking machine. The day prior to milking, cows and calves were separated before 1000 h, paired and allowed to nurse at 1630 h, then separated again for approximately 14 h until machine milked. Each cow received an intramuscular injection of oxytocin (20 IU; Vedo Inc., St. Joseph, MO) 10 min prior to milking to facilitate milk letdown. Milking began at 0630 h the following day and was completed using a portable milking machine (Porta-Milker, Coburn Company Inc., Whitewater, WI) until machine pressure could not extract any additional fluid. Milk weight, time of last separation, and time of milking initiation were recorded for calculation of 24-h milk yield. The 24-h milk yield and days in milk at each timepoint were used to calculate area under the curve (AUC) for each cow, which was a representation of cumulative milk production throughout the lactation period.

Cow body weight (BW) and body condition score (BCS; 1 = emaciated, 9 = obese) were collected prior to calving, weekly from the onset of the study through the breeding season, and at weaning. Body condition score was determined visually and through palpation by a trained technician. All cows were bred via natural service (1:15 bull:cow) during a 45-d breeding season. Pregnancy diagnosis was conducted via transrectal palpation by a local veterinarian ~90 d following bull removal.

Calf BW was recorded at birth and on all days the cows were milked (~ d 30, 60, 90, 120, and weaning). All March-born steers were implanted at weaning (year 1: Component TE-IS, Elanco, Greenfield, IN; year 2: Synovex Choice, Zoetis). May-born steers were implanted with 25.7 mg estradiol (Compudose, Elanco) at weaning.

Post-weaning steer management differed by season of calving. March-born calves were weaned November 1 and May-born calves were weaned December 1. All calves were fed ad libitum meadow hay and 1 lb/d dry distillers grain for 2 wk. March steers were then transported 90 miles to the West Central Research and Extension Center (WCREC) in North Platte, NE. Following a 2 wk acclimation period, steers were placed in a GrowSafe feeding system (GrowSafe Systems Ltd., Airdrie, AB, Canada). A 2-d average weight was recorded 10 d after GrowSafe entry and considered the initial feedlot entry BW. Approximately 100 d before slaughter, steers were implanted with Synovex Plus (Zoetis).

May-born steers were backgrounded over winter to gain either 1 or 2 lb/d, then grazed upland native range from May to September. In May, steers were implanted with Component ES (Zoetis). In September,

Table 1. Twenty-four-hour milk yield for March- and May-calving cows throughout lactation

	2020		2021	
Item	March	May	March	May
24-hr milk yield, lb				
d 30	15.16	18.30	14.30	20.64
d 60	9.75	13.44	12.19	15.77
d 90	12.76	12.10	14.26	15.05
d 120	10.52	8.25	13.75	8.95
d 210	4.64	5.59	7.28	8.01

Table 2. Regression coefficients and odds ratios used to evaluate the influence of increasing total milk produced during the entire lactation period on cow body weight and reproductive performance

Measurement	Estimate	SEM	*P*-value
Body weight, lb			
Pre-calving	-0.044	0.044	0.37
Pre-breeding	-0.088	0.066	0.17
Breeding	-0.110	0.066	0.09
Weaning	-0.088	0.066	0.13
Pregnancy rate, % (odds ratio)[2]	0.990		0.58
Cycling[1], % (odds ratio)	0.990		0.53

[1]Cycling before the start of the breeding season; evaluated by weekly serum progesterone concentration.

[2]The odds ratio is the odds of being pregnant with milking 2,277 lbs of milk over the lactation period over the odds of being pregnant at 2,255 lb of milk.

steers were shipped to WCREC and managed similarly to the March-born steers in the GrowSafe feeding system. Upon feedlot entry, all May steers were implanted with Component TE-200 (Elanco). A common finishing diet of 48% dry rolled corn, 40% corn gluten feed, 7% prairie hay, and 5% supplement was fed throughout both herd's finishing periods. Average daily gain (ADG) feedlot performance were recorded for all steers.

All analyses were performed using SAS 9.4 PROC GLIMMIX (SAS, Cary, NC). A similar initial model was used to analyze both the cow and progeny performance data. To account for differences in calving season (March or May) and differences among years, a SEASONYR term was determined. To account for differences in birth date within calving season, days within calving season was determined (CDATE). The initial model included the fixed effects of calf gender (CALFSEX; Heifer, Steer), cow age (COWAGE; 4, 5, 6), linear Milk AUC (MILKAUC), and linear and quadratic CDATE and the random effect of SEASONYR and residual error. For the behavior data, which was measured both early and late in the year, an additional fixed effect of time (TIME; Early, Late) and the random effect of SEASONYR was replaced by Cowid(SEASONYR), to account for the repeated measurements on the same experimental unit. In order to account for the differences between seasons and between years, the error term used for testing the MILKAUC effect was the Cowid(SEASONYR) random effect. All other effects were tested over the residual. Non-significant terms ($P > 0.05$) were dropped to produce the final model. A normal distribution was assumed for all measures, except for cow pregnancy rate and cycling rate where a binomial distribution was assumed. Binomial data was evaluated using the odds and odds ratio. Odds (*0*) are the probability (p) of the event occurring over the event not occurring ($1-p$). Odds ratio is the ratio of the odds for two different levels. Significance was determined at $P < 0.05$ and tendency was determined at $0.05 < P < 0.10$.

Results

Means for 24-h milk production at each timepoint during the lactation period are shown in Table 1 for March-calving and May-calving cows. Milk yield values ranged from 14.30–20.64 lb at 30 d postpartum and 4.64–8.01 lb at weaning (~210 d postpartum).

Cow BW was not influenced by milk AUC (Table 2) at pre-calve ($P = 0.37$), pre-breed ($P = 0.17$), or weaning ($P = 0.13$). At breeding, cow BW tended ($P = 0.09$) to be negatively associated with total milk production with a 0.11 lb decrease in BW for every 1 lb increase in total milk produced. Increased milk produced did not influence BCS at pre-calve ($P = 0.97$), pre-breed ($P = 0.48$), or breed ($P = 0.55$). At weaning, BCS decreased ($P = 0.02$) by 0.0006 points for every 1 lb increase in milk AUC. In this study, the odds of cows becoming pregnant were not influenced ($P = 0.58$; Table 2) by increasing milk production. The odds of cows cycling before the start of the breeding season were not influenced ($P = 0.53$) by milk production.

Calf pre-weaning BW was positively associated with increased total milk production at day 30, 60, 90, and 120 ($P < 0.01$; Table 3) of age. A positive association was also observed between milk AUC and calf BW at weaning ($P < 0.01$) with a 0.11 lb increase in weight for every 1 lb increase in total milk production. As expected with the increased calf BW, ADG from birth to 30 d ($P < 0.01$), 30 to 60 d ($P = 0.04$), and 60 to 90 d ($P < 0.01$) were positively influenced by increasing milk production. However, d 120 to weaning calf ADG tended ($P = 0.09$) to be positively associated with increasing milk AUC, illustrating the decreasing impact that milk production has on calf gain as forage consumption increases. In addition, steer ADG in the finishing phase was not associated ($P = 0.63$) with total milk produced by the dam.

Conclusion

In summary, increasing total milk produced throughout the lactation period had minimal influence on the cow production parameters assessed in this study in the Nebraska Sandhills forage environment. In general, BW, BCS, and reproductive productivity were maintained regardless of total milk produced during the lactation period. This suggests that the genetic potential for milk in the current study's cowherd is effectively supported by the environmental forage quality conditions, which is illustrated in Table 1 by signifi-

Table 3. Regression coefficients used to evaluate the influence of increasing total milk produced during the entire lactation period on calf body weight and average daily gain

Measurement	Estimate	SEM	*P*-value
Body weight, lb			
Birth	-0.0044	0.0044	0.28
d 30	0.0396	0.011	< 0.01
d 60	0.0528	0.011	< 0.01
d 90	0.0748	0.0154	< 0.01
d 120	0.088	0.0176	< 0.01
d 210 (weaning)	0.110	0.022	< 0.01
Average daily gain, lb/d			
Birth to d 30	0.0022	< 0.001	< 0.01
d 30 to 60	< 0.001	< 0.001	0.04
d 60 to 90	< 0.001	< 0.001	< 0.01
d 90 to 120	< 0.001	< 0.001	0.01
d 120 to 210	< 0.001	< 0.001	0.09
Feedlot performance			
Average daily gain, lb/d	0.00022	0.00044	0.63

cantly lower overall milk production than industry average. Although the data indicate milk production increases pre-weaning calf growth, this relationship weakens after 120 d, which may be due to the increase in forage intake and reliance on forage to meet requirements of the growing calf. Further examination of post-weaning calf efficiency will provide understanding of how of dam milk yield selection impacts the overall beef production system.

Selby L. Boerman, graduate student.

Jacki A. Musgrave, research technician

Kathryn J. Hanford, professor, Department of Statistics, University of Nebraska Lincoln

Mitchell Stephenson, range scientist, Panhandle Research and Extension Center, Scottsbluff

J. Travis Mulliniks, range nutritionist, West Central Research and Extension Center, North Platte

Artificial Insemination of Beef Heifers with Multi-Sire Semen

Dempster M. Christenson
Jordan M. Thomas
Daniel J. Kelly
John G. Maddux
Rick N. Funston

Summary with Implications

This study compared pregnancy rates of beef heifers artificially inseminated with multi-sire semen to single-sire semen at ranch 1 and demonstrated pregnancy to multi-sire sexed semen at ranch 2. It was hypothesized pregnancy rates resulting from multi-sire semen would be increased compared to single-sire semen. Ranch 1 heifers were inseminated with either single-sire or multi-sire semen and all heifers expressing estrus at ranch 2 were inseminated with multi-sire sexed semen. Heifers inseminated with multi-sire semen averaged numerically greater pregnancy rate than the average single-sire pregnancy rate and pregnancy outcomes from multi-sire sexed semen exceed previous literature but cannot be directly compared. Despite similar pregnancy results between each single-sire treatment, paternity results suggest sires produce unequal proportions of offspring when their semen is mixed. In summary, producers looking to maximize pregnancy rate to artificial insemination may consider multi-sire insemination but more data is required.

Introduction

Multi-sire (aka. heterospermic or sperm pack) semen is rarely used for artificial insemination (**AI**) when assignment of paternity is important, and the value of genotyping is low. However, previous studies reported pregnancy success increased 11—13% in heifers inseminated with multi-sire semen compared to single-sire AI. This increase is believed to be the result of interactions between semen from different sires and differences in optimal viability between sires, which may optimize matching of the peak sperm and ovum viability.

Sexed semen has been available for many years, but it has only recently become cost-effective for commercial producers. There are still challenges associated with utilizing sexed semen because it requires a more intensive protocol. Due to reduced semen quality after the sex sorting process, pregnancy rates are decreased among heifers not exhibiting estrus at the time of AI. Bull semen differ in resiliency to sex sorting and subsequent cryopreservation, and thus exhibit varied viability of sexed sperm cells post-deposition, but a mixture of semen may provide a longer period of optimal viability than an individual bull. The objective of this study was to compare pregnancy rates of beef heifers artificially inseminated with multi-sire semen to single-sire semen at ranch 1 and demonstrated pregnancy to multi-sire sexed semen at ranch 2.

Procedure

Ranch 1 utilized 441 Angus crossbred spring calving beef heifers (762 ± 64 lb) from Sutherland, NE in 2022. Estrus was synchronized with the melengestrol acetate—prostaglandin $F_{2\alpha}$ (**MGA-PG**) timed-AI protocol (Figure 1). Estrotect™ patches were applied to identify behavioral estrus before AI and the response was compared by treatment.

Three black Angus bulls were chosen for AI from the ABS Global (DeForest, WI) AI directory based on non-relation to each other and the heifers, availability for simultaneous collection, ranch management choice, and consistent prior AI success rate. One collection was made from each bull (1, 2, 3) and allotted to either the single sire treatments (**SS1, SS2, or SS3**; n = 75 each) or the multi-sire (**MS**; n = 216) treatment, which contained a one third sample from each bull. A breeding soundness exam was performed on all three bulls and the mixture of sperm, which determined sperm

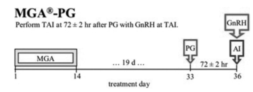


Fig. 1. Melengestrol acetate—prostaglandin $F_{2\alpha}$ (PG) timed artificial insemination protocol used for synchronization of estrus in ranch 1 beef heifers. Melengestrol acetate is fed from Day 1 to 14 and PG is administered on Day 33 along with an aid to detect estrus. Heifers are inseminated on Day 36 and heifers not exhibiting estrus are administered gonadrotropin releasing hormone. Beef Reproduction Task Force; BeefRepro.org.

morphology, motility, and survivability exceeded industry standards.

Treatment assignment alternated between the three SS and MS treatments utilizing 10 semen straws for each SS and 30 straws for MS as heifers entered the chute before repeating. Unrelated bulls were introduced 7 days after AI and remained with the heifers for 29 days. Pregnancy rate to AI was determined by fetal aging using ultrasound 82 days post AI. Due to drought conditions, half the pregnant heifers were sold before calving, but 57 calves born to the remaining MS heifers were genetically tested (Quantum Genetix, Saskatoon, SK, Canada) to determine paternity within the MS treatment. Paternity of 49 SS calves were also confirmed.

Data were analyzed using PROC GLIMMIX of SAS 9.4 (Cary, NC USA). Heifer was the experimental unit. Pregnancy status and estrus response were analyzed as a response to each SS treatment, each SS treatment and the MS treatment, or the combined SS treatments and the MS treatment.

Ranch 2 is a field demonstration evaluating AI to multi-sire sexed semen that utilized 937 and 914 crossbred composite summer calving beef heifers, in year 1 and 2 respectively (2021 and 2022), from Imperial, NE. Estrus was synchronized with the MGA-PG split-time AI protocol, (Figure 2). Please see (*2023 Nebraska Beef Report*, pp 19–21) for a more thorough description of the procedure.

Fig. 2. Split-Time AI: Melengestrol acetate—prostaglandin F2α (PG) protocol used for synchronization of estrus in ranch 2 beef heifers. Melengestrol acetate is fed from Day 1 to 14 and PG is administered on Day 33 along with an aid to detect estrus. Heifers exhibiting estrus by Day 36 or 37 are inseminated with multi-sire sexed semen. All remaining heifers are administered gonadotropin releasing hormone and inseminated with conventional semen. Estrus Synchronization Recommendations for Artificial Insemination of Beef Heifers; extension.missouri.edu

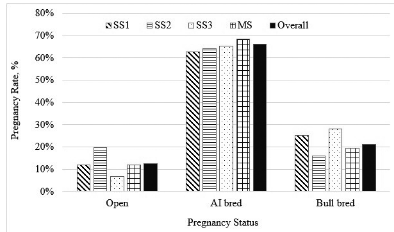


Fig. 3. Pregnancy rate to artificial insemination of semen from three bulls, a combined semen sample, and their average by pregnancy status after natural service at ranch 1.

Semen was collected from twelve 5-way cross bulls from year 1 and eight bulls from year 2, born and raised on ranch 2. Unlike ranch 1, semen volume and concentration were not equivalent between sires. Semen was sex sorted to favor female progeny (SexedULTRA4M) with progeny expected to be 85–90% heifers and 15–10% bulls. Semen from three random sires were mixed forming sire groups A, B, C, and D in year 1 and sire groups E, F, and G in year 2 (sire group G contained 2 bulls). Heifers exhibiting estrus were inseminated with sexed multi-sire semen on day 36 and 37 of the protocol. Different bulls were introduced immediately after AI for 60 days at a heifer to bull ratio of 25:1. Success of AI was determined by fetal aging using ultrasound 100 days post AI. Heifers determined pregnant within 20 days of AI were considered pregnant due to AI and all others were considered bull bred, but heifers considered to be bred to AI had a narrow opportunity to be bred by a different bull. At birth, progeny sex and date of birth (**DOB**) were recorded.

Due to the inability to differentiate between AI bred and bull bred heifers around the time of AI, pregnancy rate was recalculated based on DOB and the percentage of heifer and bull calves born, which was expected to approach 85–90% heifer calves among dams successfully bred by multi-sire sexed semen. The earliest DOB where heifer calves made up 85–90% of total progeny ranged from 295–300 days post AI in year 1 and ranged from 290–297 days post AI in year 2. Pregnancy rate and heifer calf percentage were calculated for each DOB where all calves born after the gestation date were considered bull bred. Based on a DOB between these time periods, a range for adjusted pregnancy rate was estimated. Genetic testing for paternity will be performed for year 2 to confirm pregnancy rate to AI and discover individual sire success within each multi-sire group but will not be completed until publishing. A control treatment was not used on Ranch-2 and observations cannot be directly compared to prior studies using single-sire sexed semen.

Results

Ranch 1 estrus detection results did not significantly differ among sire groups (SS1 = 64%, SS2 = 73%, SS3 = 75%, MS = 70%; P = 0.43). The average pregnancy rate was 66% with no significant differences between treatments (SS1 = 63%, SS2 = 64%, SS3 = 65%, MS = 69%; P = 0.80, Figure 3). Pregnancy rate averaged 64% in SS (SS1=63%, SS2=64%, SS3=65%) and 69% in MS (P=0.32). Pregnancy rate was not significantly different between MS and SS1 (P=0.36). When heifers did not express estrus before timed-AI, pregnancy rate was 51% in SS and 60% in MS (P=0.31). Paternity was determined in 57 MS calves. Within this random sample of the MS treatment population, bull 1 sired 7%, bull 2 sired 56%, and bull 3 sired 37%. Although bull 1 was much less successful than bull 2 or 3, the values are not significantly different due to the small sample size (P = 0.11 and P = 0.24, respectively). It is quite surprising to see such a disparity between the bulls given the pregnancy rate of each sire in the SS treatments were similar. There are several theories about the interaction of semen from different sires in the female tract, but the influence of bull 1 on MS pregnancy rate isn't clearly positive or negative without more data comparing MS and SS pregnancy rate.

Ranch 2 percentage of heifers expressing estrus (87% and 88% in year 1 and 2 respectively) and overall pregnancy rate after AI and 60 days of bull breeding (89% and 92% in year 1 and 2 respectively) were consistent with other studies using MGA-PG split-time AI. Pregnancy rate to multi-sire sexed semen was 65% in year 1 and 75% in year 2. Although they should not be compared directly, prior studies have averaged 53% pregnancy success to single-sire sexed semen. Pregnancy rate differed by sire group ranging from 57 to 69% in year 1 and 74 to 76% in year 2 (Table 1).

Date of birth was used to informally attribute parentage and recalculate pregnancy rate to an adjusted pregnancy rate but does not directly negate the aforementioned pregnancy results. Adjusted pregnancy rate was 55–62% in year 1 and 58–67% in year 2 (Table 1). For reference, the expected value of 53% for pregnancy rate to single-sire sexed semen is below these ranges, but these values cannot be directly compared. Adjusted pregnancy rate among each sire group (Table 1) was decreased. One sire group from year 1 adjusted pregnancy rate ranged from 63–68% and another sire group from year 2 adjusted pregnancy rate ranged from 62–72%, but it is unknown if this high pregnancy success rate is due to random chance or the sires that make up this group. In either scenario, the relationship between pregnancy rate and parentage to AI with multi-sire sexed semen requires more research. Greater detail on the results of year 1 can be found in (*2023 Nebraska Beef Report*, pp 19–21).

Conclusions

Methods that increase pregnancy rate to AI in heifers increase the productivity of the herd by increasing the lifetime productivity of those heifers and their progeny and decreasing the costs associated with development of heifers who take more time and feed to produce a calf. Ongoing research may indicate artificial insemination with multi-sire semen increases pregnancy rate to AI and increase consistency of results by improving pregnancy rate in heifers that do not exhibit estrus during a timed AI protocol. However, more research is required to solidify these conclusions and understand what unexplored interactions are influencing these benefits and causing the unequal

Table 1. Pregnancy results of heifers at ranch 2 inseminated with sexed semen by multi-sire groups

	n	OPEN[1], %	AI[2], %	Adj[3], %
Year 1 total	706	9	65	55–62
Sire group A	197	9	62	50–57
Sire group B	176	11	69	56–66
Sire group C	187	5	69	63–68
Sire group D	146	12	58	50–54
Year 2 total	763	7	75	58–67
Sire group E	232	7	74	50–62
Sire group F	241	7	76	62–72
Sire group G	290	7	76	59–66

[1]Open: Pregnancy was not observed through ultrasound after artificial insemination (AI) and a 60-day breeding period.

[2]AI: Fetal age was observed through ultrasound to be between 80 and 101 d post AI.

[3]Adjusted pregnancy rate was calculated based on the percentage of calves born day 295–300 (year 1) or 290–297 (year 2) post AI multiplied by the number of heifers observed pregnant through ultrasound to multi-sire sexed semen divided by the total number of heifers who received multi-sire sexed semen. Gestation length was chosen based on the DOB when the percentage of heifer to bull calves equaled 85–90% heifers.

sire representation in progeny. Adoption of sexed semen AI is reduced due to economically relevant considerations by producers that may be improved if pregnancy rate to AI can be increased. Multi-sire sexed semen continues to show promise as a potentially improved method for AI with sexed semen, but no conclusions can be made without further study.

Dempseter M. Christenson, research technician and graduate student.

Jordan M. Thomas, assistant professor, Animal Science (University of Missouri).

Daniel J. Kelly, producer, Sutherland, Ne.

John G. Maddux, producer, Impreial, NE.

Rick N. funston, full professor, animal science, West Central Research and Extension Center, North Platte NE.

Effect of Heifer Percent Mature Body Weight at Breeding on Heifer Performance, Calf Production, and Subsequent Pregnancy Rates

Josie N. Crouch
J. Travis Mulliniks
Jacki A. Musgrave
Kathy J. Hanford
Kacie L. McCarthy

Summary with Implications

A retrospective study was done utilizing 1,434 March- and May- calving Red Angus x Simmental crossbred cows and heifers from 2005 through 2019. Heifer weight as a percentage of mature body weight at breeding was used to conduct a regression analysis from 50 to 70% of mature body weight to determine the impact of body weight at breeding on reproductive performance. Heifer pregnancy rates and second pregnancy rates as 2-year-olds were greater for heifers at 60, 65, and 70% of mature body weight at breeding than heifers at 50 and 55%. However, heifer percent mature body weight at breeding did not influence pregnancy rates as 3-, 4-, and 5-year-olds. As heifer percentage of mature body weight at breeding increased, calf birth weight and weaning weight increased. A greater percentage of heifers at a mature body weight of 50, 55, and 60% at breeding calved during the first 21d of the calving season than 65 and 70%. For producers, these results suggest that developing heifers at 60–70% of mature body weight at the time of breeding will likely have increased heifer pregnancy rates and as a 2-year-old. However, heifers below 60% of mature body weight at the time of breeding will likely have a higher percentage calve earlier in the first calving season, but calf weaning weights will not be increased. Although input costs would likely be reduced, the greatest challenge with developing heifers below 60% of mature body weight is rebreeding as 2-year-olds, however, there is no impact on subsequent pregnancy rates after 2-years of age.

Table 1. Mean, standard deviation (SD), minimum and maximum cow and heifer body weight (BW)

Measurement	Mean	SD	Minimum	Maximum
Cow BW[1], lb				
March	1,107	37	761	1,745
May	1,072	68	825	1,742
Heifer BW[2], lb				
March	653	73	399	888
May	708	73	412	944

[1]Cow BW was adjusted to a common body condition score (BCS) of 5 for 5-, 6-, and 7-yr-old mature cows.

[2]Heifer BW was recorded at the time of breeding within each calving season.

Introduction

Developing heifers as replacements accounts for a substantial amount of production costs with feed being a main contributor. Lower input costs can increase long-term profitability in the herd if overall performance is not jeopardized. Traditional recommendations suggest that a heifer should be at 65% of her mature body weight (BW) at the time of breeding to obtain optimal production efficiency and achieve the greatest pregnancy rates. Previous research has shown that heifers that do not reach that target of 65% of mature BW do not have negative impacts on reproduction or longevity within the herd. Conversely, developing heifers to a lighter mature BW percentage could serve as a management strategy to lowering input costs without sacrificing reproductive performance. Therefore, the objective of this study was to determine the impact of differing percentages of heifer mature BW at breeding on reproductive performance and calf production.

Procedure

Data from Red Angus x Simmental crossbred cows and heifers (n = 1,434) were collected near Whitman, NE at the University of Nebraska, Gudmundsen Sandhills Laboratory (GSL) from 2005 through 2019. Data were collected from both March- and May-calving herds. Heifer BW was collected at the time of breeding. The average herd mature BW within the March and May calving herds was calculated by averaging 5, 6, and 7-year-old cow adjusted BW at weaning within each calving season and are reported in Table 1. Using an equation from recent literature, cow BW at weaning was adjusted to a body condition score (BCS) of 5. Heifer weights at the time of breeding were divided by their respective average mature BW within each season to determine percent of mature BW achieved at the time of breeding. Within the March herd, percent mature BW at the time of breeding ranged from 42 to 85% with the average being 60%. Mature BW percent at the time of breeding in the May herd ranged from 46 to 92% with the average being 67%. A retrospective regression analysis was conducted on percentage of estimated mature BW heifers obtained by the time of breeding to determine the impact of varying mature BW percentages at the time of breeding on heifer performance, subsequent calf performance, and subsequent pregnancy rates.

All analyses were performed using the PROC GLIMMIX procedure of SAS 9.4 (SAS, Cary, NC). A similar initial model was used to analyze both the heifer and progeny data. To account for differences in calving season (March or May) and differences among years, a SEASONYR term

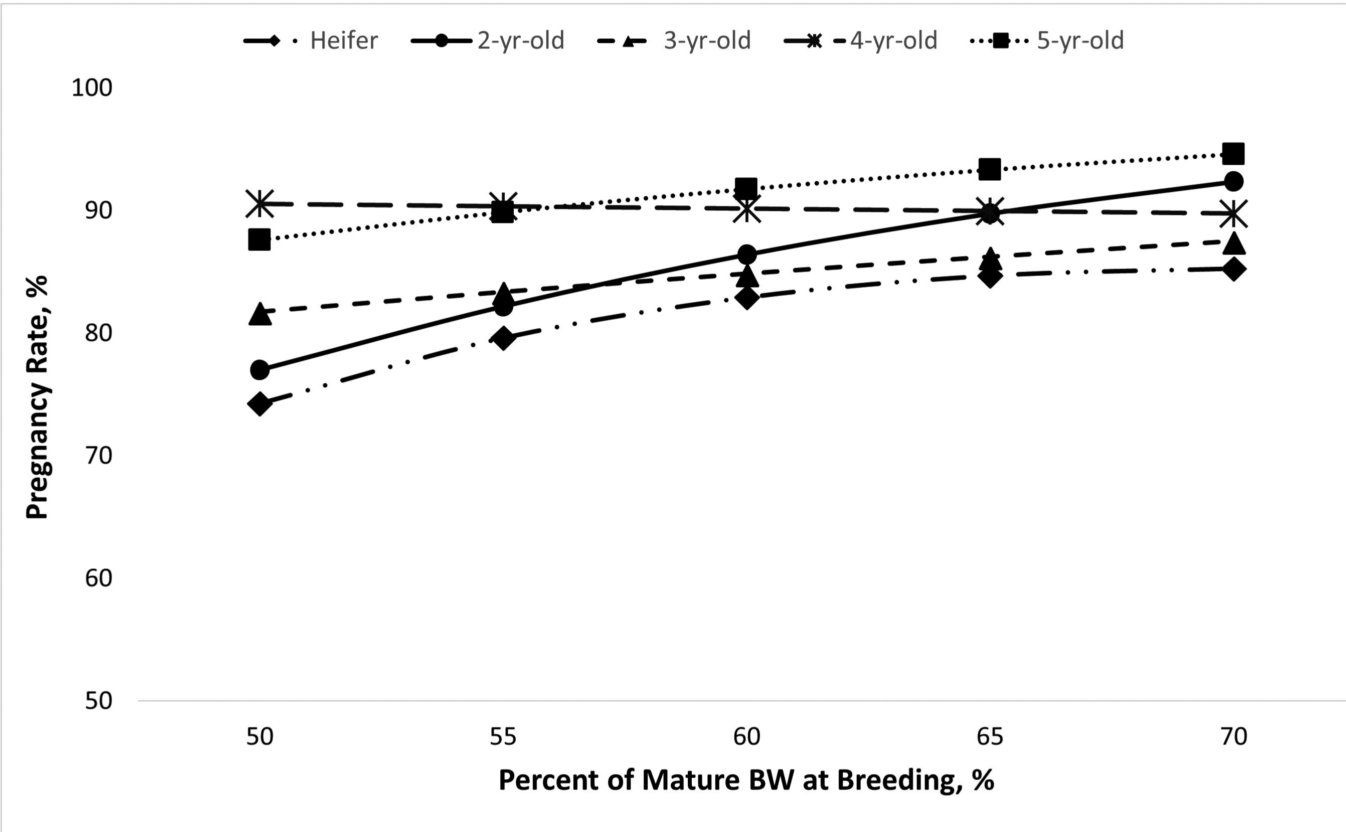


Fig. 1. The impact of percent of mature BW at breeding in replacement heifers on subsequent pregnancy rates as a heifer, 2-, 3-,4- and 5-yr-old. Where yearling heifers is represented by a dashed and dotted line with diamonds ($P < 0.001$), 2-yr-old a solid line with circles ($P < 0.001$), 3-yr-old a dashed line with triangles ($P = 0.19$), 4-yr-old a dotted line with squares ($P = 0.85$), and a 5-yr-old a long-dashed line with stars ($P = 0.15$).

was determined. To account for differences in birth date within calving season, days within calving season (CDAYSEAS) was determined. The initial model included fixed effects of calf gender, covariate CDAYSEAS, linear and quadratic percent mature weight (PCTMAT) and the random effects of SEASONYR by linear PCTMAT, SEASONYR by quadratic PCTMAT and residual error. To account for the differences between seasons and between years, the error term used for testing the linear PCTMAT was the SEASONYR by linear PCTMAT and for testing the quadratic PCTMAT was the SEASONYR by quadratic PCTMAT. All other effects were tested over the residual. Non-significant terms ($P > 0.05$) were dropped to produce the final model. A normal distribution was assumed for all measures, except for heifer pregnancy rate and calving within first 21 days of calving season, where a binomial distribution was assumed. Binomial data were evaluated using the odds and odds ratio. Odds (*0*) are the probability (*p*) of the event occurring over the event not occurring (1-*p*). Odds ratio is the ratio of the odds for two different levels. Estimate statements were used to determine the predicted responses at different percent mature weights and differences between levels of percent mature weight. Significance was determined at $P < 0.05$ and tendency was determined at $0.05 < P < 0.10$.

Results

Initial pregnancy rates of heifers that were 60, 65, and 70% (83, 85, and 85%, respectively) of mature BW at the time of breeding were increased ($P < 0.001$) compared to heifers at 50 and 55% (74 and 80%, respectively) of mature BW. Additionally, pregnancy rates as 2-year-olds were increased ($P < 0.001$) for heifers that were 60, 65, and 70% of mature BW at breeding, with respective pregnancy rates from 50 to 70% being 75, 82, 87, 90, and 92%. However, mature BW percentage at breeding did not influence ($P \geq 0.15$) pregnancy rates as 3-, 4-, and 5-year-old cows (Figure 1). A greater percentage ($P = 0.05$) of heifers at a mature BW percentage of 50, 55 and 60% at breeding calved during the first 21d of the calving season. Heifer first calf BW at birth was greater ($P < 0.001$) as percent of mature body weight at breeding increased with calf birth weight rising 1.2 lbs. with every 5% increase in heifer mature BW at breeding. Additionally, as heifer percent mature BW increased 5% from 50 to 70%, subsequent year calf weaning weights were greater within each cow age ($P = 0.007$).

Conclusion

A mature BW percentage of 60, 65, and 70% at the time of breeding increased pregnancy rates as heifers and 2-year-olds. Furthermore, with every 5% increase in percentage of mature BW at the time of breeding, calf birth weights increased by 1.2 lbs. At the time of weaning, as heifer mature BW percent increased 5%, calf weaning weights increased 5 lbs. However, heifers at a lower percentage of mature BW calved at

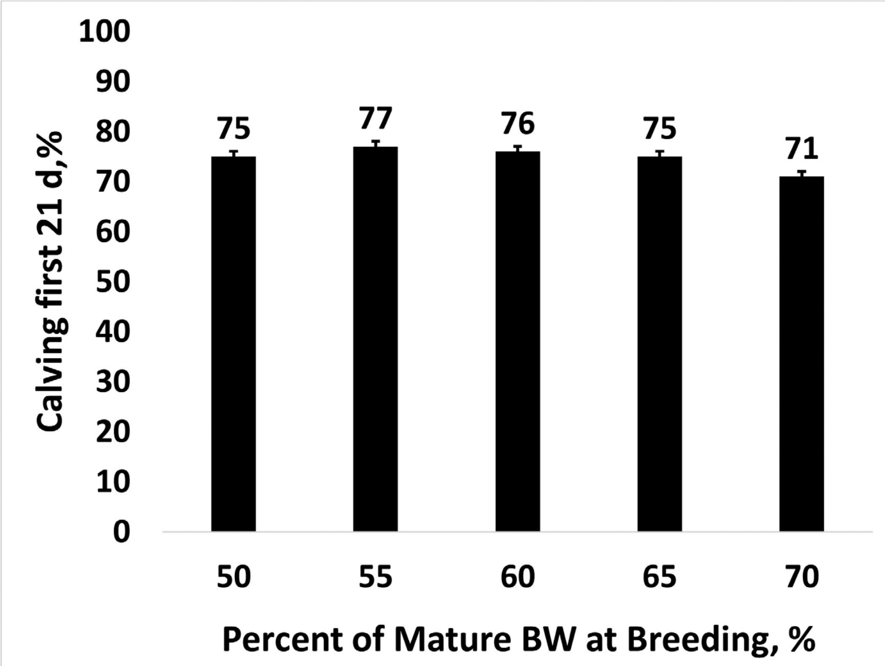


Fig. 2. The impact of percent of mature body weight of replacement heifers at breeding on heifers that calved in the first 21-d of the calving season ($P = 0.05$).

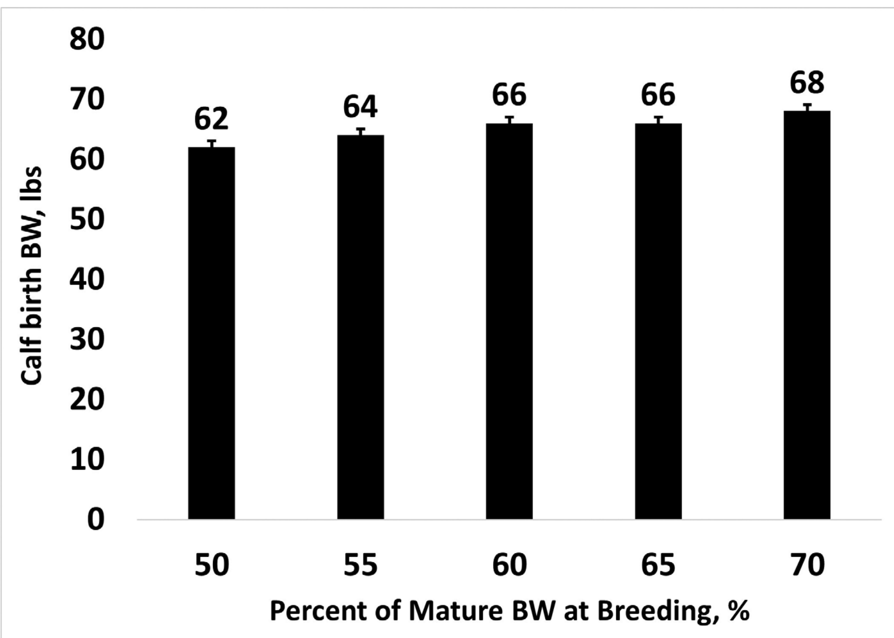


Fig. 3. The impact of percent of mature body weight of replacement heifers at breeding on calf body weight at birth ($P < 0.01$).

a greater percentage during the first 21 d of the subsequent calving season. Additionally, pregnancy rates at 3-, 4-, and 5-year-olds in the cowherd was not influenced by heifer BW at the time of breeding. These results indicate that producers developing heifers below 60% of mature body weight at the time of breeding may have increased challenges in rebreeding 2-yr-old cows; however, subsequent pregnancy rates as a 3-yr-old and older are not impaired by percent of mature BW at breeding as a heifer.

Josie N. Crouch, graduate student.

J. Travis Mulliniks, associate professor, animal science, University of Nebraska-Lincoln West Central Research and Extension Center, North Platte, NE.

Jacki A. Musgrave, research technician.

Kathy J. Hanford, professor, statistics, University of Nebrasa- Lincoln , Lincoln, NE.

Kacie L. McCarthy, assistant professor, animal science, University of Nebraska-Lincoln, Lincoln, NE.

Effect of Glucogenic Feed Additive on Reproductive Performance in Young Postpartum Range Cows

Tasha M. King
Jacki A. Musgrave
Nicole M. Woita
Selby L. Boerman
Jim C. MacDonald
J. Travis Mulliniks

Summary with Implications

Performance of young March-calving range cows receiving a protein supplement with the addition of either monensin or propionate salt were compared to evaluate the effect of feed additive on overall production in the postpartum stage. Cow body weight and body condition were not impacted by postpartum supplementation throughout the study. Calf body weights were not impacted by type of feed additive at birth, weaning, or 205-d. Twenty-four-hour milk production was not impacted by the type of feed additive. Conception rates for cows receiving postpartum supplementation containing propionate salt were greater than cows receiving monensin. This implies that the addition of propionate salt when supplementing young range cows in the postpartum period can increase pregnancy rate resulting in an increase in marginal revenue compared to cows fed monensin.

Introduction

Increased nutrient demands are observed in young cows due to lactation and continued growth which can result in negative energy balance and decreased reproductive performance when grazing native range. Providing an additional or increasing source of energy can allow cows to repartition energy during this time of lactational demand and reproductive repair post-calving. Furthermore, increasing post-ruminal supply of glucose from the diet through increase ruminal propionate supply has been shown to partition nutrients away from milk production while increasing reproductive performance. Therefore, increasing ruminal propionate supply to young cows consuming low-quality forage-based diets may increase energy metabolism and reproductive performance. Supplementation with the inclusion of either monensin or propionate salts have been shown to decrease days to resumption of estrus and increase pregnancy rates in young range cows. Understanding the efficacy of differing glucogenic precursor feed additives can provide insight to develop supplementation strategies to optimize reproductive performance in young cows.

The objective of this study was to determine the impact of addition of either monensin (Rumensin 90, Elanco Animal Health) or propionate salt (NutroCal 100, Kemin Industries) in protein supplements on body weight (BW) change, body condition score (BCS), energy metabolism, reproduction, milk production, and calf weaning BW in young postpartum range cows.

Procedure

This study was conducted over a 3-year period (2019–2021) at Gudmundsen Sandhills Laboratory (GSL) located near Whitman, NE utilizing Red Angus/Simmental composite cows in their first or second parity (n = 189). Cows were stratified at calving by BW (1036 ± 103 lbs) and assigned randomly to a supplementation treatment. A 30% crude protein (CP) supplement (Table 1) was provided at a rate of 2 lb/d with the addition of either: 1) 160 mg/cow daily of monensin (MON; Elanco Animal Health) or 2) 40 g/cow daily of propionate salt (CAP; NutroCal 100, Kemin Animal Nutrition and Health). Supplementation was individually fed and offered for an average of 70 d postpartum after calving. Cows were individually supplemented daily by Super SmartFeed (C-Lock Inc., Rapid City, SD) electronic pasture feeding system.

Table 1. Nutrient composition of postpartum protein supplements for 2- and 3-yr-old range cows

	Supplement[1]	
Item	MON	CAP
Dry matter, %	90.4	90.4
Crude protein, %	29.8	29.8
NutroCal[2], %	0	4.4
Rumensin[3], mg/d	160	0
RUP, % of CP	39.7	39.7
RDP, % of CP	60.4	60.4
Crude fat, %	4.64	4.5
Crude fiber, %	6.01	7.0
Zinc, mg/kg	147	147
Copper, mg/kg	32.7	32.0
Manganese, mg/kg	86.1	86.0
Vitamin A, IU/kg	22,750	22,026

[1]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

Cows were offered ad libitum access to meadow hay averaging 6.8% CP and 69.6% NDF throughout the study.

Cow BW and BCS (1 = emaciated, 9 = obese) were recorded once weekly upon placement onto trial. Cow BW was taken at 0830 h, prior to hay being provided. Cows were exposed to fertile bulls (1:17 bull to cow ratio) for a 45-d breeding season starting in June of each year. Pregnancy was detected via transrectal ultrasonography in October to determine reproductive performance of cows. Calving distribution in 21-d intervals was calculated with the start of the calving season coinciding with the first day that 2 or more heifers calved.

Calf BW was taken at birth within the first 24 h, pre-breeding, and weaning. Calves were vaccinated with Alpha 7 (Boehringer/Ingelheim) at birth and Vista Once and Vision 7 (Merck) were administered at branding (late April). Bull calves were castrated at branding. Calves were weaned in

October with calf BW adjusted to a 205-d age constant BW without adjusting for age of dam and sex of calf.

Blood samples were taken weekly beginning 45-d postpartum via coccygeal venipuncture into serum separator vacuum tubes and analyzed for metabolites. A commercial enzyme-linked immunoassay kit (DGR International, Inc., Springfield, NJ) was used with a 96-well microplate spectrophotometer (Epoch, BioTek, Winooski, VT) to determine circulating serum progesterone concentrations. Cows were considered cycling before the start of the breeding season if two consecutive samples were ≥ 1.0 ng/mL. In years 1 and 2, milk production was determined using a modified weigh-suckle-weigh method around d 60 postpartum. Cows were milked with a machine after a separation from calves and 24-h milk production was calculated.

A hypothetical partial budget model was developed to compare the economic marginal returns due to supplementation strategy of two 100-cow herds in a 2-yr partial budget using the results. A 2-yr budget was utilized to show the potential impact of supplemental treatments in the year of supplemented and the subsequent year to capture difference in reproductive responses from the first year. Two separate herds are assumed, one consisting of young range cows consuming MON and one consuming CAP. Performance parameters of the partial budget were derived from the results of the current study. Calf prices were estimated using an average price for steers and heifers over a 10-yr period combined from auctions in Nebraska and calf crop was adjusted with an average calf loss. Supplement cost was the average 3-yr cost for the study.

Statistical Analysis

Data were analyzed as a randomized block design using the MIXED procedure of SAS. Cow served as experimental unit with supplemental treatment, year, cow age, and their interactions set as fixed effects. Interactions which were not significant were removed from the model. Cow BW, BCS, and serum metabolite concentrations were analyzed as repeated measures with date of collection serving as a repeated factor with an autoregressive covariate structure. Significance level was set at $P \leq 0.05$.

Table 2. Postpartum supplement effects on cow body weight, body condition score, and reproductive performance for 2- and 3-yr-old postpartum cows.

	Supplement[1]			
Measurement	MON	CAP	SEM	*P*-value
Cow body weight, lb				
Precalving	1020	1010	11	0.50
Calving	933	923	11	0.51
Prebreeding	926	906	11	0.19
Begin of Breeding	917	897	11	0.17
Nadir	882	864	11	0.23
Weaning	933	911	11	0.15
Cow body weight change, lb				
Calving to Prebreeding	-4	-15	4	0.04
Calving to Breeding	13	15	4	0.91
Calving to Weaning	0	-13	7	0.12
Body Condition Score				
Precalving	5.6	5.5	0.04	0.25
Calving	5.3	5.3	0.04	0.69
Prebreeding	5.3	5.2	0.03	0.26
Breeding	5.3	5.2	0.03	0.38
Weaning	5.3	5.2	0.04	0.11
Reproductive Measurements				
Cycling prior to breeding, %	45	58	4	0.03
Pregnancy rate, %	80	89	3	0.04
Calved in first 21 d, %	43	52	3	0.02

[1]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; **MON**) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; **CAP**).

Results

Difference in cow BW was not influenced ($P \geq 0.55$; Table 2) by postpartum supplemental treatments at all measurement points from calving to weaning. However, cows consuming CAP did lose more ($P = 0.04$) BW from calving to pre-breeding than their counterparts. Cow body weight change from calving to breeding and to weaning were not influenced ($P \geq 0.12$) by postpartum supplementation strategies. Like cow BW, BCS was not influenced ($P \geq 0.11$) by postpartum supplementation at each measurement time. Calf BW was not influenced ($P \geq 0.68$) by supplemental treatments of dam at birth, weaning, and 205-d adjusted BW. Calves averaged 68, 462, and 418 lbs at birth, weaning, and 205-d respectively.

Reproduction in young breeding females plays a critical role in overall ranch profitability, therefore, shortening the length of the postpartum interval in young range cows can increase overall profitability through improved reproductive efficiency due to more opportunities for conception in the given breeding season. Though no change in BW or BCS was observed, a greater percentage of cows were cycling at the beginning of the breeding season ($P = 0.03$; Table 2) when consuming CAP. Overall pregnancy rates were greater ($P = 0.04$) with cows receiving CAP compared to their counterparts. The increased percentage of cows cycling prior to the start of the breeding season in the CAP supplemental group may have allowed increased opportunities for cows to conceive, which positively impacted pregnancy success. In addition, percentage of calves born in the first 21-d of the calving season were increased ($P = 0.02$) from dams fed CAP.

Serum non-esterified fatty acids (NEFA), urea nitrogen, and glucose concentrations were not influenced ($P \geq 0.47$) by postpartum supplementation strategy. Beta-hydroxybutyrate (BHB) concentration was lower ($P = 0.01$) in cows fed CAP

Table 3. Effect of postpartum supplementation on milk production and milk components for 2- and 3-yr-old range cows

	Supplement[1]			
Measurement	MON	CAP	SEM	*P*-value
24-h Production[2], lb/d	10.00	9.94	0.49	0.94
Milk Components				
Protein, %	2.68	2.56	0.04	0.06
Fat, %	2.79	2.64	0.12	0.42
Lactose, %	5.31	5.40	0.03	0.04
Solids-not-fat, %	8.87	8.86	0.06	0.88
Urea nitrogen, mg/dL	17.93	17.06	0.45	0.06

[1]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

[2]Millk production measured ~d 60 postpartum.

Table 4. A partial budget model comparing cost and net revenue for 2 postpartum supplementation strategies for two 100-cow herds for 2 consecutive years[1]

	Supplement[2]	
Item	MON	CAP
Year 1		
No. of cows	100	100
Cost of supplement, $/t	345	374
Days of postpartum supplementation	70	70
Supplement cost, $/d	0.345	0.374
Postpartum supplement cost, $/cow	24.15	26.18
Days of postpartum supplementation	209	210
Price of calves, $/lb	1.684	1.684
Weaned calf value, $	774.14	777.84
Minus feed cost, $	749.99	751.66
Total Revenue per cow herd, $	74,998.60	75,166.00
Difference from MON, $	—	167.40
Pregnancy rates, %	80	89
Calving death loss based on exposed females, %	2.8	2.8
Calf crop, %	77.2	86.2
Year 2		
No. of Cows	77	86
Cost of supplement, $/t	345	374
Days of postpartum supplementation	70	70
Supplement cost, $/d	0.345	0.374
Postpartum supplement cost, $/cow	24.15	26.18
Calf weaning weight, kg	209	210
Price of calves, $/kg	1.684	1.684
Weaned calf value, $	774.14	777.84
Minus Feed Cost, $	749.99	751.66
Total Revenue per cow herd, $	57,748.92	64,642.76
Difference from MON, $	—	6,893.84

[1]Data from the current study were used to construct the 2-yr partial budget.

[2]Supplement: 2.0 lb/d with a 30 % crude protein supplement with the addition of either: 1) 160 mg/cow daily of monensin (Rumensin 90, Elanco Animal Health; MON) or 2) 40 g/cow daily of propionate salt (NutroCal 100, Kemin Industries; CAP).

compared to MON. Circulating NEFA and BHB concentrations can be used to identify negative energy balance as they indicate the mobilization of fat stores. The decrease in BHB in cows fed CAP compared to MON suggests that the addition of CAP in the supplementation strategy helped to prevent a metabolic imbalance during the postpartum period.

Milk production was not influenced ($P = 0.94$; Table 3) by supplementation strategy. Milk fat, protein, and solids-not-fat (SNF) were not impacted ($P > 0.05$) by supplementation strategy. Cows fed CAP had greater ($P = 0.04$) lactose percentage compared to MON. Milk urea nitrogen (MUN) concentration, which is associated with the ratio of protein and energy intake, tended ($P = 0.06$) to be lower in cows receiving CAP. This suggests that the addition of CAP improved protein utilization.

An evaluation of potential revenue from two 100-cow herds was conducted with a 2-yr partial budget of the 2 postpartum supplements using results from the study (Table 4). Total supplemental feed costs for the supplemental period were $21.56 and 28.56/cow for MON and CAP, respectively. In year 1, net revenue was $167.40/cow more for cows receiving CAP, respectively, compared with MON. Increased net revenue in year 1 was due to a numerical increase in calf weaning BW. Pregnancy rates across the 3-yr averaged for the supplement year (yr 1) were 80 and 89% for MON and CAP, respectively. Consequently, young range cows fed CAP in year 1 had an increase in net revenue in year 2 of 10.6% compared with MON-fed young range cows. This increase in revenue is the sum of an increase in pregnancy rates and to a lesser extent a decrease in days to first estrus, which offset the greater postpartum feed costs for the year. The increase in revenue did not account for income from cull cows or the cost of developing additional heifers to replace culled open cows.

Conclusion

Although, postpartum supplementation strategies did not influence cow BW or BCS after calving, supplementing young range cows with 40 g of calcium propionate increased the number of cows cycling prior to the initiation of breeding and increased pregnancy rate. In addition, a greater percentage of cows calved in the first 21-d of the calving season the subsequent year, allowing for the potential to wean older, heavier calves. Addition of calcium propionate to a protein supplement resulted in a decrease of BHB concentration indicating lower fat store mobilization suggesting improved energy efficiency, which may have allowed for decreased days from calving to resumption of estrus and overall increased pregnancy rates. Even with the increased cost of supplementation, feeding young range cows 40 g per day of calcium propionate increased marginal revenue compared to feeding cows monensin.

Tasha M. King, former graduate student.

Jack A. Musgrave, research technician, West Central Research, Extension, and Education Center, North Platte

Nicole M. Woita, graduate student.

Selby L. Boerman, graduate student.

Jim C. MacDonald, professor Animal Science, Lincoln.

J. Travis Mulliniks, associate professor Animal Science, West Central Research, Extension, and Education Center, North Platte.

Nutrocal 100 used for this research was provided by Kemin Animal Nutrition 7 Health (Des Moines, IA).

The Effect of Late Gestation Supplementation Strategy on Cow-Calf Performance in March-Calving Mature Cows

Jacki A. Musgrave
Kacie L. McCarthy
J. Travis Mulliniks

Summary with Implications

Implementation of supplemental protein strategies during late gestation has been shown to positively affect postweaning progeny performance. A 2-yr study was conducted to evaluate the effects of late gestation supplementation strategies on reproduction, cow body weight, and calf performance in March-calving mature range cows grazing dormant upland range. Supplementation was individually fed and provided daily with treatments being: 1) no supplementation, 2) 2 lb per day of a 30% CP distillers-based supplement, 3) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 160 mg/cow daily of monensin, 4) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 40 g/cow daily of propionate salt. Cows that received any of the 3 supplemental protein treatments gained similar BW; whereas cows that received no supplement gained the least BW during late gestation. Supplementation strategy did influence subsequent reproductive performance with CaProp and Supp cows having the greater pregnancy rates. Late gestation supplementation did not influence subsequent calf BW at birth, weaning, and entry into the feedlot. However, late gestation strategy tended to influence steer BW at finishing with offspring from NoSupp dams had the lightest finishing BW. Average daily gain, DMI, and F:G were not influenced by dam's late gestation supplementation strategy. Overall, protein supplementation in general had a positive impact on overall cow-calf performance compared to no protein supplementation. However, cows that were fed protein supplement or protein supplement with the inclusion of propionate salts had increased subsequent pregnancy rates.

Introduction

Implementation of supplemental protein strategies during late gestation may have the potential to affect cow-calf and postweaning progeny performance. Previous research has suggested evidence for prenatal influences on steer progeny from cows grazing dormant winter range with and without protein supplementation. However, protein may not be the only nutrient limiting performance of late gestating cows grazing low-quality native range. Available evidence indicates that postruminal supply of glucogenic precursors may increase nutrient utilization of forages, especially when cattle are grazing low-quality forages. Therefore, the objective of this study was to determine the impact of late gestation supplementation strategies on reproduction, cow body weight, and pre-weaning calf performance and subsequent steer feedlot performance in March-calving mature range cows.

Procedure

This study was conducted over a two-year period (2021 to 2023) utilizing mature range beef cows from the March-calving herd at the University of Nebraska Gudmundsen Sandhills Laboratory (GSL) located near Whitman, NE. Cows (n = 236) were Husker Reds (5/8 Red Angus, 3/8 Simmental) and were stratified by cow body weight and BCS and assigned randomly to a late gestation supplementation treatment. Supplementation was initiated in December each year and terminated approximately 30-d prior to the start of the calving season in February. During the supplemental period, all cows grazed dormant upland native range in one group. Cows were individually supplemented daily by Super SmartFeed (C-Lock Inc., Rapid City, SD) electronic pasture feeding system. Supplementation treatments were: 1) no supplementation as the negative control (**NoSupp**), 2) 2 lb per day of a 30% CP distillers-based supplement (**Supp**), 3) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 160 mg/cow daily of monensin (**RUM**), 4) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 40 g/cow daily of propionate salt (**CaProp**). Supplemental treatments of RUM and CaProp were designed to provide additional glucogenic precursors that may increase nutrient utilization and efficiency impacting both the performance of the cows and developing fetus.

Cow body weight (BW) and body condition score (BCS; 1 = emaciated, 9 = obese) by palpation were measured and recorded at weaning (November), pre-calving (February), and pre-breeding (May). Fertile bulls were introduced for natural service and removed on d 45 of the breeding season. Cow pregnancy diagnosis was detected via transrectal ultrasonography and rectal palpation at weaning each year.

Calves were weighed at birth and at weaning. At weaning, steers (n = 118) were held in a drylot on ad libitum hay for 2 weeks postweaning and then shipped to West Central Research and Extension Center (WCREC; North Platte, NE) and entered the feedlot. Steers were placed in a GrowSafe feeding system approximately 2 weeks after arrival at WCREC. Following a 10-d acclimation period in the GrowSafe, steers were weighed 2 consecutive d and the average was the initial feedlot entry BW used in calculating feedlot performance. All steers experienced a 21 d transition period to a common finishing diet of 48% dry rolled corn, 40% corn gluten feed, 7% prairie hay, and 5% supplement. All steers were implanted with 14 mg estradiol benzonate and 100 mg trenbolone acetate (Synovex Choice, Zoetis) at feedlot entry. Approximately 100 d before slaughter, calves were implanted with 28 mg estradiol benzoate and 200 mg trenbolone acetate (Synovex Plus, Zoetis). Each year, steers were slaughtered at a commercial facility (Tyson Fresh Meats, Lexington, NE) when estimated visually to have 0.5 inch fat thickness as a entire group over the 12^{th} rib. Carcass data were collected 24 h post slaughter and final BW was calculated from hot carcass weight

Table 1. Effect of late gestation supplementation on cow performance

	Treatment[1]					
Measurement	NoSupp	Supp	CaProp	RUM	SEM	*P*-value
Cow body weight, lb						
Nov	1063	1059	1064	1060	5	0.89
Feb	1086[a]	1153[b]	1146[b]	1142[b]	7	0.04
May	1063	1057	1060	1052	10	0.73
Body weight change, lb						
Nov to Feb	23[a]	94[b]	82[b]	82[b]	3	0.01
Feb to May	-23[a]	-96[b]	-86[b]	-90[b]	4	0.01
Cow BCS						
Nov	5.3	5.4	5.4	5.4	0.3	0.91
Feb	4.9	5.2	5.4	5.3	0.2	0.45
May	5.2	5.3	5.5	5.4	0.2	0.78
Pregnancy rate, %	89[a]	95[b]	94[b]	90[a]	2	0.05

[1] Supplementation were: 1) no supplementation as the negative control (NoSupp), 2) 2 lb per day of a 30% CP distillers-based supplement (Supp), 3) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 160 mg/cow daily of monensin (RUM), 4) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 40 g/cow daily of propionate salt (CaProp).

Table 2. Effect of late gestation supplementation on subsequent offspring performance

	Treatment[1]					
Measurement	NoSupp	Supp	CaProp	RUM	SEM	P-value
Calf body weight, lb						
Birth	73	75	76	76	3	0.68
Weaning	577	587	585	582	5	0.49
Feedlot Performance, lb						
Entry	805	821	823	819	12	0.69
Finishing	1325	1368	1363	1363	20	0.18
ADG, lb/d	2.97	3.13	3.09	3.11	0.26	0.56
DMI, lb/d	21.46	22.56	20.71	20.74	0.75	0.45
F:G	7.22	7.21	6.71	6.67	0.31	0.11
Carcass Characteristics						
Hot carcass weight, lb	835[a]	862[b]	859[b]	859[b]	11	0.02
Choice or greater, %	89	77	100	77	8	0.08
Yield Grade	2.74	2.63	2.85	2.54	0.35	0.52
LM area, in^2	14.54[a]	15.36[b]	15.45[b]	15.65[b]	0.44	0.03
Marbling score[2]	508	514	510	465	25	0.22
Backfat, in	0.53	0.57	0.59	0.57	0.43	0.88

[1] Supplementation were: 1) no supplementation as the negative control (NoSupp), 2) 2 lb per day of a 30% CP distillers-based supplement (Supp), 3) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 160 mg/cow daily of monensin (RUM), 4) 2 lb per day of a 30% CP distillers-based supplement with the inclusion of 40 g/cow daily of propionate salt (CaProp).

[2] Marbling score: 400 = Small^{00}, 450 = Small^{50}, 500 = Modest^{00}

(HCW) based on an average dressing percentage of 63%. Carcass data included HCW, marbling, yield grade, backfat, and longissimus muscle (LM) area.

Data were analyzed as a randomized block design using the MIXED procedure (SAS Inst. Inc., Cary, NC, USA) with cow as the experimental unit using the Kenward-Roger degrees of freedom method. The model included fixed effects of year, age, treatment, calf sex, and their interactions. Separation of least squares was performed by the PDIFF option in SAS when a significant ($P \leq 0.05$) effect was detected. Significance level was set at $P \leq 0.05$.

Results

Initial cow BW at the beginning of the experiment in November at weaning was not different ($P = 0.89$; Table 1) among late gestation supplementation strategies. However, pre-calving BW in February was influenced ($P = 0.04$) by treatments. Cows that received any of the 3 supplemental protein treatments gained similar BW; whereas cows that received no supplement gained the least BW during late gestation. By the start of the breeding season in May, cow BW was not different ($P = 0.73$) among late gestation strategies, which was driven by NoSupp cows losing the least amount of BW from calving to breeding. Cow BCS was not different ($P \geq 0.45$) at weaning, calving, and pre-breeding among the late gestation strategies. Subsequent pregnancy rates were influenced ($P = 0.05$) by late gestation supplementation strategy. Cows that received CaProp or Supp had similar pregnancy rates, which were greater than cows receiving RUM or NoSupp that did not differ from each other.

Late gestation supplementation did not influence ($P > 0.49$; Table 2) subsequent calf BW at birth, weaning, and entry into the feedlot. However, late gestation strategy tended to influence ($P = 0.06$) steer BW at finishing with offspring from NoSupp dams having the lightest finishing BW. Average daily gain, DMI, and F:G were not influenced ($P > 0.11$) by dam's late gestation supplementation strategy.

Steer HCW was influenced ($P = 0.02$; Table 2) by late gestation supplementation strategy with offspring from NoSupp cows having the lightest HCW and no difference among the offspring of dams that received a protein supplement. Yield grade, marbling score, and backfat thickness were not influenced ($P > 0.22$) by late gestation supplementation strategy. However, there was a tendency ($P = 0.08$) for offspring from cows receiving CaProp to have a greater percentage of Choice or greater than other offspring. Lastly, LM area was increased ($P = 0.03$) in offspring from dams that received a protein supplement compared to offspring from cows that received no supplement.

Conclusion

Supplementation strategy did influence cow BW change during late gestation; however, this response was driven by protein supplementation (i.e., cows receiving supplementation or no supplementation) rather than the addition of feed additives to the protein supplementation. However, pregnancy rates were increased in cows receiving protein supplementation with or without the additional propionate salt compared to no supplementation or protein supplementation with the addition of rumensin. In post-weaning steer performance, protein supplementation (Supp, CaProp, or RUM) during late gestation did increase overall subsequent finishing steer BW and carcass weight over steers from non-supplemented cows with same days on feed.

Jackie A. Musgrave, research technician.

Kacie L. McCarthy, cow-calf extension specialist, Lincoln.

J. Travis Mulliniks, range nutritionist, West Central Research and Extension Center, North Platte.

The Impact of Prepartum Supplementation Strategy on Cow-Calf Performance in May-Calving Mature Cows

Jacki A. Musgrave
Kacie L. McCarthy
J. Travis Mulliniks

Summary with Implications

Implementation of minimal supplemental protein strategies during late gestation may have the potential to minimize any negative postweaning progeny performance while decreasing feed costs. A 3-yr study was conducted to evaluate the effects of mid- to late-gestation supplementation strategies on reproduction, cow body weight, and calf performance in May-calving mature range cows grazing upland native range. Supplementation was provided 2x weekly with treatments being: 1) 0.5 lb per day of a 30% CP distillers-based supplement, 2) 1 lb per day of a 30% CP distillers-based supplement, 3) a negative control as a flexible supplementation strategy. The Flex strategy was developed to allow for brief and intermittent supplementation at 1 lb/d based on periods of acute environmental stress, such as snow cover, and is best described as flexible supplementation. Mid- to late-gestation supplementation strategy in May-calving cows had no effect on pregnancy rates or pre- and postnatal calf growth. Considering the cost for prepartum supplementation, feeding a protein supplement just during environmentally stressful periods during gestation appears to be a viable alternative to more conventional methods and reduces winter feed costs.

Introduction

Feeding accounts for a large portion of annual production costs in cow-calf production systems. Shifting from a spring to summer calving herd can decrease cost of supplementation and shifts timing of peak late gestation nutrient requirements and increased forage quality. May-calving beef cows in the Sandhills graze low-quality dormant forage during mid-gestation and calve on increased plane of nutrition. Due to the decreased forage quality and lower nutrient requirements, supplementation may be minimized to decrease winter prepartum supplementation costs in May-calving herds. Implementation of minimal supplemental protein strategies during late gestation may have the potential to affect postweaning progeny performance. Therefore, the objective of this study was to determine the impact of minimized protein supplementation by decreasing amount fed per day or the number of days fed on cow performance during late gestation, subsequent reproductive performance and subsequent offspring performance.

Procedure

This study was conducted over a three-year period (2019 to 2022) utilizing mature range beef cows from the May-calving herd at the University of Nebraska Gudmundsen Sandhills Laboratory (GSL) located near Whitman, NE. Cows (n = 315) were Husker Reds (5/8 Red Angus, 3/8 Simmental) and were stratified by cow body weight and BCS and assigned randomly to a prepartum supplementation treatment. Supplementation was initiated in December each year and terminated approximately 30-d prior to the start of the calving season in April. Supplementation was provided 2x weekly with treatments being: 1) 0.5 lb per day of a 30% CP distillers-based supplement (**Half**), 2) 1 lb per day of a 30% CP distillers-based supplement (**Pound**), or 3) a negative control (**Flex**). The Flex strategy was developed to allow for brief and intermittent supplementation at 1 lb/cow based on periods of acute environmental stress, such as snow cover, and is best described as flexible supplementation. The Flex strategy better reflects minimal practices that could be implemented by commercial operations in comparison with a no supplementation strategy that would rarely be found in extensive production settings. This Flex strategy relied on managerial discretion to supply protein supplementation when conditions were determined to be critical for cattle well-being, but the directive was to minimize usage. Supplementation rate, duration of supplemental feeding periods, total consumption, and supplemental costs are shown for each supplementation strategy by year for each prepartum treatment in Table 1.

Cow body weight (BW) and body condition score (BCS; 1 = emaciated, 9 = obese) by palpation were measured and recorded at weaning (December), pre-calving (April), and pre-breeding (July). After the termination of the prepartum treatments, all cows were managed similarly in a common pasture. Fertile bulls were introduced for natural service and removed on d 45 of the breeding season. Cow pregnancy diagnosis was detected via transrectal ultrasonography and rectal palpation at weaning each year.

After weaning, steers grazed subirrigated meadow with a dried distiller grain supplement or fed a background ration until May. In May, all steers grazed subirrigated meadow until Aug/Sept when steers were shipped to West Central Research and Extension Center (WCREC). Steers were placed in a GrowSafe feeding system approximately 2 weeks after arrival at WCREC. Following a 10-d acclimation period in the GrowSafe, steers were weighed 2 consecutive d and the average was the initial feedlot entry BW used in calculating feedlot performance. All steers experienced a 21d transition period to a common finishing diet of 48% dry rolled corn, 40% corn gluten feed, 7% prairie hay, and 5% supplement. All steers were implanted (Component TE-S, Elanco Animal Health) at feedlot entry. Each year, steers were slaughtered at a commercial facility (Tyson Fresh Meats, Lexington, NE) when estimated visually to have 0.5 inch fat thickness over the 12th rib as a group. Carcass data were collected 24 h post slaughter and final BW was calculated from HCW based on an average dressing percentage of 63%. Carcass

Table 1. Feeding rate, duration of supplemental period, total amount of supplement fed, and supplemental cost to cow receiving different prepartum supplements.

	Treatments[1]		
Measurement	Flex	Half	Pound
Year 1			
Cows, n	35	35	35
Rate, lb/d	1	0.5	1
Duration, d	0	112	112
Total fed, lb/cow	0	56	112
Supplemental cost, $/cow	0.00	8.40	16.80
Year 2			
Cows, n	35	35	35
Rate, lb/d	1	0.5	1
Duration, d	26	112	112
Total fed, lb	26	56	112
Supplemental cost, $/cow	4.23	9.10	18.20
Year 3			
Cows, n	35	35	35
Rate, lb/d	1	0.5	1
Duration, d	10	112	112
Total fed, lb	10	56	112
Supplemental cost, $/cow	1.75	9.80	19.60

[1] Supplementation was provided 2x weekly with treatments being: 1) 0.5 lb per day of a 30% CP supplement distillers-based supplement (**Half**), 2) 1 lb per day of a 30% CP supplement distillers-based supplement (**Pound**), 3) a negative control (**Flex**) on only fed during environmental stress periods.

Table 2. Effect of prepartum supplementation on cow performance

	Treatments[1]				
Measurement	Flex	Half	Pound	SEM	*P*-value
Cow BW, lb					
Weaning—on treatment	1118	1117	1124	12	0.88
Pre-calving	1077	1056	1107	17	0.11
Pre-breeding	1139	1118	1163	19	0.09
Weaning—off treatment	1104	1091	1118	22	0.69
Cow BW change, lb					
Weaning to pre-calving	-41[a]	-61[a]	-17[b]	11	0.05
Pre-calving to pre-breeding	62	62	56	13	0.82
Pre-breeding to weaning	-35	-27	-45	12	0.49
BCS					
Weaning—on treatment	5.2	5.2	5.3	0.2	0.89
Pre-calving	5.3	5.2	5.3	0.3	0.91
Pre-breeding	5.6	5.5	5.6	0.3	0.87
Weaning—off treatment	5.4	5.2	5.4	0.3	0.92
Pregnancy rate, %	91	92	91	4	0.91

[1] Supplementation was provided 2x weekly with treatments being: 1) 0.5 lb per day of a 30% CP supplement distillers-based supplement (**Half**), 2) 1 lb per day of a 30% CP supplement distillers-based supplement (**Pound**), 3) a negative control (**Flex**) on only fed during environmental stress periods.

data included HCW, marbling, yield grade, backfat, and LM area.

Data were analyzed as a randomized block design using the MIXED procedure (SAS Inst. Inc., Cary, NC, USA) with pasture as the experimental unit using the Kenward-Roger degrees of freedom method. Separation of least squares was performed by the PDIFF option in SAS when a significant ($P \leq 0.05$) effect was detected. Significance level was set at $P \leq 0.05$.

Results

At the initiation of the trial, cow BW was not significant ($P = 0.88$; Table 2) among prepartum supplementation treatments. In addition, prepartum supplementation strategy did not influence ($P \geq 0.11$) cow BW at pre-calving and at weaning the subsequent year. However, there was a tendency ($P = 0.09$) for cows on the Flex and Half treatments to be lighter at pre-breeding than their counterpart in the Pound treatment. Cows in the Pound treatment group did lose less ($P = 0.05$) BW from weaning to pre-calving than the Flex and Half groups. However, BW change from pre-calving to pre-breeding and pre-breeding to weaning was not influenced ($P = 0.49$) by the previous prepartum supplementation. In addition, BCS was not different ($P \geq 0.89$) at any time point of this study for the 3 different prepartum supplementation groups. Similarly, overall pregnancy rates were not influenced ($P = 0.91$) by previous prepartum supplementation. Prepartum dam supplementation did not influence ($P \geq 0.56$; Table 3) calf BW at birth, pre-breeding, or weaning. In addition, dam prepartum supplementation did not influence ($P \geq 0.45$) post-weaning steer performance or carcass characteristics through the finishing phase.

Conclusion

Mid- to late-gestation supplementation strategy in May-calving cows had no effect on pregnancy rates or calf growth and performance from birth throughout the finishing phase. Considering the cost for prepartum supplementation, feeding a protein supplementation just during environmentally stressful periods during gestation appears to be a viable alternative

Table 3. Effect of late gestation supplementation on subsequent offspring performance

	Treatments[1]				
Measurement	Flex	Half	Pound	SEM	*P*-value
Calf Pre-weaning BW, lb					
Birth	77	77	78	3	0.94
Pre-breeding	191	184	187	5	0.56
Weaning	484	477	485	7	0.76
Backgrounding BW, lb					
Jan	505	492	494	8	0.45
May	656	647	660	9	0.73
Feedlot BW, lb					
Entry (Sept)	991	983	987	9	0.76
Finishing (Jan)	1475	1480	1468	10	0.45
DMI, lb/d	30.2	30.3	29.7	3	0.66
ADG, lb/d	3.98	4.01	3.93	0.15	0.39
F:G	7.59	7.56	7.56	0.23	0.55
Carcass Characteristics					
HCW, lb	926	930	925	6	0.43
Choice or greater, %	88	87	90	4	0.86
Yield grade	2.82	2.69	2.83	0.22	0.69
LM area, in^2	15.13	15.33	15.09	0.25	0.73
Marbling score[2]	528	511	530	15	0.55
Backfat thickness, in	0.54	0.52	0.52	0.11	0.79

[1]Supplementation was provided 2x weekly with treatments being: 1) 0.5 lb per day of a 30% CP supplement distillers-based supplement (**Half**), 2) 1 lb per day of a 30% CP supplement distillers-based supplement (**Pound**), 3) a negative control (**Flex**) on only fed during environmental stress periods.

[2] Marbling score: 400 = Small^{00}, 450 = Small^{50}, 500 = Modest^{00}

to more conventional methods and reduces winter feed costs. Flexible supplementation strategies do require livestock producers to be more pro-active to environmental and livestock trigger points to intervene and start supplementing cows.

Jacki A. Musgrave, research technician.

Kacie L. McCarty, cow-calf extension specialist, Lincoln.

J. Travis Mulliniks, range nutritionist, West Central Research and Extension Center, North Platte.

The Effect of Postpartum Supplementation Strategy on Performance in May-Calving 2- and 3-yr-old Range Cows

Nicole M. Woita
Selby L. Boerman
Jacki A. Musgrave
Kacie L. McCarthy
J. Travis Mulliniks

Summary with Implications

Reproductive performance in young 2- and 3-yr-old cows are often the lowest in the cow herd, which is due to their inability to consume enough energy and protein to meet their requirements for growth and lactation. A 3-yr study was conducted to evaluate the effects of postpartum supplementation strategy on reproduction, cow body weight, and calf performance in lactating young 2- and 3-yr-old May-calving range cows. Supplementation was initiated 30 d prior to the start of the breeding season (45-d postpartum) and continued throughout the 45-d breeding season (125-d postpartum). Supplementation was provided daily with treatments being: 1) mineral supplement alone, 2) mineral with an additional 0.5 lb/d of a high rumen undegradable protein source (porcine blood meal and hydrolyzed feather meal), or 3) dried distiller grains. Supplementation strategy did not influence changes in cow body weight or body condition score. However, reproductive performance in cows receiving either the mineral with RUP and the dried distiller grains cows were increased over the mineral alone, which demonstrates the need to increase metabolizable protein supply during the breeding season to positively impact reproduction in young, May calving cows.

Introduction

Young May-calving cows grazing primarily native upland range in the Nebraska Sandhills can experience a negative energy balance (NEB) postpartum and throughout the breeding season, which can lead to a decrease in reproductive performance. Historically, pregnancy rates in young May-calving cows at GSL have been low, averaging 74%, which creates long-term profitability challenges. As summer months progress, maturing native upland range forages lead to deficiencies in both energy and metabolizable protein (MP) (*2019 Nebraska Beef Cattle Report*, p. 5–7). In addition, meeting nutrient requirements of summer calving herds can be a challenge due to the location of summer grazing pastures. Therefore, the objective of this study was to determine the effects of supplementation strategy on reproduction, cow body weight, and calf performance in lactating young May-calving range cows.

Procedure

This study was conducted over a three-year period (2020 to 2022) utilizing 2- and 3-yr-old range beef cows from the May-calving herd at the University of Nebraska Gudmundsen Sandhills Laboratory (GSL) located near Whitman, NE. Cows (n = 167) were Husker Reds (5/8 Red Angus, 3/8 Simmental) and were stratified by calving date, cow body weight, and age, and assigned randomly to a supplementation treatment. Supplementation was initiated 30 d prior to the start of the breeding season (45-d postpartum) and continued throughout the 45-d breeding season (125-d postpartum). Supplementation was individually fed and daily with treatments being: 1) mineral with no additive for a negative control at a targeted rate of 4 oz/d (**MIN**; Ag Valley CO-OP, North Platte, NE), 2) MIN (4 oz/d) with an additional 4 oz/d of porcine blood meal and 4 oz/d of hydrolyzed feather meal with a total daily target of 12 oz/d (90% CP, **SMP**; Ag Valley CO-OP, NE), or 3) dried distiller grains at a rate of 2 lb/d (30% CP, **DDG**; Central Valley Ag, Ainsworth, NE). The SMP and DDG supplemental treatments were designed to provide similar amount of crude protein with DDG supplying increased dietary energy and SMP supplying increased RUP supply. The rationale for the design of SMP was aimed to establish a protein-dense self-fed supplement that could substitute hand feeding DDG multiple times per week.

Approximately d 40 postpartum, cow body weight (BW) and body condition score (BCS; 1 = emaciated, 9 = obese) by palpation were measured and recorded biweekly. Approximately d 80 postpartum, cows were synchronized with a controlled internal drug releasing (CIDR) device (Eazi-Breed CIDR, Zoetis Inc, Kalamazoo, MI) with a 7-d CO-Synch + CIDR protocol. On d 0 of the synchronization protocol, cows received 2 mL i.m. of GNRH (Fertagyl, Merck, Kenilworth, NJ) and a CIDR insert. On d 7 CIDR inserts were removed and 5 mL of PGF_2 (Estroplan, Parnell Technologies, Overland Park, KS) was administered. Artificial insemination (AI) was conducted approximately 65 hr after CIDR removal, with administration of 2 mL GnRH for fixed time AI. Fertile bulls were introduced 7 d after AI for natural service and removed d 45 of the breeding season. Cow pregnancy diagnosis was detected via transrectal ultrasonography and rectal palpation 35 d following bull removal. Calves were weighed at birth, ~ 60 d of age, and at weaning. Calf BW at 60 d and weaning were adjusted for a 60-d and 205-d BW with no adjustments for sex of calf or age of dam.

Data were analyzed as a randomized block design using the MIXED procedure (SAS Inst. Inc., Cary, NC, USA) with cow as the experimental unit using the Kenward-Roger degrees of freedom method. The model included fixed effects of year, age, treatment, calf sex, and their interactions. Separation of least squares was performed by the PDIFF option in SAS when a significant ($P \leq 0.05$) effect was detected. Significance level was set at $P \leq 0.05$.

Results

Cow BW and BW change were not influenced ($P \geq 0.52$) by postpartum

Table 1. Effect of postpartum supplementation strategy on cow BW, BW change, BCS, reproductive performance, and calf performance in young range May-calving cows

	Supplement[1]				
Measurement	MIN	SMP	DDG	SEM	*P*-value
Cow body weight, lb					
Start of supplementation	949	947	948	17	0.72
Begin of breeding	972	988	980	16	0.92
End of supplementation	951	964	958	17	0.92
Weaning	908	926	922	16	0.84
Cow body weight change, lb					
Begin of supplementation to breeding	23	41	32	19	0.95
Begin of supplementation to end of supplementation	2	17	10	13	0.88
Begin of supplementation to weaning	-41	-21	-26	12	0.52
Body Condition Score					
Begin of supplementation	5.5	5.5	5.5	0.04	0.39
Begin of breeding	5.6	5.5	5.5	0.05	0.47
End of supplementation	5.5	5.4	5.5	0.05	0.14
Weaning	5.2	5.2	5.3	0.06	0.31
Reproductive Measurements					
AI conception rate, %	50	52	55	3	0.37
Pregnancy rate, %	84[a]	93[b]	93[b]	2	0.04
Calf body weight, lb					
Birth	65	67	65	2	0.24
60 d	206	220	207	12	0.79
205 d	447	453	461	11	0.71

[1]Supplements: MIN =4 oz/d of mineral; SMP = 4 oz/d blood meal + 4 oz/d feather meal + 4 oz/d mineral; DDG = 2 lb/d dried distiller grains

supplementation strategy from start of supplementation until weaning. Cows in all treatments maintained a positive energy balance (i.e., gained or maintained BW) until the end of supplementation where cows lost BW until weaning. Similar to cow BW, cow BCS was not influenced ($P \geq 0.14$) by supplemental strategy. Postpartum supplementation did not influence ($P = 0.37$) fixed time AI pregnancy rates. However, overall pregnancy rates were influenced ($P = 0.04$) by postpartum supplementation. Cows that received SMP or DDG had the greatest pregnancy rates, whereas MIN cows had the lowest. Calf BW at birth, 60 d, and 205 d were not influenced ($P \geq 0.24$) by dam's supplemental treatment.

Conclusion

Supplementation strategy did not influence any changes in cow BW or BCS. Therefore, the increase in reproductive performance in SMP and DDG cows were uncoupled from changes in BW or BCS. Comparing SMP and DDG, the additional energy in the DDG did not result in increased performance, which illustrates the benefit of increasing metabolizable protein supply on reproduction. These results illustrate that a self-fed high RUP supplement mixed with a mineral supplement can be strategically utilized in cow-calf operations that have challenges in feeding young range cows multiple times per week to increase reproductive performance.

Nicole M. Woita, graduate student.

Selby L. Boerman, graduate student.

Jacki A. Musgrave, research technician.

Kacie L. McCarthy, cow-calf extension specialist, Lincoln.

J. Travis Mulliniks, range nutritionist, West Central Research and Extension Center, North Platte.

Vitamin A in Cow-Calf Production

Impacts of Maternal Supplementation and Status on Offspring

Hannah F. Speer
Harvey C. Freetly
Karla H. Wilke
Mary E. Drewnoski

Summary with Implications

The young calf is at greatest risk of vitamin A deficiency when cow vitamin intake is low in late pregnancy. Two studies were conducted to evaluate the relationship between cow and calf vitamin A status and how vitamin A status of cow-calf pairs was influenced by maternal vitamin A supplementation. In general, calves did not have adequate liver vitamin A concentrations despite cows having adequate liver vitamin A stores following calving. Both cow liver stores and cow vitamin A intake during late gestation influence the amount of vitamin A in colostrum, so it benefits the calf if the cow has both adequate liver vitamin A stores and receives adequate supplemental vitamin A in late gestation. Current supplemental vitamin A recommendations provided to cows fed stored feeds for a year or more do not result in adequate beef cow or calf liver vitamin A concentrations. USDA is an equal opportunity employer and provider.

Introduction

Vitamin A has several important roles in the body. It is well-known for its role in vision, but it is also important for proper immune function and epithelial integrity, specifically in the gastrointestinal and respiratory tracts. Clinical deficiency is unlikely to occur in most cases, but marginal deficiencies can still impact calf health and potentially cow productivity. Calves are born with very low vitamin A stores, and their primary source of vitamin A is colostrum. Vitamin A concentrations in colostrum have been reported to be six to fourteen times greater than that of milk, so colostrum is critical for establishing vitamin A stores in the young calf. Calves not getting enough vitamin A from colostrum are at increased risk for diarrhea and respiratory disease in their first one to two weeks of life.

Fresh green forage contains high amounts of beta carotene, a vitamin A precursor. It is used by the cow to synthesize the vitamin A needed to support a variety of biological functions. Excess vitamin A can be stored in the liver and used during times when dietary vitamin A intake is low. Cows fed diets consisting primarily of stored forages and concentrates may be at risk for vitamin A deficiency because these feedstuffs are low in beta carotene. Low amounts of vitamin A in the cow's diet during late gestation which may lead to a deficiency in the calf and impact its health. There is minimal placental transfer of vitamin A, so calves at birth rely on colostrum to supply vitamin A. The objectives of these studies were to identify the relationship between cow and calf vitamin A status using plasma and liver samples, and to understand the effect of amount of supplemental vitamin A provided from mid-gestation to early lactation on liver vitamin A concentrations in the cow and her calf.

Procedure

Experiment 1

The study was conducted at the U.S. Meat Animal Research Center near Clay Center, Nebraska. Multiparous beef cows that had previously been grazing on pasture (6.4 ± 1.2 years of age; n = 120) in mid-gestation were assigned to receive 9,638 IU/d vitamin A (n = 30) or 24,973 IU/d vitamin A (n = 90). These amounts were approximately one-third and two-thirds of the current recommendation of 1,273 IU/lb DM (33,000 IU/d in this study) for gestating beef cows weighing 1,300 lb consuming 2.0% of body weight in DM per day. Cows were individually supplemented in Calan gates from 111 days pre-calving to 32 days post-calving. Their diet consisted of alfalfa hay, corn silage, and a pellet that contained supplemental vitamin A, which was provided as retinyl acetate. Basal diet vitamin A concentration was calculated to be 223 IU/lb DM based on its beta carotene content, so mean vitamin A intake from the basal diet was 4,583 ± 649 IU/d. For assessing vitamin A status, liver biopsies and blood samples were collected at day 0 (111 days pre-calving) and day 144 (32 days post-calving), and calves were sampled at 32 ± 7 days of age. Vitamin A concentrations, measured as retinol, were analyzed in plasma and liver, and Pearson correlations were used to test for linear relationships between cow liver and plasma retinol concentrations, calf liver and plasma retinol concentrations, and liver retinol concentrations between the cow and her calf.

Experiment 2

This study took place at the Panhandle Research and Extension Center in Scottsbluff, Nebraska. Multiparous beef cows (n = 54) that had been fed in the drylot for a year or more were stratified by body condition score and time in the drylot and assigned to a pen. Pens (n = 9) were then randomly assigned to receive 1 of 3 amounts of supplemental vitamin A: the current recommendation for gestating beef cows (31,000 IU/d; 1X), 3 times (93,000 IU/d; 3X), or 5 times the current recommendation (155,000 IU/d; 5X). The 1X treatment was set in this study assuming a cow weight of 1,200 lb that consumed 2.0% of body weight in DM per day. Prior to treatment initiation, all cows were receiving 31,000 IU/d (1X). Treatments were initiated in mid-gestation and concluded 32 days post-calving. Cows were limit-fed a diet consisting of wheat straw, corn silage, and wet distillers grains. Vitamin A, as retinyl acetate, was added to the diet via a micronutrient machine. Liver biopsies were collected for retinol analysis on cows 24 days before treatment initiation, d 40 and d 81 of

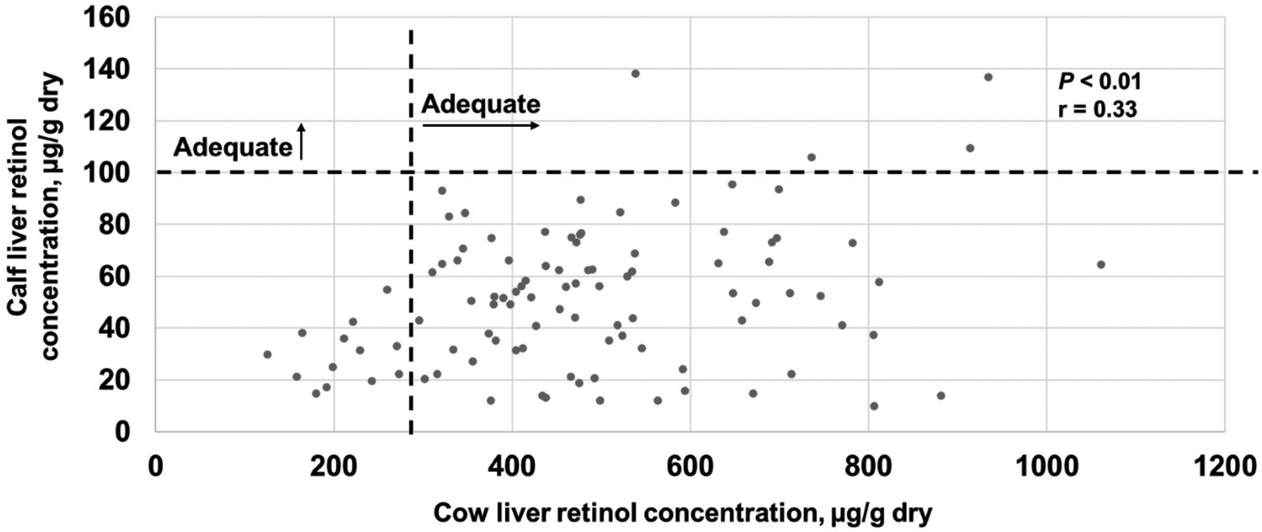


Fig. 1. Relationship between cow and calf liver retinol concentrations measured 32 days post-calving from Experiment 1. Dashed lines indicate the liver retinol concentration considered adequate for cows (300 µg/g DM) and calves at 32 days of age (100 µg/g DM).

supplementation, and both cows and calves were sampled 32 d post-calving (mean 165, SD 22 d of supplementation).

Results

Experiment 1

Because cows had recently spent time on green grass, initial liver retinol concentrations (mean 830 µg/g DM) of cows were well above adequate. By 32 days post-calving, mean cow liver retinol concentration (482, SD 182 µg/g DM) had decreased but was still considered adequate based on the current reference range of 300–700 µg/g DM. Cow plasma retinol (mean 272, SD 40 ng/mL) was slightly below the reference range of 300–800 ng/mL. No linear relationship (P = 0.10; r = 0.16) was observed between liver and plasma retinol in cows, which is not surprising because plasma retinol concentrations are tightly regulated and will not fluctuate unless liver vitamin A concentrations are very low. A positive correlation (P < 0.01; r = 0.37) was detected between calf liver (mean 51, SD 27 µg/g DM) and plasma (mean 190, SD 47 ng/mL) retinol concentrations. Both were below what would be considered adequate (100–350 µg/g DM in liver; 225–325 ng/mL in plasma) for calves at 32 days of age. It is suspected a correlation was observed here because most calves had liver retinol concentrations less than 100 µg/g DM (Fig. 1), which may have been too low to allow the calves to maintain adequate plasma retinol concentrations.

There was a positive correlation (P < 0.01; r = 0.31) between cow and calf liver retinol 32 days post-calving (Fig. 1), suggesting that as cow retinol liver concentrations increased, calf liver retinol concentrations increased. However, it appears that despite cows having adequate liver retinol concentrations, when supplemental vitamin A was fed below current recommendations, it did not result in calf liver retinol stores considered adequate given current reference ranges. This is likely because cow liver retinol stores are not the only contributor to vitamin A in colostrum. Research in beef cattle indicates cow stores only contribute about 40% of the vitamin A found in colostrum, while the other 60% comes from the cow's diet. Therefore, dietary vitamin A the cow receives during late gestation, as well as her liver vitamin A stores, affect the amount of vitamin A her calf receives via colostrum to build its own liver vitamin A stores.

Experiment 2

No differences (P = 0.86) in initial cow liver retinol concentration (mean 186 µg/g DM; Fig. 2) were observed between treatments. Cows were receiving the 1X amount of supplemental vitamin A before the study, suggesting the current supplemental vitamin A recommendation of 31,000 IU/d was not enough to get cows to adequate liver retinol concentrations (300–700 µg/g DM). A significant treatment × day interaction (P < 0.01) was observed for cow liver retinol. On d 40, cows in 1X had liver retinol concentrations (178 µg/g DM) that were not different (P = 0.12) from 3X (213 µg/g DM) but less (P = 0.02) than 5X (241 µg/g DM), while 3X and 5X did not differ (P = 0.21). Liver retinol on d 81 was lower (P < 0.05) in 1X (189 µg/g DM) compared to 3X (334 µg/g DM) and 5X (412 µg/g DM), which did not differ (P = 0.20). For cow liver retinol 32 days post-calving, 1X (187 µg/g DM) was less (P < 0.05) than 3X and 5X, and 3X (454 µg/g DM) was less (P < 0.05) than 5X (674 µg/g DM). Liver retinol concentrations of 1X cows remained below adequate reference ranges (300–700 µg/g of DM) throughout the study, whereas 3X and 5X were elevated into the adequate range by d 81 of supplementation.

Calf liver retinol concentration also differed among treatments (P = 0.01; Fig. 3), as calves of cows in 1X had lower (P < 0.05) liver concentrations than 3X and 5X calves which did not differ (P = 0.12). Liver retinol concentrations considered adequate for calves at 32 days of age (100–350 µg/g of DM) were not observed in 1X calves (51 µg/g DM) but were observed in calves from 3X and 5X cows (119 and 165 µg/g DM, respectively).

Conclusion

A cow with adequate liver vitamin A stores at the time of calving does not ensure

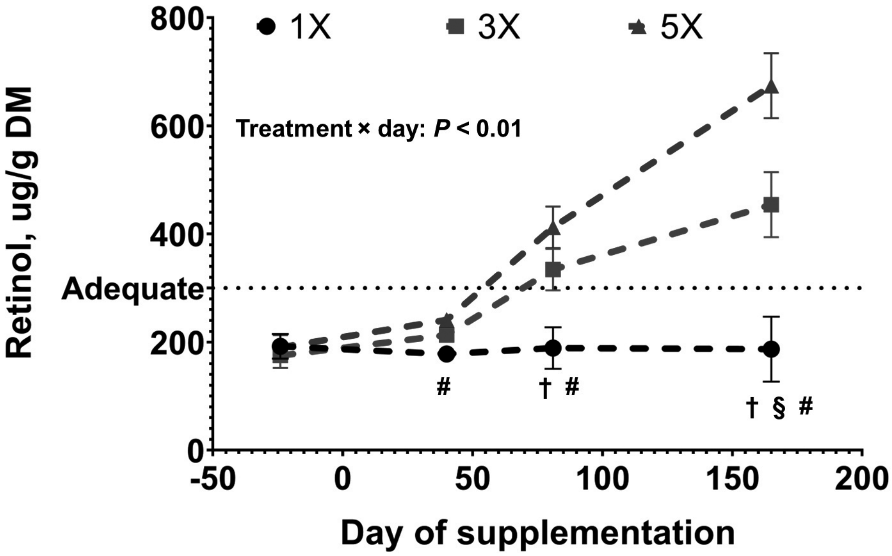


Fig. 2. Effect of amount of supplemental vitamin A [1X = 31,000 IU/d (current recommendation), 3X = 93,000 IU/d, and 5X = 155,000 IU/d] on cow liver retinol concentrations throughout Experiment 2. Initial liver concentrations were measured 24 days prior to treatment initiation (average 149 days before calving), and Day 165 concentrations were measured 32 days post-calving. Supplementation began on Day 0. Dashed line indicates the liver retinol concentration considered adequate for cows (300 µg/g DM). Significant differences ($P \leq 0.05$) between treatments within time point denoted as follows: † (1X vs. 3X) § (3X vs. 5X) # (1X vs. 5X)

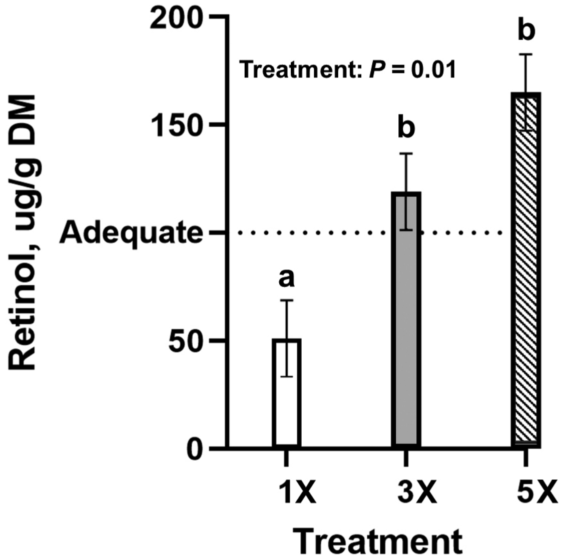


Fig. 3. Effect of cow supplemental vitamin A amount [1X = 31,000 IU/d (current recommendation); 3X = 93,000 IU/d; 5X = 155,000 IU/d] on calf liver retinol concentration at 32 days of age in Experiment 2. Dashed line indicates the liver retinol concentration considered adequate for calves at 32 days of age (100 µg/g DM). [a,b] Means lacking a common superscript differ ($P \leq 0.05$).

that the calf will also have adequate liver vitamin A stores. These results suggest that for cows fed stored feeds long term (1 year or longer), the current recommendation for supplemental vitamin A will not result in their calf's liver vitamin A concentrations being within the adequate reference range. These data also suggest that cows with initially low liver retinol stores needed to be fed 93,000 IU/d (3 times the current recommendation) of vitamin A for 81 days to achieve adequate liver retinol concentrations. However, continuing to feed this amount did appear to result in continuously increasing liver stores. More research is needed to understand the quantity of supplemental vitamin A required to maintain cow liver retinol concentrations in the adequate range and ensure adequate concentrations in the colostrum for the calf.

Hannah F. Speer, graduate student.

Harvey C. Freetly, scientist, U.S. meat Animal Research Center, Clay Center, NE.

Karla H. Wilke, professor, Panhandle Research and Extension Center Scottsbluff.

Mary E. Drewnoski, associate professor Animal Science, Lincoln.

Effect of Methionine Supplementation During Late Gestation in Beef Females

Landon F. Tadich
Jim R. Teichert
Kathryn J. Hanford
Jackie A. Musgrave
Rick N. Funston

Summary with Implications

Some amino acids are known to be essential to cattle and effect protein availability to the animal, especially during gestation when nutrient requirements are higher. Methionine is found to be one of the most limiting in low quality forage diets. Two 3- yr studies were performed to evaluate the impact of methionine supplementation during late gestation on intake, body weight, average daily gain, and subsequent calf performance in primiparous and multiparous females. In exp 1, 120 artificially inseminated pregnant heifers were placed in a Calan gate feeding system (n= 40/yr) and assigned 1 of 3 treatments during late gestation and fed ad libitum grass hay with either: no supplement, 2 lbs. distillers based supplement, or 2 lbs. distillers based supplement with 1 oz of rumen protected methionine. In exp 2, multiparous cows on upland winter range were fed 1 of 5 treatments: no supplement, ad libitum meadow hay, 1 lb. of a distiller's based cube, 2 lb. of a distiller's based cube, or 2 lb. of a distiller's based cube plus 1 oz of a rumen protected methionine. Body weight, body condition score, reproductive responses, and subsequent calf performance were recorded in both studies. No differences were observed in calving performance or progeny carcass characteristics in either experiment in response to methionine supplementation, so it may not be a necessary supplementation strategy.

Introduction

Gestational nutrition is crucial to both the dam and progeny during pregnancy, and the success that they have following parturition. While supplemental nutrient requirements may change drastically across production systems, it is important to both fulfill requirements while not over supplementing. A well balanced supplemental strategy must be well understood and utilized. Some research (*2023 Nebraska Beef Report*, pp. 13–15) has suggested that beef heifer development systems that developed heifers to lower body weights (BW) have little to no impact on reproduction, while reducing production cost for the producer. In the Nebraska Sandhills, low input development systems often involve wintering heifers post-weaning on native range preceding the breeding season. This often involves bringing heifers into a dry lot scenario to be synchronized, supplemented energy, and artificially inseminated before being placed with bulls on summer range. With methionine levels found to be low in most forage based diets; it is a combination of these factors that suggest rumen protected methionine supplementation may benefit growth in younger heifers. In addition to benefiting the immature dam, supplementation may also have the potential to influence both terminal progeny's quality and growth potential, and reproductive efficiency in female progeny entering the herd as replacements through epigenetic factors.

Procedure

Primiparous Heifers in Calan Gates

In experiment 1, 120 (n= 40/yr) randomly selected AI-pregnant Angus crossbred heifers were utilized at the West Central Research, Extension, and Education Center (WCREEC), North Platte, NE. Heifers were placed in 1 of 4 pens (10 headgates per pen) in a Calan Broadbent (American Calan, Northwood, NH) individual feeding system. Heifers were allowed a 20 d acclimation period before beginning the 90 d trial beginning at approximately 170 d of gestation. Following the acclimation period, heifers were stratified by age, AI sire, BW, and pen and assigned to 1 of 3 treatments from late October to early February: ad libitum grass hay with either no supplement (CON), 2lb distillers based supplement as is (DDG), or 2lb distillers based supplement with 1oz of a rumen protected methyl hydroxy analog as MFP (Novus, St Charles MO) (MET). Hay was offered twice daily with supplementation added once daily during the morning feeding. The amount of hay offered was recorded daily and based off previous feedings to allow for ad libitum intake. Feed refusals were collected once weekly and recorded. Dry matter intake was calculated by daily intake values and nutrient analysis conducted at Ward Laboratories (Kearney, NE).

After the feeding trial, all heifers were calved in a dry lot, pairs then grazed upland range in South Central Nebraska. At approximately 2 mo of age calves were branded, weighed, vaccinated, and males where castrated. Calves were limit fed a starter diet for 5 d at 2.0% BW before determining initial feedlot BW. There was a 21 day transition period on a backgrounding diet to a common feedlot diet. Backgrounding and finishing diets are shown in Table 1. Calves received a Synovex Choice (Zoetis; 200 mg of trenbolone acetate and 14mg of estradiol benzoate) at the start of the finishing period and were reimplanted with a Synovex Plus (Zoetis; 200mg trenbolone acetate and 24mg of estradiol benzoate) roughly 105 d later or 110 d before slaughter. Steers were weighed at the beginning of the finishing diet. Hot carcass weight was determined at slaughter and used to calculate final BW by using an average dressing percentage of 63%. Carcass characteristics were evaluated 24 h later.

Multiparous Cows on Upland Range

In experiment 2, 150 March calving multiparous cows (3/4 Red Angus, 1/4 Simmental) were utilized in a 3 yr study on upland winter range at the Gudmundsen Sandhills Laboratory, Whitman, NE.

Table 1. Composition of backgrounding and finishing diets of all calves in both experiment 1 and experiment 2

	DM, %	
Item	**Backgrounding**	**Finishing**
Dry rolled corn	15	48
Wet corn gluten feed	40	40
Hay	35	7
Supplement[1]	10	5
Nutrient analysis[2]		
CP, %	16.4	22.3
RUP, % CP	30.0	36.5
TDN	73.5	83.7
Crude fat, %	4.0	3.8

[1] Provided dietary concentration of .98 oz/ton of monensin and .35 oz/ton of tylosin (DM basis; Elanco Animal Health, Indianapolis, IN)

[2]Calculated values based on NRC estimated values and nutrient analysis of feed ingredients.

Table 2. Effect of methionine supplementation on intake, gain and calving performance in primiparous beef heifers (Exp 1)

Item	CON[1]	DDG[2]	MET[3]	SEM	*P*-value
N[4]	3	3	3		
Initial BW, lb	1021	1019	1027	19.79	0.78
Final BW[5], lb	1138[a]	1182[b]	1184[b]	32.54	<0.01
Treatment ADG, lb	1.24[a]	1.70[b]	1.70[b]	0.34	<0.01
Dry matter intake, lb	23.13	23.26	22.84	0.84	0.45
Gestation length, days	277	275	277	1.08	0.28
Birth Weight, lb	71	68	71	1.47	0.29
Calving ease[6], %	86	98	87	0.06	0.23
Calf Vigor[7]	84	78	76	0.07	0.72

[1]CON = heifers receiving ad libitum hay in a Calan gate individual feeding system twice daily with no added supplementation.

[2]DDG = heifers receiving 2 lb distillers based supplement once daily in the morning in addition to ad libitum hay in the Calan gate individual feeding system twice daily during the 90 d treatment period.

[3]MET = heifers receiving 2 lb distillers based supplement with 1oz of methionine as MFP once daily in the morning in addition to ad libitum hay in a Calan gate individual feeding system twice daily for the 90 d treatment period.

[4] Represents number of replications; 1 yr = 1 replication.

[5] Calculated from HCW and adjusted to a common dressing percent (63.0%).

[6] Percent of heifers with a calving score of 1. Calving ease scoring system: 1 = no assistance, 2 = easy pull, 3 = mechanical pull, 4 = hard mechanical pull, and 5 = Caesarean section.

[7] Percent of calves with a vigor score of 1. Calf vigor scoring system. 1 = nursed immediately, 2 = nurse on own, took some time, 3 = required some assistance to suckle, 4 = died shortly after birth, 5 = dead on arrival.

[a, b] Within each row, means without common superscripts differ (*P* < 0.05)

During late gestation over winter, cows were stratified by BW and age and then fed 1 of 5 treatments on 1 of 10 pastures that rotated annually : no supplement (NS), ad libitum meadow hay (HAY- average 7.4% CP, 58.4% TDN and 38.7% ADF), 1lb of a distillers based cube as is (DDG1), 2lb of a distillers based cube (DDG2), or 2lb of a distiller's based cube plus 1oz MFP (MET). The roughly 90 d treatment period began each year in early December and ended prior to calving in late February. Body condition score (BCS) and BW were recorded prior to the start of the treatment period in December, at the end of the treatment period prior to calving in late February, prior to breeding in May, and at weaning the first of November each year. Cows retained their treatment allocations each year of the study and were managed as a common group from calving until weaning each year. At the start of the breeding season each year, all cows were administered prostaglandin $F2^{a}$ (Lutalyse Highcon, Zoetis, Florham Park, NJ) 5 days after being placed on summer range with bulls at a bull to cow ratio of 1:17 for 45 days. Pregnancy determination was conducted via transrectal ultrasonography at weaning in early November each year. Calves were weighed within 24 hr of birth, prior to breeding and at weaning. Calves were vaccinated at birth, and at branding the beginning of May, bull calves were castrated and vaccinated. Following weaning, steer calves (yr 1, n = 62; yr 2, n = 62; yr 3, n = 48) remained in a dry lot with ad libitum hay for 2 weeks before being shipped 100 miles to a feedlot at the WREEC. Backgrounding and finishing diets are shown in Table 1. Weaned steer calves were treated the same as experiment 1.

Statistical Analysis

In Experiment 1, data were analyzed using the PROC GLIMMIX procedure in SAS 9.4 (Cary, NC USA). Variables were analyzed with a linear model that included the fixed effects of treatment and calf gender and random effects of yr, pen by yr and the residual Pre-treatment body weight was treated as a covariate when necessary. Pairwise differences were evaluated using the LSMEANS option in SAS. For Experiment 2, Data were analyzed with a repeated measures mixed-model analysis of variance using the PROC GLIMMIX procedure in SAS 9.4 (Cary, NC USA). Year and treatment were tested over the random yr by treatment effect. Cow post-treatment BW and BCS were analyzed with the same model with the addition of calf gender and December BW or BCS as a covariate. Pairwise differences were evaluated using the LSMEANS option in SAS using a Tukey's multiple comparison adjustment. Data were considered significant if $P \leq 0.05$ and tendency was considered if $P \leq 0.10$ but $P > 0.05$ for both studies.

Results

In Experiment 1, heifer BW, ADG, intake, and calving performance is summarized in Table 2. End of treatment BW and ADG was greater ($P < 0.01$) in DDG and MET heifers when compared to control. This was expected given the added protein and energy in DDG and MET diets. A lack of differences between these two groups

Table 3. Effect of methionine supplementation on subsequent calf performance in primiparous beef heifers (Exp 1)

Item	CON[1]	DDG[2]	MET[3]	SEM	P-value
N[4]	3	3	3		
Initial BW, lb	536[x]	538[x]	512[y]	10.25	0.09
Final BW, lb	1310	1290	1283	39.41	0.56
Finishing ADG, lb	3.50	3.42	3.50	0.20	0.45
Hot carcass weight[5], lb	825	811	806	25.20	0.56
Ribeye area, in^2	13.5	13.0	13.2	0.33	0.24
Marbling Score[6]	662	659	650	24.21	0.38
Yield grade	3.63	3.63	3.49	0.14	0.58
12[th] rib fat, in	0.73	0.71	0.67	0.03	0.43

[1]CON = calves whose dam's received ad libitum hay in a Calan gate individual feeding system twice daily with no added supplementation.

[2]DDG = calves whose dam's received 2 lb distillers based supplement once daily in the morning in addition to ad libitum hay in a Calan gate individual feeding system twice daily during the 90 d treatment period.

[3]MET = calves whose dam's received 2 lb distillers based supplement with 1oz of a methionine as MFP once daily in the morning in addition to ad libitum hay in a Calan gate individual feeding system twice daily for the 90 d treatment period.

[4]Represents number of replications; 1 yr = 1 replication.

[5]Calculated from HCW and adjusted to a common dressing percent (63.0%).

[6]500 = Small[0]

[x, y] Within each row, means without common superscripts differ ($P < 0.10$).

Table 4. Effect of Methionine supplementation on BW, body condition score, calving performance and pregnancy outcomes in multiparous beef cows (Exp 2)

Item	NS[1]	DDG1[2]	DDG2[3]	MET[4]	HAY[5]	SEM	P-value
N[6]	3	3	3	3	3		
Pretreatment BCS	5.21	5.19	5.22	5.04	5.27	0.07	0.26
Pretreatment BW, lb	1027	1043	1043	1014	1058	24.80	0.73
Precalving BCS	4.45[a]	5.00[b]	5.29[b]	5.18[b]	5.29[b]	0.07	<0.01
Precalving BW, lb	1012[a]	1091[b]	1118[b]	1118[b]	1157[c]	7.21	<0.01
Calf birth weight, lb	71	77	77	75	77	1.81	0.22
Prebreeding BCS	4.55	4.79	5.55	4.83	5.17	0.28	0.19
Prebreeding BW, lb	941[a]	974[b]	992[bc]	1003[bc]	1023[c]	7.36	<0.01
Pregnancy rate, %	81[a]	95[b]	94[b]	94[b]	94[b]	0.04	0.04
Weaning BCS	4.98	4.89	4.95	4.90	4.93	0.06	0.76
Weaning BW, lb	1087	1058	1118	1058	1098	26.63	0.48

[1]NS= cows that received no supplement while grazing dormant upland winter range in the Nebraska Sandhills.

[2]DDG1= cows grazing upland winter range that were supplemented 1 lb of a distillers based cube per hd/d throughout the treatment period.

[3]DDG2 = cows grazing upland winter range that were supplemented 2 lb of a distillers based cube per hd/d throughout the treatment period.

[4] MET= cows grazing upland winter range that were supplemented 2 lb of a distiller's based cube plus 1oz methyl hydroxy analog as MFP per hd/d.

[5]HAY= cows grazing upland winter range and provided ad libitum hay throughout the treatment period.

[6] Represents number of replications; 1 yr = 1 replication.

[8] Percent of heifers with a calving score of 1. Calving ease scoring system: 1 = no assistance, 2 = easy pull, 3 = mechanical pull, 4 = hard mechanical pull and 5 = Caesarean section.

[9] Percent of calves with a vigor score of 1. Calf vigor scoring system. 1 = nursed immediately, 2 = nurse on own, took some time, 3 = required some assistance to suckle, 4 = died shortly after birth, 5 = dead on arrival.

[a, b, c] Within each row, means without common superscripts differ ($P < 0.05$).

however may illustrate that sufficient levels of rumen degradable protein and rumen undegradable protein from the dried distiller's grain may be adequate supplementation. Methionine supplementation had no detectable impact on heifer ADG or BW during the prepartum treatment period. There were also no differences observed in DMI among heifers across the treatment period ($P = 0.38$). Length of gestation, calf birth weight, and calving performance data was also similar among treatment groups. Subsequent calf performance and carcass data is shown in Table 3. There was a tendency ($P = 0.09$) for MET calves to be lighter at the start of the finishing period (511 lb) compared to DDG (538 lb) and CON (536 lb) calves. Given that no other performance variables point to MET calves underperforming, there are two possible explanations for this response: a greater number of experimental units may lead to no observed differences between groups, or excess methionine led to hypermethylation and reduced growth during late gestation and early postnatal development. No differences were observed in final BW at time of slaughter, and carcass characteristics were similar among treatments.

In Experiment 2, cow BW and BCS were not different at the start of the treatment period. Prior to calving however, NS cows had significantly lower BCS and BW than all other groups ($P < 0.01$). Given the environmental challenges and low protein forages while grazing dormant winter range, this response is not surprising.
No differences were observed in calving performance, nor calf birth weights. While pre-breeding BCS were not significantly different among groups, differences were observed in pre-breeding BW ($P < 0.01$). Pregnancy rates for HAY (94%), MET (94%), DDG2 (94%), and DDG1 (95%) were significantly higher ($P < 0.01$) than NS (81%) cows. At weaning, no differences were seen among cow BW and BCS (Table 4). Progeny performance and carcass data is available in Table 5. At weaning, calves from NS dams had lower BW compared to DDG2 and MET cows ($P = 0.03$). No differences were observed in initial and final finishing weights. This challenges the findings in experiment 1 that suggest MET calves may be lighter at feedlot entry. Additionally, carcass data were similar among groups. There was however a tendency for calves

Table 5. Effect of methionine supplementation on subsequent calf performance in multiparous beef cows (Exp 2)

Item	NS[1]	DDG1[2]	DDG2[3]	MET[4]	HAY[5]	SEM	*P*-value
N[6]	3	3	3	3	3		
BW at breeding, lb	139[a]	157[b]	161[b]	152[ab]	161[b]	3.88	0.01
Weaning Weight, lb	465[a]	494[ab]	507[b]	487[ab]	511[b]	8.99	0.03
Initial BW, lb	578	602	624	625	617	12.32	0.13
Final BW[7], lb	1250	1279	1266	1281	1302	26.39	0.68
Finishing ADG, lb	3.66	3.70	3.75	3.64	3.79	0.07	0.66
Hot carcass weight, lb	783	803	820	805	820	13.89	0.30
Ribeye area, in^2	14.0	14.0	14.5	14.3	14.3	0.18	0.30
Yield grade	2.47	2.75	2.72	2.56	2.69	0.10	0.34
Marbling score[8]	509[x]	537[xy]	540[xy]	522[xy]	586[y]	17.90	0.09
12th rib fat, in	0.45	0.52	0.55	0.49	0.51	0.02	0.16

[1]NS= cows that received no supplement while grazing dormant upland winter range in the Nebraska Sandhills.

[2]DDG1= cows grazing upland winter range that were supplemented 1 lb of a distiller's based cube per hd/d throughout the treatment period.

[3]DDG2 = cows grazing upland winter range that were supplemented 2 lb of a distiller's based cube per hd/d throughout the treatment period.

[4] MET= cows grazing upland winter range that were supplemented 2 lb of a distiller's based cube plus 1oz methyl hydroxy analog as MFP per hd/d.

[5]HAY= cows grazing upland winter range and provided ad libitum hay throughout the treatment period.

[6] Represents number of replications; 1 yr = 1 replication.

[7] Calculated from HCW and adjusted to a common dressing percent (63.0%).

[8] 500 = Small[0].

[a, b] Within each row, means without common superscripts differ ($P < 0.05$).

[x, y] Within each row, means without common superscripts differ ($P < 0.10$).

from HAY cows to have greater marbling scores than calves from NS cows.

Conclusions

Ultimately, late gestation supplementation had limited detectable impact on dam and subsequent progeny performance. There is no question that winter supplementation strategies change drastically with environment and cow requirements based on the timing of the production system. Based on the results of the current study, the addition of methionine to late gestation diets in primiparous heifers had no impact on DMI, but heifers receiving distillers based supplement did gain more throughout the treatment period. Likewise, in the second study, cows receiving greater supplementation while grazing winter range had greater BW and BCS at critical timepoints throughout the production year whether that supplementation was in the form of hay, DDG, or DDG with methionine. This suggest that some supplementation strategy is warranted, and these findings support the belief that gestational nutrition does have an impact on progeny performance, however, more research is needed to further elucidate mechanisms influencing this process.

Landon F. Tadich, graduate student.

Jim Teichert, research technician.

Jackie A. Musgrave, research technician.

Kathryn J. Hanford, professor, statistics, University of Nebraska- Lincoln.

Rick N. Funston, professor, animal science, University of Nebraska- Lincoln West Central Research and Extension Center, North Platte, NE.

Long-term Performance of Steers Grazing Smooth Bromegrass Pastures

Table 1. Number of grazing days and precipitation (inches) data from 2005 to 2021

	Grazing Days	Month						Grazing Season Total Rainfall	Annual Total Rainfall
		Apr	May	Jun	Jul	Aug	Sep		
Minimum1	112	0.29	1.38	0.97	0.26	0.77	0.89	11.7	16.8
Maximum	168	4.92	7.87	9.89	7.22	10.2	7.66	32.7	42.3
17-yr average	**151**	**2.98**	**5.07**	**5.05**	**2.89**	**4.48**	**3.44**	**23.9**	**32.0**

[1] Minimum and maximum precipitation values are shown for each month and all months within a row are not from the same year; therefore, the sum of the months does not add up to the total listed for the grazing season.

Morgan Hodges
Holly Heil
Rebecca McDermott
Anastasios Mazis
Tala Awada
Galen Erickson
Andrea Watson

Summary with Implications

Body weight gain of yearling steers grazing smooth bromegrass pastures was measured across 17 years from 2005 to 2021. Three treatments were applied, (1) control pastures with no additional inputs, (2) pastures fertilized with 80 lb of N per acre, and (3) pastures grazed with cattle supplemented daily with approximately 5 lb of dry distillers grains. The control treatment pastures (1.4 acres/steer) were stocked 30% lighter than the fertilized and supplemented pastures (1.0 acre/steer). Across the 17 years, the supplemented cattle gained 2.24 lb/day while the non-supplemented cattle (both control and fertilized treatments) gained 1.57 lb/day. Body weight gain per acre was greatest for the supplemented cattle (358 lb/acre), intermediate for cattle grazing the fertilized pastures (251 lb/acre) and least for the control pastures (172 lb/acre). Fertilizing smooth bromegrass pastures directly or through supplementation of cattle improved land use efficiency in eastern Nebraska, while supplementation also improved cattle body weight gain.

Introduction

Land used for agriculture purposes has been steadily declining while agriculture production expenses, such as fertilizer, have increased, especially during the past two decades. Land use efficiency and utilization of economically advantageous management practices will be critical to the long-term survivability of agriculture operations. Moving forward, producers will need to factor energy costs, forage production, and animal performance into management decisions in forage-based livestock production systems. Backgrounding growing cattle on pasture prior to feedlot placement can be an economically favorable option due to fluctuating market conditions and grain prices.

Supplementation of dried distillers grains plus solubles (DDGS) can improve cattle weight gain, reduce forage intake, and result in excess nitrogen excreted on pastures. The objective of this experiment was to examine the long-term effects of DDGS supplementation and nitrogen fertilization on animal performance and pasture productivity. Seventeen years of cattle performance data were analyzed.

Procedure

This experiment was conducted at the Eastern Nebraska Research, Extension, and Education Center near Mead, NE. A randomized complete block design consisting of three blocks (pastures) and three treatments was used for this experiment. The following treatments were applied: 1) **SUPP**–calves grazed non-fertilized smooth bromegrass pasture and were supplemented daily with DDGS at 0.6% of body weight (BW) on a dry matter basis (adjusted throughout the grazing season for years 2005 through 2016 and set at 5 lb/day throughout the grazing season for years 2017 through 2021); 2) **FERT–**calves grazed smooth bromegrass pastures fertilized with 80 lb of N/acre; and 3) **CONT**–calves grazed unfertilized smooth bromegrass pastures without supplementation. At the start of the experiment, each pasture was divided into 3 sections with treatments assigned to these areas. The treatment assignments remained the same throughout the 17 years.

In late April, 45 steer calves weighing 730 ± 59 lb were identified from a pool of approximately 1,000 calves. Each year from 2005 through 2021, steers rotationally grazed smooth bromegrass pastures for a total of 17 grazing seasons. Within each year, cattle were stratified by BW and assigned to a group (n = 9). Groups were then assigned to one of three treatments with three replications per treatment and 5 calves in each group. The FERT and SUPP pastures were 4.97 acres and the CONT pastures were 7.17 acres. Cattle rotated through all pastures 5 times throughout the grazing season. In a few years, the grazing season was shortened due to weather events, a hailstorm in 2010 and drought conditions in 2012, 2013, and 2020. Precipitation data for the site are described in Table 1.

Table 2. Performance of yearling steers grazing smooth bromegrass pastures during the grazing season from 2005 to 2021

	Treatment1				
	CONT	FERT	SUPP	SEM	*P*-value
Initial BW, lb	728	728	726	14.2	0.80
Ending BW, lb	961[a]	966[a]	1065[b]	12.2	< 0.01
ADG, lb/d	1.56[a]	1.58[a]	2.24[b]	0.07	< 0.01
BW gain, lb/acre	172[a]	251[b]	358[c]	3.68	< 0.01
AUM/acre[2]	3.14[a]	4.55[b]	4.83[c]	0.16	< 0.01

[a,b,c] Means within a row with differing superscripts were significantly different ($P < 0.05$).

1Treatments include 1) SUPP—calves grazing non-fertilized smooth bromegrass pasture supplemented daily with DDGS at 0.6% BW on a DM basis; 2) FERT—calves grazing smooth bromegrass pastures fertilized with 80 lb N/ac; and 3) CONT—calves grazing unfertilized smooth bromegrass pastures without DDGS supplementation.

[2]AUM = animal unit month, calculated based on average body weight of steers divided by 1,000 lb standard animal unit and number of grazing days each year.

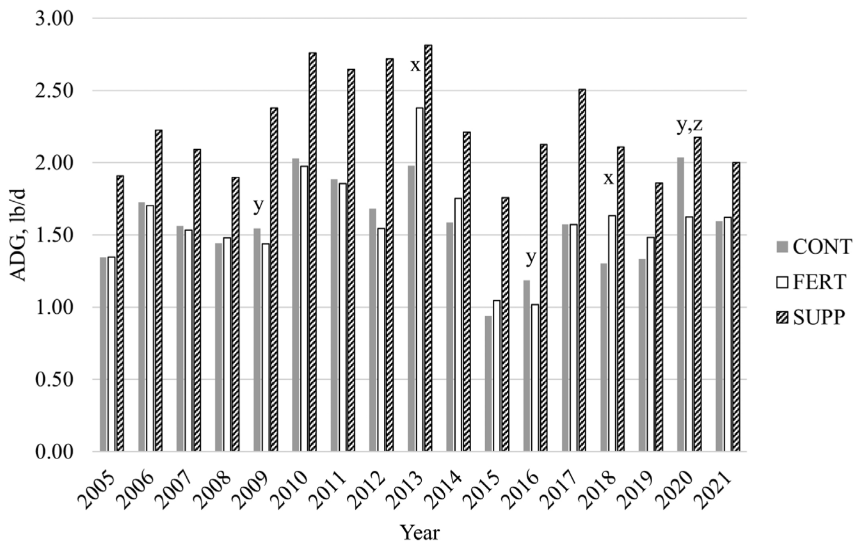


Fig.1. Average daily gain (lb) of yearling steers grazing smooth bromegrass pastures during the grazing season from 2005 to 2021. Main effects of year, treatment, and treatment × year interactions were significant ($P < 0.01$). Treatments include 1) SUPP—calves grazing non-fertilized smooth bromegrass pasture supplemented daily with DDGS at 0.6% of body weight on a DM basis; 2) FERT—calves grazing smooth bromegrass pastures fertilized with 80 lb of N/acre; and 3) CONT—calves grazing unfertilized smooth bromegrass pastures without DDGS supplementation. Across 12 years, the SUPP treatment had the greatest ADG ($P < 0.01$) while CONT and FERT treatments did not differ ($P = 0.60$). Five years deviated from this norm and are noted with x, y, and z superscripts. [x] Years that ADG of SUPP and FERT treatments were the same (2013, 2018; $P \geq 0.11$). [y] Years that ADG of FERT and CONT treatments differed (2009, 2016, and 2020; $P \leq 0.07$). [z] Years that ADG of SUPP and CONT treatments were the same (2020; $P = 0.43$)

Cattle did not receive an implant from 2005 to 2009. All cattle received a Revalor-G (Merck Animal Health) implant in 2010 through 2014 and 2017 through 2021. In 2015 and 2016 cattle received a Ralgro (Merck Animal Health) implant. Performance measurements were taken using five steer calves that remained on each pasture at all times. From 2005 through 2016 additional cattle were added or removed from the pastures as needed throughout the grazing season to manage grass growth. From 2017 through 2021, only 5 calves grazed in each group season long. Initial BW and ending BW measurements were taken following five days of cattle being limit fed at approximately 2% BW. The diet fed was 50% alfalfa hay and 50% Sweet Bran (Cargill Corn Milling, Blair, NE; DM basis). Measurements were taken in the morning before feeding daily for three days and averaged with adjustments made for BW gain during the weighing procedure.

Statistical analysis was performed using the GLIMMIX procedure of SAS. The model tested for effects of block, year, treatment, and year × treatment interactions for each response variable.

Results

Results discussed below are calculated from a total of 149 observations (9 observations per year for 17 years with 4 observations excluded). Excluded observations included one rep of the CONT treatment in 2017, due to 2 calves having to be removed from 1 pasture. In 2020 one replication (1 pasture, 3 treatments) was excluded due to an overlapping experiment that required different supplementation strategies. The number of grazing days per year averaged 151 days, with a low of 112 days in 2020 and a high of 168 days in 2009 and 2011.

Cattle performance data are summarized in Table 2. Year × treatment interactions ($P < 0.01$) and year effects ($P < 0.01$) were detected for ADG, ending BW, and BW gain. Initial BW did not differ between treatments ($P = 0.80$). Across all years, the SUPP cattle had the greatest ADG at 2.24 lb/d ($P < 0.01$). Average daily gain for CONT and FERT cattle were similar (1.56 and 1.58 lb/d, respectively; $P = 0.60$) across all years. Similar ADG of the FERT and CONT cattle demonstrates that forage availability was the same and appropriate paddock sizes were used for this experiment. However, treatment × year interactions were observed ($P < 0.01$) and there was variation in ADG. The CONT cattle ranged from 0.95 lb/d to 2.02 lb/d, while FERT and SUPP cattle ranged from 1.01 lb/d to 2.38 lb/d and 1.72 lb/d to 2.82 lb/d, respectively.

Average daily gain over time is summarized in Figure 1. Across the 17 years, there were 5 years that did not follow the same pattern as the overall summary. In 2009, 2016, and 2020, ADG of FERT was less than the CONT treatment ($P = 0.03$, $P = 0.07$, $P = 0.07$, respectively). In 2020, the CONT treatment had similar ADG to the SUPP treatment ($P = 0.43$), and both were greater than the FERT treatment ($P \leq 0.07$). In 2013 and 2018 the ADG of SUPP and FERT treatments did not differ (P = 0.24, P = 0.11, respectively), while ADG of the FERT treatment did not differ from the CONT ($P \geq 0.24$). Annual precipitation and grazing season precipitation levels were below the 17-year average (32.0 in and 23.9 in, respectively) in 2009, 2013, and 2020 and above the 17-year average in 2016 and 2018. This suggests in dry years the N fertilizer was not effectively used and the FERT treatment was at a disadvantage. In wetter than average years treatment differences were minimized, although timing of rainfall and temperatures also play a critical role. In all years, the DDGS supplement helped alleviate weather risks with cattle maintaining at least 1.7 lb/d ADG, at least partly due to protein supply.

Ending body weight (EBW) also differed among treatments ($P < 0.01$). As a result of the increased ADG, SUPP cattle also had the greatest EBW (1065 lb; $P < 0.01$). Increased ADG is likely a result of supplementation of both protein and energy in the DDGS. The FERT and CONT cattle had similar EBW ($P = 0.70$) at 966 and 961 lb, respectively. Body weight gain per acre was 172 lb/ac for CONT cattle, 251 lb/ac for FERT cattle, and 358 lb/ac for SUPP cattle ($P < 0.01$). Stocking rate was greatest for the SUPP treatment (4.83 AUM/ac) and least for the CONT treatment (3.14 AUM/ac; $P < 0.01$). These data indicate that pasture use efficiency is increased through DDGS supplementation and fertilization of pastures, with the SUPP treatment being the most productive per ac.

The chemical properties of the soil at this pasture site were measured in 2020 (0 to 8 in) and reported by Anastasios Mazis (2023 article in Agriculture, Ecosystems, and Environment). The pH of grazed CONT soils (5.97 ± 0.03) was greater than the grazed SUPP and FERT soils (5.83 ± 0.07 and 5.87 ± 0.06, respectively). Soil organic matter did not differ across all treatments at 4.30%. Soil nitrate did not differ between the SUPP (2.07 ± 0.12 ppm N) and FERT (2.13 ± 0.35 ppm N) treatments and was lower in CONT pastures, 1.60 ± 0.10 ppm N. Cation exchange capacity per 100 g (a measure of the soil's ability to hold onto essential nutrients with a greater number being better) differed between the CONT (17.30 ± 0.25), FERT (18.00 ± 0.41) and SUPP (18.43 ± 1.42) treatments. Mazis also found that fertilization improved pasture biomass, specific leaf area, leaf area index, and forage quality compared to the CONT. The use of N fertilization did not offer an advantage over DDGS supplementation.

Conclusion

Supplementing cattle daily with DDGS at 0.6% of BW on a DM basis demonstrated positive effects on cattle daily gain and ending body weight. Cattle supplemented with DDGS were also more resilient to changes in precipitation. This may serve as a risk management strategy that protects against the negative impacts that adverse weather conditions can have on cattle performance. Additionally, fertilizing pastures with 80 lb of N/ac and supplementing cattle daily with DDGS increased body weight gain per acre and improved carrying capacity of smooth bromegrass pastures.

Morgan Hodges, Graduate Student.

Holly Heil, Graduate Student.

Rebecca McDermott, Research Technician.

Anastasios Mazis, Graduate Student, School of Natural Resources.

Tala Awada, Professor, School of Natural Resources.

Galen Erickson, Professor.

Andrea Watson, Research Associate Professor, Animal Science, University of Nebraska, Lincoln.

Experiment funded as part of the USDA-ARS Long-Term Agroecosystem Research (LTAR) Network. These pastures are a part of the Platte River, High Plains Aquifer site.

Strategies for DDGS Supplementation Frequency to Grazing Yearling Steers

Sydney T. Vanderhoff
Rebecca L. Sjostrand
Mitchell M. Norman
Isaque F. Vicci
Jim C. MacDonald
Mary E. Drewnoski

Summary with Implications

Infrequent supplementation saves labor and may reduce animal performance, but recent research with reduced fat distillers grains has provided inconsistent results. This experiment evaluated the effects of daily and three times a week supplementation of dried distillers grains on yearling steer performance grazing smooth bromegrass pastures from May to August. Daily supplemented steers received 5.6 pounds of dry matter per steer of dried distillers grains with solubles 7 days/week. The three times a week supplemented steers received 13.0 pounds of dry matter per steer of dried distillers grains with solubles three days/week (Monday, Wednesday, Friday). A control treatment received no supplementation. Providing distillers grains supplement increased gain by 0.89 pounds per day compared to non-supplemented cattle. Daily supplementation of dried distillers grains increases gain by 0.31 pounds per day compared to three times a week supplementation and a non-supplemented control. Supplementing distillers gains three times per week may reduce ADG by 10% compared to daily supplementation.

Introduction

Supplemental rumen undegradable protein and energy may be provided in a forage-based production system during periods of limited forage quantity and/or quality. Supplementation can increase animal weight gain to meet desired performance but can also increase labor requirements. However, the labor needs for supplementation may be mitigated by reducing frequency of supplementation. A common supplement choice for grazing cattle is dried distillers grains (DDGS). Previous work done at the University of Nebraska observed that infrequent supplementation of DDGS reduced steer average daily gain (ADG) by 10% (*2003 Nebraska Beef Cattle Report*, pp 8–10). More recent work done at the University of Nebraska observed no differences in animal performance with daily vs. infrequent supplementation of DDGS (*2022 Nebraska Beef Cattle Report*, pp 26–27). Thus, infrequent supplementation may reduce labor costs but its impact on steer performance is unclear. Therefore, the objective of the study was to evaluate the performance of yearling steers grazing smooth bromegrass pastures supplemented dried distillers grains plus solubles (DDGS) either daily or three times per week.

Procedure

One hundred forty-four crossbred yearling steers (698 lb; SD = 2.75) were randomly assigned to one of twenty-four paddocks in a randomized generalized block design with three treatments. The blocking factor was pasture location. There were four pasture blocks, each containing six paddocks and two treatment replicates. Steers were weighed on three consecutive days after limit feeding a common diet of 50% alfalfa and 50% Sweet Bran at 2% of BW for ten days to minimize gut fill at the initiation and end of the grazing period. Steers were stratified by body weight and randomly assigned to paddock within pasture block.

The three treatments included a control treatment (CON) received no supplement, a daily treatment (DAILY) which received 5.59 lbs/steer (dry matter) of DDGS 7 days a week, and a three times per week treatment (ALT) which received 12.99 lbs/steer (dry matter) of DDGS Monday, Wednesday, and Friday. The DAILY treatment received 0.8% BW of supplement per day of initial BW and ALT received 1.86% of BW of supplement per day of initial BW. At the end of the week ALT received the same amount of supplement as DAILY. Limestone was included in the supplement at 2.25% diet DM. Supplement was delivered into a feed bunk to minimize waste. All steers were implanted with 40 mg trenbolone acetate and 8 mg estradiol (Rev-G; Merck Animal Health, De Soto, KS) at trial initiation. Paddocks were divided equally into three strips and rotationally grazed. Grazing was initiated May 4th & 5th with cattle removed from pastures August 8th, for a total of 97 grazing days. Put-and-take steers were utilized to match stocking rate with forage growth. One steer was added to each paddock and was removed on June 30. The performance of these steers was not included in the statistical analysis. Each treatment group rotated through three 2.00-acre strips per pasture. Pre-graze and post-graze biomass were measured in duplicate at ground level from each paddock at each rotation. Pre-graze biomass samples were used to determine forage availability.

Data were analyzed with MIXED procedure of SAS with paddock as experimental unit and treatment and block as fixed effects. Biomass was analyzed with repeated measures model of SAS with block and treatment measures repeated over Julian dates. Significance was declared at $P \leq 0.05$.

Results

The control calves gained 1.86 lb/d. Both DDGS treatments increased ADG compared to the control ($P < 0.01$; Table 1), with DAILY supplementation gaining 2.75 lb/d and ALT gaining 2.45 lb/d. However, the ADG was decreased ($P < 0.01$) with ALT compared to DAILY supplementation. The differences in ADG were reflected in similar differences in ending BW. The ending BW of both DDG treatments (DAILY = 961 lb, ALT = 933 lb) was greater ($P < 0.01$) than the CON treatment (878 lb). Accordingly, the ending BW of DAILY steers was greater

Table 1. Effect of daily or 3x weekly distillers grains supplementation on performance of grazing steers

	Treatments[1]				
	DAILY	ALT	CONTROL	SEM	P-value
Performance					
Initial BW, lb	698	699	700	2.75	0.96
Ending BW, lb	961[a]	933[b]	878[c]	6.23	<0.01
ADG, lb	2.75[a]	2.45[b]	1.86[c]	0.06	<0.01

[1]Treatments included daily (DAILY) DDGS supplementation fed at 5.6 lb DM per steer, alternate (ALT) DDGS supplementation fed 3x per week at 13.0 lb DM per steer, and a non-supplemented control (CONTROL).

[a,b,c] Means within a row with different superscripts differ (*P < 0.05*)

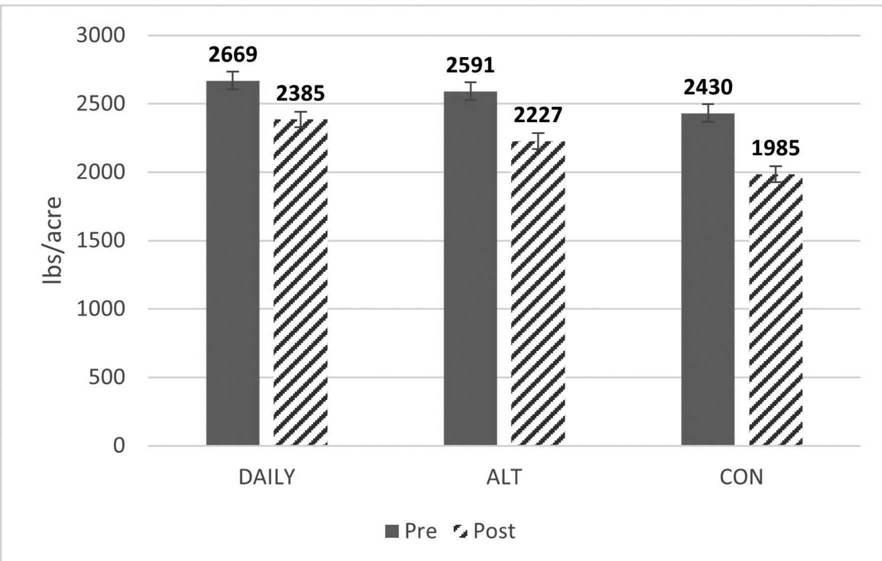


Figure 1. Pre and post graze biomass availability from 3 DDGS supplementation strategies of steers grazing Smooth Bromegrass paddocks1.

than ALT steers ($P < 0.01$). Therefore, daily supplementation of DDGS resulted in greater ADG and greater final BW when compared to three times a week supplementation and the non-supplemented control for steers grazing smooth bromegrass pastures. These results agree with past research (*2003 Nebraska Beef Cattle Report*, pp 8–10) with ALT supplementation of DDGS to heifers reducing ADG by 10.5% compared to DAILY. In the current study, pre-biomass of CON was lower when compared to DAILY ($P < 0.01$; Figure 1). Similarly, post biomass was reduced in control treatments compared to the supplemented treatments ($P < 0.01$; Figure 1) thus CON treatment may have consumed more forage than the supplemented treatments.

Conclusion

Providing supplemental DDGS increases ADG compared to non-supplemented steers, while infrequent supplementation reduces gain compared to daily supplementation by approximately 10%. Forage intake of supplemented steers is likely reduced compared to non-supplemented steers which may allow producers to increase the stocking rate of a pasture system. The economic and logistical viability of daily supplementation depends on the cost and availability of labor required to provide the supplement.

Sydney T. Vanderhoff, graduate student.

Rebecca L. Sjostrand, research technician.

Mitchell M. Norman, research technician.

Isaque Vicci De-Araujo, graduate student.

Mary E. Drewnoski, associate professor.

Jim C. MacDonald, professor, Department of Animal Science, University of Nebraska-Lincoln.

NOTES

1. Treatments included daily DDGS supplementation fed daily 5.6 lb DM per steer, alternate DDGS supplementation fed 3x per week 13.0 lb DM per steer, and a non-supplemented control

Pre: ALT vs CON *$P = 0.07$*, ALT vs DAILY *$P = 0.36$*, CON vs DAILY *$P < 0.01$*

Post: ALT vs CON *$P = 0.003$*, ALT vs DAILY *$P = 0.042$*, CON vs DAILY *$P < 0.01$*

Impact of Strip-Grazing Stockpiled Annual/Cover Crop Forages on Carrying Capacity and Animal Performance

Shelby L. Davies-Jenkins
Abigail Sartin
Devin Jakub
Zac Carlson
Erin Laborie
Jack Arterburn
Ben Beckman
Brad Schick
Mary E. Drewnoski

Summary with Implications

Annual forages/cover crops can be used to fill the fall/winter grazing gap, and strip grazing may increase carrying capacity by reducing trampling losses of the forage. The current experiment utilized a series of on-farm experiments across two growing seasons to compare continuous and strip grazing of various summer planted cover crops. Strip grazing increased carrying capacity by an average of 47 ± 15% and gain per acre by 44 ± 5% compared to continuous grazing although significant variability in the amount of increase was observed. This variability can likely be attributed to forage type (quality), frequency of moves, and forage allowance. Overall, strip grazing can be a valuable tool to increase carrying capacity when grazing summer planted cover crops during the fall and winter.

Introduction

Annual forages/cover crops can be used to fill the grazing gap in between perennial pasture in the fall and start of corn residue grazing. Currently, small cereal grains, warm season grasses, and brassicas are all commonly planted in the summer for fall/winter grazing. The cool season species (small cereals and brassicas) typically produce less forage than the warm seasons but are higher in quality.

Grazing management is a key component that impacts the profitability of grazing these annual forages. Strip grazing can increase forage utilization by allocating animals to a smaller portion of a larger paddock for relatively short times. When compared to continuous grazing, strip grazing has been shown to result in greater harvest efficiency and thus allowing more grazing from the same acres in perennial grass systems. However, this usually comes at the cost of reduced forage selectivity and thus reduced individual performance, such as reduced average daily gain for growing calves. Also, there may be an increase in labor needed to move fence with strip grazing.

Thus, a series of on-farm experiments were conducted over two growing seasons (2020 and 2021) in Nebraska to evaluate the effects of strip grazing on cattle performance when utilizing various annual forage resources during the late fall and winter.

Procedure

Research was conducted at 5 locations across the state of Nebraska (Table 1). One location in eastern NE had three groups of cattle that grazed their paddock continuously (CONT) and three that were strip grazed (STRIP) in each of the two years, while the remaining 4 locations each had one group that was continuously grazed and one group that was strip grazed. One of these four locations had data collected in both years and the other three only had data collected in a single year. The eastern NE location had replication within year, but used different forage types in each year. Thus, these data from the eastern NE locations were first analyzed to compare the effects of grazing management within year and then averaged within treatment and year replicates for a single value within year in a pooled analysis with the other locations. This was done to ensure that in the pooled analysis (n = 7 site years), all site years had a similar statistical weight to analyze the effect of grazing management across all locations.

Eastern Nebraska Year 1: Oats and Brassicas

Just prior to planting on August 12, 2020, an herbicide was applied to control weeds that grew after spring oats were harvested. Then the 93-acre irrigated field was no-till drilled with 50 lb/ac of Jerry oats and 3 lb/ac of Trophy rapeseed. Post emergence, nitrogen was applied at a rate of 38 lb/ac. The field received 1.6 ac-inches of water through a pivot during growth of the cover crop. The field was divided into 6 paddocks split between 2 treatments for a total of 3 replicates per treatment. Treatments were arranged in a completely randomized block design where paddock was the experimental unit. Paddocks were separated into 3 blocks with 2 blocks containing only irrigated land and 1 block which included dryland corners.

Steers (n = 84) were stratified by initial body weight (524 lbs) and assigned to 1 of 6 groups (n = 14 per group) that were assigned to a paddock. Seven of the 14 steers in each group were designated as testers and used to measure animal performance. Grazing began on November 12, 2020 and was terminated on February 3, 2021 (83 d) when the average forage height of CONT was 2 inches. The STRIP treatment groups were given access to new forage twice weekly, with a target of 2-inch post-grazing height and cattle were not back fenced. Steers grazing continuously had access to 15.5 ± 0.01 acres (1.11 acre/head) while STRIP calves used 8.5 ± 1.36 acres (0.60 acre/head).

Prior to grazing, forage was clipped at ground level and sorted by species to determine forage biomass and quality. Four locations (3 x 2 ft) in each of the irrigated paddocks and 5 locations of the paddocks containing the dryland corners were clipped (3 from the irrigated and 2 in the dryland portion of the paddock). On days 21, 41, and 70 of grazing, biomass was clipped again from 4 locations in each of the CONT paddocks. On these days for STRIP, 2 locations were clipped in the strip

Table 1. Summary of management of experiment sites located in Nebraska to evaluate the effect of continuous (CONT) vs. strip-grazing (STRIP) of summer planted annual forages in the fall/winter.

Site	Year	Planting Date	Species	Initial biomass lb/ac	Start Grazing Date	Treatment	Days grazed	Animal Type	Stocking density, lb BW/ac	AUM/ ac1	Increase in grazing capacity, %	Frequency of moves
East	2020	Early Aug	Oat and Rapeseed mix	4,356	Mid Nov	CONT	83	600 lb steer	560	1.48	-	-
						STRIP	83		21,000	2.75	86%	Twice a week
East	2021	Mid-July	17 species mix with millet and sunflower predominate	2,364	Early Dec	CONT	54	675 lb steer	675	1.20	-	-
						STRIP	54		13,235	1.70	42%	Twice a week
North west	2020	August	Oat and Turnip	-	Late Nov	CONT	44	1400 lb cow	1,225	1.53	-	-
						STRIP	38		9,224	2.12	39%	Once a week
North west	2021	August	Oat and Turnip	-	Early Nov	CONT	73	475 lb heifer	1,676	2.17	-	-
						STRIP	73		8,177	2.44	12%	Once a week
South west	2020	Mid-August	Oat and Rapeseed	989	Early Nov	CONT	7	1400 lb cow	1,300	0.28	-	-
						STRIP	16		5,040	0.61	118%	Twice a week
South central	2020	Early Aug	Oats and Rapeseed	1,164	Early Oct	CONT	26	1400 lb cow	790	0.76	-	-
						STRIP	26		5,287	0.87	14%	Once a week
North east	2021	August	forage sorghum, radish, turnip, pea, vetch, rye, oat, sunflower	2,108	Mid October	CONT	33	1400 lb cow	940	1.40	-	-
						STRIP	56		40,084	1.70	21%	Daily

[1]AUM = Animal Unit Month, a 1000-pound animal over a month of time

Table 2. Initial forage species composition and quality of oat-rapeseed mix grazed in the fall/ winter in Eastern NE Year 1: Oats and Brassicas

Forage type	Biomass, %	DOM[1], %	CP[2], %
Oats	74.5	70.5	8.4
Rapeseed	25.5	80.1	15.8
Forage as offered		72.3	10.3

[1]DOM = Digestible Organic Matter, a proxy for TDN (energy)

[2]CP = Crude Protein

that would be allocated and 2 locations from the grazed strip that was previously sampled for pre-graze biomass were taken to allow for a more accurate estimate of disappearance. No final biomass clippings were able to be collected as steers from an adjacent field grazed in the experimental paddocks prior to sample collection.

Forage samples were then dried for 48–72 hours in a 60°forced air oven to determine biomass and analyzed for crude protein (combustion method) and digestible organic matter (DOM) to determine quality. The DOM was determined by incubating samples in buffered rumen fluid for 48 hours to determine invitro organic matter digestibility (IVOMD) and then multiplying that by the organic matter content of the sample. This serves as an evaluation of the energy content of the forage and is a proxy for total digestible nutrients (TDN).

To determine the economics of grazing a partial budget analysis was conducted. Costs included seed ($10.80/ac), seeding ($12.00/ac), irrigation ($15.02/ac), nitrogen fertilizer ($15/ac) and nitrogen application ($8.75/ac), herbicide ($18.77) and herbicide application ($7.00/ac) and temporary perimeter fencing ($5.00/ac). Labor for moving the STRIP fence was charged at $20/hr and 0.5 hr per move per group ($28.04/ac). In total, continuous grazing costs were budgeted at $92.34 per acre while strip grazing was $120.38.

Eastern Nebraska Year 2: Diverse Annual Mix

In mid-July after wheat harvest, a 17 species mix which included warm and cool season grasses, legumes, and forbs was planted on 60 ac of irrigated land. No irrigation or nitrogen fertilizer was applied. The field was divided into six, 10 acre paddocks that were blocked by location in the field. Treatment (CONT or STRIP) was randomly assigned to paddock within block for a total of 3 replicates per treatment. Paddock was considered the experimental unit. The STRIP groups were allocated forage approximately twice a week, with new strips provided when approximately 40% of the forage had disappeared.

Steers (n = 60) were stratified by initial body weight (635 ± 0.71 lb) with 10 steers assigned to each paddock. Grazing was initiated on December 9, 2021 and terminated on February 1, 2022 (54 d) when the average forage disappearance of the CONT was approximately 40% of the biomass. Steers grazing continuously had access to 9.99 ± 0.01 acres (1 acre/head) while STRIP calves used 7.16 ± 1.21 acres (0.72 acre/head).

Forage clippings for biomass and quality analysis were collected prior to grazing initiation (pre-graze) and clippings for biomass analysis were collected following grazing termination (post-graze). Each paddock was divided into 5 equal parts and biomass was clipped from a random location (3 feet by 2 feet area) with each of the five zones. Following collection, forage samples were sorted by plant functional type and pre-graze samples were analyzed for quality as described previously.

A partial budget analysis was again conducted to determine the economics of grazing. Between treatments, costs kept consistent in the budget included seed ($50.00/ac), seeding ($12.00/ac), and temporary perimeter fence ($5.00/ac). Expenses applied only to STRIP paddocks included labor for moving the STRIP fence and was charged at $20/hr and 0.5 hr per move per group. In total, continuous grazing cost $67.00/ac while strip grazing cost $85.16/ac.

Pooled Analysis: Stockpiled Mixes Across Nebraska

A total of 4 additional locations, across 2 years were utilized for a total of 5 additional site years of the comparison of CONT to STRIP grazing of stockpiled cover crops (Table 1). An oat brassica mix (purple top turnips or rapeseed) was planted on 4 of the 5 site years with the remaining site year being planted to a mix of forage sorghum, radish, turnip, pea, vetch, rye, oat, and sunflower. Cows were utilized on 4 of the 5 site years with the remaining utilizing developing heifers. Grazing was initiated in the fall and was terminated when the producer felt that forage was limited.

Results

Eastern Nebraska Year1: Oats and Brassicas

The initial forage biomass was predominantly oats with the rapeseed comprising about a quarter of the forage available (Table 2). The amount of forage (initial biomass 4328 vs. 4383 ± 300 lbs/ac for CONT and STRIP, respectively) and energy content (DOM, % DM) of the forage offered were not different ($P \geq 0.58$) between CONT and STRIP. Both species were relatively high in energy with the rapeseed having almost double the amount of CP of the oats. As designed, the initial BW of steers did not differ ($P = 0.54$) between treatments (Table 3). Following grazing termination, STRIP steers were lighter ($P = 0.01$) due to lesser ADG (difference of 0.31 lb/d) than CONT steers. However, the STRIP steers were allotted about a third less acres per calf compared to CONT. Consequently, STRIP had increased ($P = 0.03$) carrying capacity with 82% more AUM/ac and increased gain per acre ($P = 0.02$) with 56% more lb of gain/ac than CONT. Though numerically there was a 10-cent decrease in cost per pound of gain for STRIP calves compared to CONT, this was not statistically significant ($P = 0.11$). This indicates that even though strip grazing might be more expensive on a dollars per acre basis, the additional gain will at minimum pay for the extra labor.

Eastern Nebraska Year 2: Diverse Annual Mix

Initial forage quality and portions of the biomass made up by various plant functional groups are shown in Table 4. Although 17 species were seeded, biomass composition predominantly consisted of pearl millet,

Table 3. Carrying capacity and performance of steers grazing an oat-rapeseed mix continuously (CONT) or strip-grazed (STRIP) over an 83 d period in the fall/winter in Eastern NE Year 1: Oats and Brassicas

Variable	CONT	STRIP	SEM	*P*-value
Initial BW, lb	524	524	0.6	0.54
Final BW, lb	687	661	2.7	0.01
ADG, lb	1.98	1.67	0.025	0.01
AUM/ac[1]	1.49	2.71	0.156	0.03
Gain, lb/ac	148	232	9.3	0.02
Cost of gain, $/lb	0.62	0.52	0.26	0.11

[1]AUM = Animal Unit Month, a 1000-pound animal over a month of time

Table 4. Initial forage species composition and quality of 17 species mix grazed in the winter in Eastern NE Year 2: Diverse Annual Mix.

Forage type	Biomass, %	DOM[1], %	CP[2], %
Grasses[3]	72.6	52.5	5.7
Grass seedheads[4]	12.6	65.1	9.9
Legumes[5]	4.4	66.1	17.1
Forbs[6]	8.6	45.6	6.8
Sunflower heads	1.8	63.9	10.9
Forage as offered	—	54.2	6.9

[1]DOM = Digestible Organic Matter, a proxy for TDN (energy)

[2]CP = Crude Protein

[3] mostly pearl, german and browtop millet

[4] german and browtop millet

[5] cowpea, mungbean, spring pea and vetch

[6] mostly sunflower stems

Table 5. Forage biomass and disappearance of summer planted 17 species mix when continuously grazed (CONT) or strip-grazed (STRIP) in the fall/winter in Eastern NE Year 2: Diverse Annual Mix

Variable	CONT	STRIP	SEM	*P*-Value
Initial biomass, lb/ac	2,509	2,219	213	0.44
Final biomass, lb/ac	1,358	1,367	51	0.91
Disappearance, lb DM/AUM[1]	963	523	208	0.28
	Disappearance, % change from initial biomass			
Grasses	36.0	29.3	10.2	0.69
Grass Seedheads	81.0	74.7	3.2	0.29
Forbs and legumes[2]	54.7	27.7	15.0	0.33
Sunflower heads	100	100	-	-

[1]AUM = Animal Unit Month = 1000-pound animal grazing over a month of time; calculated based on the weight and number of the grazing animals and duration of grazing; expected intake would be 702 lb of DM per AUM

[2]mostly sunflower stems

german millet, browntop millet and sunflower. At the start of grazing the german and browntop millets had fully developed seedheads with hand plucked samples containing 32% and 20% starch (DM basis), respectively. The sunflower heads had started to fill with seed and hand plucked samples contained 7.5% fat (DM basis).

Initial and final biomass were not different ($P \geq 0.44$) between treatments (Table 5). Calves were allowed to be selective with a target disappearance of 40% of the total biomass. Steers selected the sunflower heads (no heads remaining post-grazing) and grass seedheads [with the majority (78%) disappearing in the grazed areas]. Following the disappearance of the reproductive structures, calves appeared to select forbs and legumes then cool-season grasses. Disappearance (lb DM/AUM) was not different ($P = 0.28$) between CONT and STRIP.

The initial BW, final BW and ADG of steers did not differ ($P \geq 0.55$). The carrying capacity (AUM/ac) tended to be increased ($P = 0.10$) by 43% in STRIP whereas gain per acre was increased ($P = 0.02$) by 31% for STRIP over CONT. The cost of gain did not differ ($P = 0.56$) between treatments, again suggesting the increased harvest efficiency can pay for the increased labor.

Eastern Nebraska Year 1 vs. Eastern Nebraska Year 2

When grazing the oat/brassica mix in year 1, ADG of steers in the STRIP was reduced (16%) compared to the CONT. However, in year 2, there was no difference in ADG between treatments, although there was a numerical decrease (6%) in the STRIP. This difference in individual animal performance response could be a result of the greater forage quality found in the oats and brassica mix (73% DOM and 10.3% CP) compared to the 17 species mix (54% DOM and 6.9% CP) which resulted in high-

Table 6. Carrying capacity and performance of steers grazing a summer planted 17 way mix continuously (CONT) or strip-grazed (STRIP) over a 54 d period in the fall/winter in Eastern NE Year 2: Diverse Annual Mix

Variable	CONT	STRIP	SEM	*P*-value
Initial BW, lb	635	635	0.7	1.00
Final BW, lb	718	713	5.3	0.55
ADG, lb	1.54	1.45	0.08	0.55
AUM/ac[1]	1.20	1.71	0.13	0.10
Gain, lb/ac	83	109	2.9	0.02
Cost of gain, $/lb	0.81	0.78	0.03	0.56

[1]AUM = Animal Unit Month, a 1000-pound animal grazing for one month; calculated based on the weight and number of the grazing animals and duration of grazing

Table 7. Effect of continuously grazing (CONT) vs. strip-grazing (STRIP) stockpiled annual forages in the fall/winter on carrying capacity and forage disappearance over 7 site years

Variable	CONT	STRIP	SEM	*P* value
Initial biomass, lb/ac	2,288	2,104	605	0.27
Final biomass, lb/ac	940	802	259	0.16
AUM/ac	1.26	1.74	0.26	0.02
Disappearance, lb DM/AUM	1,643	767	544	0.20

[1]AUM = Animal Unit Month = 1000-pound animal grazing over a month of time; calculated based on the weight and number of the grazing animals and duration of grazing; expected intake would be 702 lb of DM per AUM

er gains in year 1 than year 2. It may also be due to differences in forage allocation. In year 1, the difference in forage offered per AUM between CONT and STRIP was greater than in year 2, however the amount of forage offered in the STRIP treatments were not vastly different. Forage offered in year 1 was 2943 lb/AUM for CONT and 1584 lb/AUM for STRIP. In year 2, the forage offered per AUM was 1970 lb/AUM for CONT and 1390 lb/AUM for STRIP. Altogether, these data show the benefit of strip grazing appeared to be greater in year 1 when there was a greater quantity and quality of forage available than in year 2. Though no direct comparison can be made from this study, strip grazing forages of higher nutritional value may provide greater gain on the same number of acres when compared to strip grazing forages of lower nutritional value.

Pooled Analysis: Stockpiled Annual Forage Mixes

Initial biomass varied greatly between sites and years (Table 1), but the average initial and final biomass was not different between CONT and STRIP (Table 7). The STRIP treatment had greater ($P = 0.02$) carrying capacity (AUM/ac) compared to CONT. In fact, across all the sites strip grazing increased carrying capacity by 47%, although this varied substantially ranging from an increase of 12% to 118%. Statistically, there was no difference ($P = 0.20$) in forage disappearance (lb DM/AUM) between the STRIP and CONT, although across sites STRIP numerically reduced disappearance per AUM by 53%. The expected intake per AUM is 702 lb of dry matter. This means that STRIP only lost an estimated 8.5% of forage to trampling loss compared to the CONT treatment which lost an estimated 57%.

Conclusions

Strip grazing increased carrying capacity and gain per acre when compared to continuously grazing stockpiled annual forages in the fall/winter. Variability in the response to strip grazing may be attributed to forage type, stocking density, frequency of moves, and how selective cattle are allowed to be when grazing (forage allowance). Overall, strip grazing can be a valuable tool to increase carrying capacity when grazing summer planted cover crops during the fall and winter.

Shelby Davies-Jenkins, graduate student.

Abigail Sartin, graduate student.

Devin Jakub, graduate student.

Zac Carlson, research technician.

Erin Laborie, extension educator, Beaver City, NE.

Jack Arterburn, extension educator, Rushville, NE.

Ben Beckman, extension educator, Hartington, NE.

Brad Schick, extension educator, Fullerton, NE.

Mary Drewnoski, associate professor, Animal Science, Lincoln.

This project was supported by funding from USDA North Central Region Sustainable Agriculture Research and Education through the grant ONC20–076 Balancing harvest efficiency and economics of grazing fall forage cove crops.

Cereal Rye, Winter Triticale or Winter Wheat
Which is Best for Early Spring Grazing?

Alyssa K. Hall
Abigail M. Sartin
Kallie J. Calus
Morgan T. Grabau
Daren D. Redfearn
Rob B. Mitchell
Mary E. Drewnoski

Summary with Implications

A study was conducted to determine which winter-hardy small cereal grain was best suited for early spring grazing. Three species were evaluated: winter wheat, cereal rye, and winter triticale, as a double-cropped forage in a continuous soybean rotation. Within this rotation the number of grazing days is limited, but all three species provided high rates of cattle weight gain, with an average daily gain (ADG) of 3 lb/d in April. However, in a year where freezing conditions occurring after cattle started grazing, cattle grazing cereal rye had the greatest ADG, likely due to greater forage growth. Thus, cereal rye may be a better choice if early spring grazing is the goal.

Introduction

The most common crop rotation used throughout much of the Midwest is a corn-soybean rotation. However, this rotation is not well-suited to double-cropping. Continuous soybean is not a common practice in eastern Nebraska, but the timing of soybean harvest lends itself to the incorporation of double-cropped forages. A disadvantage to continuous soybean is minimal residue coverage that can leave soils prone to erosion and nutrient loss. Adding winter annual, small grain forages after soybean can provide additional ground cover and provide supplemental forage and grazing opportunities. Winter wheat *(Triticum aestivum* L.), cereal rye *(Secale cereale* L.), and winter triticale (x *Triticosecale* Wittm. ex A. Camus) are the most common winter annual, small grain forages used for grazing in early spring. The objective of this study was to evaluate early spring grazing potential and animal performance of these species when used as a double-cropped forage in a continuous soybean rotation in eastern Nebraska.

Procedure

In this three-year study (year 1: 2019–2020, year 2: 2020–2021, year 3: 2021–2022), an 18-acre field was managed under a dryland, continuous no-till soybean system. A short-season variety (Group 1) soybean was planted in 30-inch row spacing. Soybeans are legumes that fix nitrogen in the soil, so no fertilizer was applied under the assumption that the soybean crop provided enough nitrogen for the small-cereal grains. After soybean harvest, the field was divided into nine 2-acre pastures where cereal rye, winter triticale, and winter wheat were each planted in 3 of the pastures. Small cereals were drilled in 7-inch spacing after soybean harvest with seeding rates of winter wheat 102 lb/ac pure live seed (PLS), cereal rye 88 lb/ac PLS, and winter triticale 108 lb/ac PLS. Year 1 and 2 used Pronghorn winter wheat, variety not stated (VNS) cereal rye, and NT11406 variety of winter triticale. In year 3, the same wheat and triticale varieties were used, but Rymin rye was used instead of VNS. The small cereals were planted on September 15th, September 22nd, and September 22nd in years 1, 2, and 3, respectively.

Growing steers were stratified by weight and assigned to 1 of 9 groups which were then randomly assigned to pasture. The average initial body weight of the steers was 673, 785, and 827 lb in year 1, 2, and 3, respectively. They were stocked at a density of 3 head/acre in year 1 and year 2, and at 2.5 head/acre in year 3 due to heavier steers and lack of precipitation. The 2-acre pastures were divided into two 1-acre paddocks that were rotationally grazed by their assigned group. Cattle were turned out when forage height reached 5-inches, and grazed paddocks until forage height was around 2-inches then were rotated to the other half of the pasture. Pre and post graze biomass samples were cut by hand at ground level from 4 locations in each paddock at each rotation to calculate forage yield.

A timeline of the grazing period in each year is shown in figure 1. In year 1, cereal rye treatments were turned out first on April 3rd, followed by wheat and triticale treatments on April 9th. Two of the three groups of steers grazing rye were removed on April 29th, due to limited forage availability and the remaining groups were removed May 8th to allow for planting of soybeans. This resulted in all three species having a grazing period of 29 days in year 1. In year 2, all treatments were turned out on April 6th. Some groups of cattle were pulled on April 21st, and the remaining were pulled on April 27th due to limited biomass, this resulted in 17, 18, and 19 grazing days for triticale, wheat, and rye, respectively. In year 3, all groups were turned out on April 12th and then removed on April 21st due to limited biomass. Cattle were returned to grazing on April 27th and then all groups were removed on May 6th due to limited biomass. All three species had 18 grazing days in year 3.

This was a completely randomized design where pasture was the experimental unit, and small cereal species was the treatment. There were 3 experimental units per treatment per year. Animal performance measures of average daily gain (ADG), gain per acre (GPA), and animal unit months per acre (AUM/acre) were analyzed using the MIXED procedure of SAS. Fixed effects were treatment, year, and interaction of treatment x year. Pre- and post- graze biomass were analyzed in SAS with rotation within year as a repeated measure. A P-value of ≤ 0.05 was considered significant.

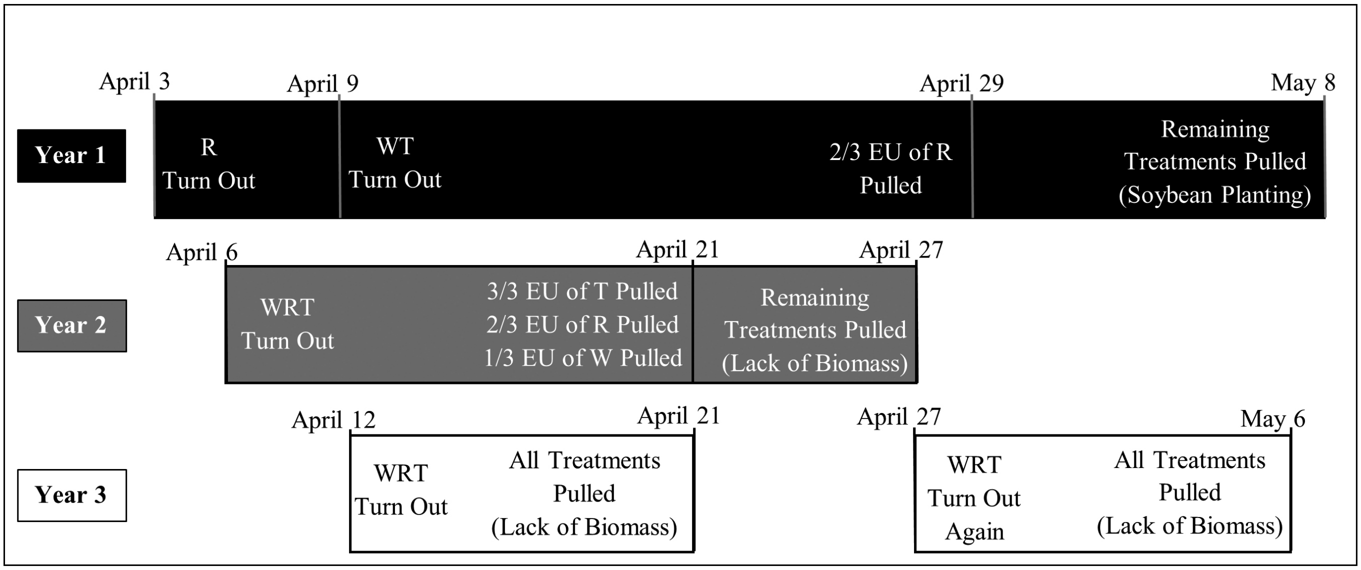


Fig. 1. Timeline of grazing winter wheat (W), cereal rye (R) and winter triticale (T) in early spring over a three-year period. For each year, the bar represents the amount of grazing provided. In years 1 and 2, 6 steers were stocked per 2 ac paddock and in year 3, 5 steers were stocked per paddock. In years 2 and 3, steers were removed early due to insufficient forage.

Table 1. Effect of treatment on forage growth and grazing performance of grazing steers when grazing winter wheat, winter triticale and cereal rye in early spring.

	Treatment				
	Wheat	Rye	Triticale	SEM	Treatment *P*-value
Initial body weight, lb	740	744	742	1.58	0.21
End body weight, lb	806	814	804	3.91	0.21
Pre-grazed biomass, lb/ac	649	761	754	45.9	0.20
Post-grazed biomass, lb/ac	244[b]	413[a]	268[b]	48.8	0.05
Carrying capacity, AUM/ac[1]	1.42	1.43	1.42	0.043	0.99
Gain, lb/ac	187	199	179	8.29	0.26

[abc] means lacking common letters within row differ ($P \leq 0.05$)

[1] AUM = animal unit month; equal to a 1,000 lb animal grazing for 30.5 days

Table 2. Effect of year on forage growth and grazing performance of growing steers when grazing winter wheat, winter triticale and cereal rye in early spring.

	Year				
	1	2	3	SEM	Year *P*-value
Initial body weight, lb	668[c]	737[b]	820[a]	1.58	<0.01
End body weight, lb	784[b]	766[c]	874[a]	3.91	<0.01
Pre-grazed biomass, lb/ac	1077[a]	397[b]	690[b]	57.0	<0.01
Post-grazed biomass, lb/ac	471[a]	153[c]	301[b]	57.4	<0.01
Carrying capacity, AUM/ac	2.07[a]	0.96[c]	1.25[b]	0.043	<0.01
Gain, lb/ac	349[a]	83[c]	134[b]	8.29	<0.01

[abc] means lacking common letters within row differ ($P \leq 0.05$)

Results

Forage Yield

There was no treatment x year effect ($P > 0.10$) for pre-graze or post-graze biomass. There was also no treatment effect ($P = 0.20$) for pre-grazed biomass (Table 1). However, there was a year effect ($P < 0.01$) of pre-grazed biomass with year 1 having greater ($P < 0.01$) pre-graze biomass than years 2 and 3, and year 2 having less ($P < 0.01$) biomass than year 3 (Table 2). Year 2 was a cold, wet spring, and year 3 was a drought year in eastern Nebraska, so differences in biomass availability may be attributed to these conditions. There was a treatment effect ($P = 0.05$; Table 1) and a year effect ($P < 0.01$; Table 2) for post-graze biomass. Cereal rye had more ($P < 0.01$) post-graze biomass remaining compared to wheat and triticale which did not differ (Table 1). Year 1 had the most ($P < 0.01$) biomass left after grazing with year 2 having less ($P = 0.05$) biomass than in year 3 (Table 2).

Initial forage heights at turn out in year 1 were 4.3 inches for wheat, 4.7 inches for cereal rye, and 4.3 inches for triticale. In year 2, initial heights before turning out were 4.3 inches for wheat, 4.7 inches for cereal rye, and 4.7 inches for triticale. In year 3, initial turnout heights were 4.7 inches

Table 3. Species by year effect on average daily gain (lb/d) of growing steers when grazing winter hardy small cereals in early spring.

	Average Daily Gain, lb/d				
	Wheat	Rye	Triticale	SEM	Treatment x year *P*-value
Year 1	4.10[a]	3.93[a]	4.07[a]	0.267	0.03
Year 2	1.83[c]	3.07[b]	1.43[c]		
Year 3	2.93[b]	3.13[b]	2.90[b]		

[abc] means lacking common letters differ ($P \leq 0.05$)

for wheat, 5.1 inches for cereal rye, and 5.1 inches for triticale.

Cattle Performance

There were no treatment x year interactions ($P > 0.05$) or treatment effects for initial ($P = 0.21$) or end BW ($P = 0.21$; Table 1). However, there was a treatment x year interaction ($P = 0.03$) for average daily gain (Table 3). In year 1 and year 3, there were no differences ($P \geq 0.10$) among treatments. However, in year 2, steers grazing cereal rye had greater ADG ($P \leq 0.01$) than wheat and triticale which did not differ ($P = 0.31$). This treatment x year interaction of ADG is important to note because there is the potential that cereal rye may present an advantage under cold stress weather, which may provide an incentive to plant and graze it if early spring grazing is desired. In two out of three years, no species showed an advantage in cattle performance through ADG; however, in the extremely cold year when not much pre-graze biomass was present (397 lb/ac), cattle on cereal rye had ADG of 3.1 lb/d compared to 1.5 lb/d for triticale and 1.8 lb/d for wheat. Across all years, cereal rye had greater post-graze biomass than wheat and triticale. Given the low biomass in all species in year 2, the higher post-graze biomass in cereal rye may have allowed for greater cattle intakes. Although cattle grazing rye gained more in year 2, over all three years, all species provided high rates of gain, with average ADG for the species ranging from 2.8 lb/d to 3.4 lb/d, suggesting that vegetative winter hardy small cereals are high quality.

There were no differences ($P > 0.01$) among treatments for gain per acre (Table 1), but differences ($P < 0.01$) among years were found, with year 1 having the greatest ($P < 0.01$) gain per acre, year 2 the least ($P < 0.01$), and year 3 intermediate ($P < 0.01$; Table 2). Carrying capacity followed this pattern with no differences ($P = 0.99$) among treatments, but with year 1 having the greatest ($P < 0.01$) AUM per acre, year 2 having the least ($P < 0.01$), and year 3 being intermediate.

The general lack of differences between small cereal species' performance could be because these small cereals typically do not separate themselves in terms of yield early in the growing season, although differences may be found as forage matures. It is also important to note that in this trial, forage was maintained in an early vegetative state as cattle were rotated between paddocks. In years 2 and 3, cattle had to be pulled off early due to insufficient forage. The grazing season could have been extended if stocking density had been lowered. It is also interesting to note that as the cattle were rotated between paddocks, the forage recovered quickly and could grow 3 to 4 inches in a week. Trends in cattle performance within years were similar to trends in forage availability, suggesting that cattle performance could have been related to the amount of forage available.

Conclusion

These data show that winter wheat, cereal rye, and winter triticale can be used for early spring grazing as a double-cropped forage in a continuous soybean system in Eastern Nebraska to fill forage deficiencies for cattle producers. Minimal differences in early spring grazing potential and animal performance were observed across species, although cereal rye had an advantage when freezing conditions occurred after early spring turn out.

Alyssa K. Hall, graduate student.

Abigail M. Sartin, graduate student.

Kallie J. Calus, graduate student.

Morgan T. Grabau, graduate student.

Daren D. Redfearn, professor, agronomy, Lincoln.

Rob B. Mitchell, USDA-ARS, Lincoln, NE.

Mary E. Drewnoski, associate professor, Lincoln.

Survey of Current Management Practices and Evaluation of their Impact on Nutrient Content of Small Cereal Silage in Nebraska

Alexa R. Johnson
Mary E. Drewnoski
Daren Redfearn
Susan VanderPlas
Jenny Rees
Ben Beckman
Erin Laborie
Todd Whitney
Kim Clark
Brad Schick
Gary Lesoing
Connor Biehler

Summary with Implications

The nutrient content of small cereal silage from 16 producers in Nebraska was measured at harvest and post-fermentation. At packing, 42% of the samples were below the target dry matter of 30–35%. Samples with dry matter percentages below 30% had a significant increase in the loss of energy (total digestible nutrient) content of the silage. The wetter silage appeared to have increased rates of clostridial fermentation as indicated by production of butyric acid. These data suggest that moisture management is a challenge and increased attention to ensuring the target dry matter content is achieved before packing could improve the quality of small cereal silage.

Introduction

Double cropping a small cereal with another annual forage, corn silage, or a cash crop can be a way to get more productivity off the same acres. Making silage from small cereals can shorten the harvest window and potentially preserve more feed value than harvesting hay. The goal of making silage is to produce a stable feed in which most of the dry matter (DM) and energy of the fresh crop is captured. However, management can have a large impact on the effectiveness of preserving the feed value of the forage. The objectives of this project were to understand current small cereal silage management practices of producers in Nebraska and identify opportunities for improved silage management.

Table 1. Dry matter (DM), energy (TDN), crude protein (CP) and fermentation profile of the small cereal silage samples (n = 18) from 16 producers in Nebraska.

	Boot	Heading	Anthesis	Milk	Soft Dough	Average[1]
Samples, %	5.6	33.3	11.1	16.7	33.3	—-
Packing (pre-fermentation)						
Dry Matter, %	35.4	28.8	28.6	31.4	33.1	31.5 ± 6.7
TDN, % of DM	63.2	57.7	56.0	57.6	54.1	56.5 ± 4.0
CP, % of DM	9.38	10.7	10.3	10.5	9.87	10.2 ± 2.1
Feed out (post-fermentation)						
Dry Matter %	33.8	27.7	24.1	34.6	30.8	30.2 ± 5.5
TDN, % of DM	61.4	53.1	45.8	48.5	53.0	51.9 ± 5.4
CP, % of DM	12.8	10.9	8.7	12.1	11.5	11.2 ± 2.1
pH	4.09	4.57	4.94	4.00	4.20	4.4 ± 0.48
Lactic Acid, % DM	5.24	2.83	5.94	6.52	2.91	3.6 ± 2.6
Acetic Acid, %DM	5.48	2.49	4.42	3.57	1.60	3.1 ± 1.9
Butyric Acid, % DM	<0.01	4.41	3.02	<0.01	0.07	2.8 ± 1.8
Ammonia-N, % of CP	11.4	21.7	28.2	6.8	11.3	15.9 ± 18.7

[1]Mean ± standard deviation

Procedure

Samples of small cereal silage were obtained from 19 different harvests from 16 producers in Nebraska during 2021. Producers answered survey questions at the time of harvest and again during feed out to allow for evaluation of the management impacts and the resulting fermentation on the silage nutritive value. Survey responses were obtained for 18 samples at the time of harvest and all 19 samples for feed out.

At harvest, a grab sample of the chopped forage was obtained as it was being placed into the silo. A post-fermentation sample was obtained during feed-out approximately 2 weeks after the pile was opened from the freshly exposed silage face. These samples were frozen for a minimum of 48 hours after collection before being shipped on ice packs to Dairyland Laboratories and were analyzed using near-infrared spectroscopy (NIR) analysis to determine DM, crude protein (CP), and total digestible nutrients (TDN). The TDN was estimated using the OARDC summative equation. Fermentation analysis evaluating the acid profile was conducted using high performance liquid chromatography (HLPC).

Silage density in the piles, bunkers, and bags was determined by obtaining 3 cores at approximately 4 feet from the ground from across the freshly opened face using a Dairy One Master Forage Probe. The depth of the core was measured to determine the volume sampled and the wet weight of the sample obtained was measured. These samples were then analyzed for DM. The amount of DM in the cores was calculated and divided by the volume of the cores to determine the density of the silage.

Results

Of the samples (n = 19) obtained 53% were cereal rye, 26% triticale, 5% wheatlage, 5% oatlage, and 11% mixed small cereal/annual legume. Based on the survey data, at harvest (n = 18), 6% were boot stage, 33% heading, 11% anthesis, 17% milk, and 33%

Table 2. Silo type and ensiling management of small cereal silage used by 16 producers in Nebraska.

	Bag	Bunker	Pile	Average
Samples[1], %	18%	35%	47%	-
Density[2], lb DM/ft[3]	3.7 ± 2.2	6.1 ± 1.9	4.9 ± 2.0	5.2 ± 2.0
Covered silage, %	—	33%	75%	57%
Inoculated, %	33%	50%	87%	57%

[1] Represents 19 different harvests as three producers had two crops

[2]Mean ± standard deviation

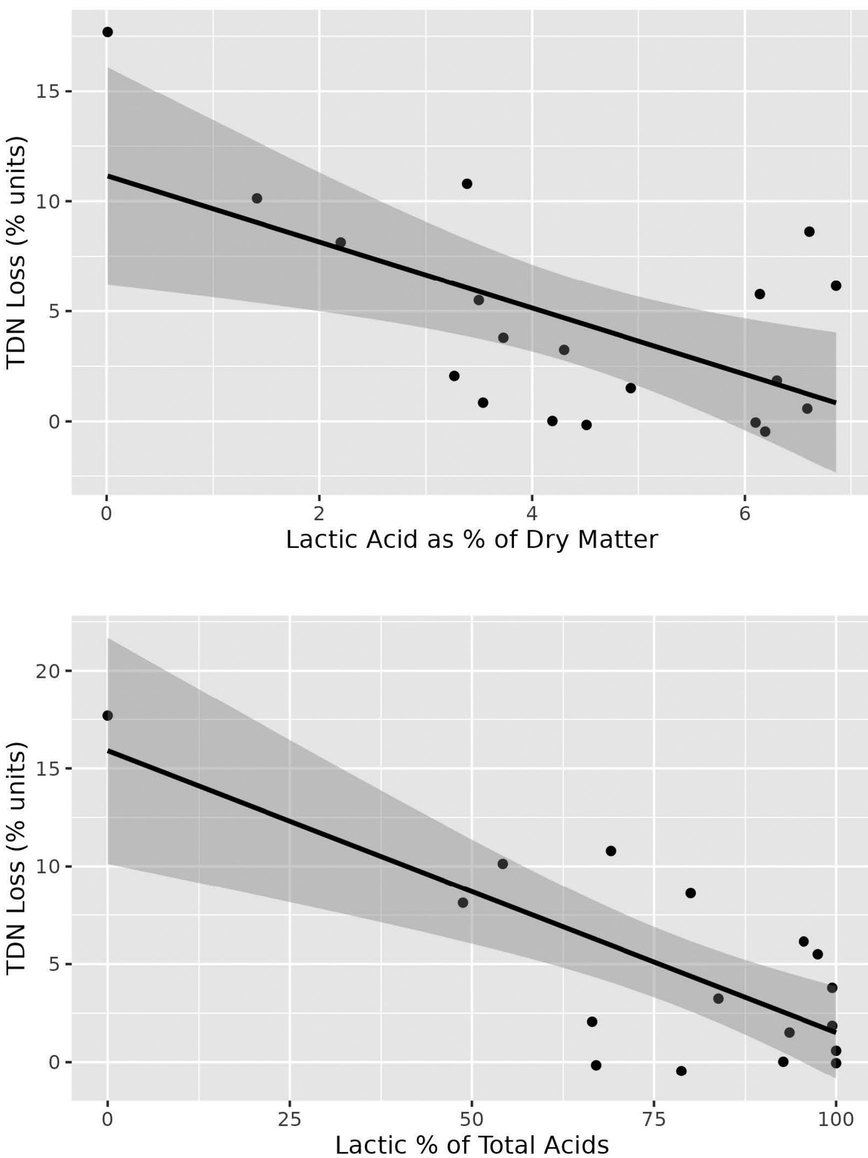


Fig. 1. The correlation of lactic acid as a percentage of the dry matter (top panel) and as a percentage of the total acids (bottom panel) and the loss of total digestible nutrients from packing to feed-out of small cereal silage. Lactic acid (% DM) Y= -1.5x + 11.2 ± 2.3 (R^2 = 0.32; $P < 0.01$). Lactic acid (% total acid) Y = -0.144 x +15.9 ± 2.7 (R^2 = 0.53; $P < 0.01$).

were soft dough at harvest (Table 1). The majority (80%) of the producers reported determining the harvest date based on growth stage of the forage. The other 20% reported harvesting based on a calendar date.

Producers also reported why they choose the date they harvested: options to choose from included, balancing yield and quality, wanting high yield and okay lower quality, wanting high quality and okay with lower yields, timing of planting for the next crop, and chopper availability. Producers were able to choose more than one option but 50% targeted high yield with lower quality, 25% wanted to balance yield and quality, and the other 25% chose chopper availability, with one of the other options.

Generally, the small grain forage going into the silo (pre-fermentation) was similar to medium- to high-quality hay with an average of 56.5% TDN and 10% CP (Table 1). However, following fermentation, energy (TDN) averaged 51.9% TDN, a 4.6% energy loss. This suggests there are opportunities to improve management and capture more feeding value.

At harvest, 47% (n = 9 / 19) of the samples were within the target DM range (30 to 35%), 42% (n = 8 / 19) were too wet, and the other 11 % (n = 2 / 19) were too dry. The majority (84%; n = 16 / 19) of the survey responses stated that the producers wilted the crop. Of those who wilted, 44% of the samples (n = 7/ 16) were still too wet suggesting a wilting period that was too short. It has been shown that earlier maturity stages have more moisture standing in the field than later maturity stages (*2023 Nebraska Beef Report*, pp. 34–36). Of those that wilted boot, heading or pollination, wilting for 16 to 24 hours appeared to achieve targeted DM content. For milk or soft dough, 0 to 2 hours seemed to commonly result in achieving the target DM.

Of those that responded to the surveys, the majority, 61% (n = 11 / 18), did not measure DM to determine when to pack the silage. The methods used by those that did measure dry matter (39%; n = 7 / 18), included sending a sample to a lab (43%; n = 3 / 7), using the Koster tester (29%; n = 2 / 7), the squeeze test (14 %; n =1 / 7), or a microwave test (14%; n =1 / 7). However, of those who measured their small cereal dry matter, 57% (n = 3 / 7) were within target

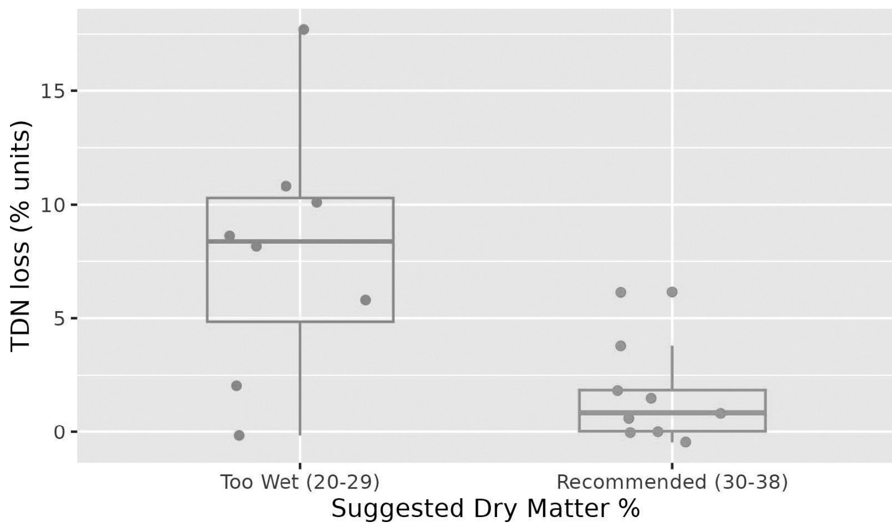


Fig. 2. The effect of dry matter content of small cereal grains at packing on energy loss during fermentation. Producers within the recommended dry matter content (right side) had significantly ($P = 0.02$) less total digestible nutrient loss (3 % units) than those which packed the silage when it was too wet (8 % units). The middle perpendicular line in the box is the median value with 50% of the samples falling above and 50% falling below this line. The box contains 50% of the samples. Single dots outside of the box would be considered an outliner (unusually large or small value) for the sample type.

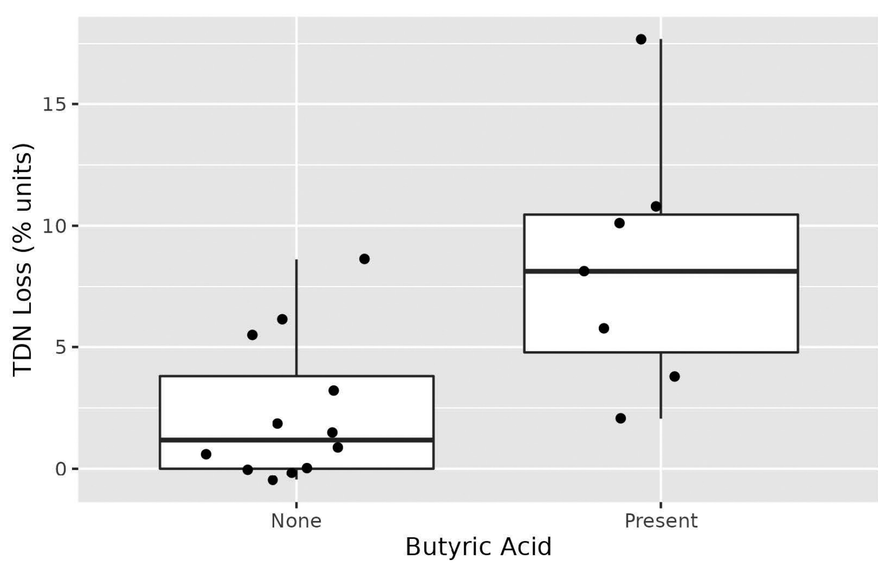


Fig. 3. The presence of butyric acid and its effect on energy loss. The average TDN loss for the small cereal silage with no butyric acid present was less ($P = 0.02$) than silage with the presence of butyric acid (2.3 vs. 8.3 % units of TDN)

DM range compared to 45% (n = 5 / 11) for those who did not.

Producers used three different silo types: bag, bunker, or ground pile (Table 2). The most common silo type used was a ground pile (45%) and 75% of these piles were covered with plastic. Bunker was the second most common (35%) silo type used and only 33% of these silos were covered.

The goal of silage production is to get rid of oxygen as quickly as possible to allow fermentation (acid production) to begin as soon as possible. Packing the silage can reduce the amount of oxygen present. The recommended packing density to best preserve the feeding value of the forage is 15 lb DM/ft^3. Overall, packing density appeared to be a major challenge as the average density achieved was one-third of the recommended at only 5 lb DM/ft^3. Small cereal silage can be harder to pack due to the hollow stems; therefore more pack tractor weight relative to the rate of incoming forage is likely needed and/or thinner layers should be packed.

The goal of fermentation is to drop the pH of the silage as quickly as possible to preserve as much of the nutritive value as possible. Post-fermentation samples with a greater percent of the lactic acid present had less ($P < 0.01$) TDN loss during fermentation (Figure 1). Due to the strong acidity of lactic acid, it would be expected that samples with more lactic acid present had a more rapid decline in pH, resulting in the forage being preserved more quickly.

Those who packed their silage too wet lost more ($P = 0.02$) energy (8 TDN units) than those who were within the target dry matter (2 TDN units; Figure 1). However, there was a wide range in loss (0 to 18% units of TDN) for those who packed their silage too wet. The low loss in this situation was created by the producers starting to feed right after packing and feeding the forage out very quickly (less than a month from packing to full utilization). The range in TDN loss for samples within target DM was much lower at 0 to 6 units of TDN.

Typically, when moisture content of silage is too high there is a risk of clostridial fermentation and production of butyric acid. The TDN loss for the samples that did not have butyric acid production (2 % units) was less ($P = 0.02$) than those that had butyric acid present (8 % units). Out of those samples that were too wet, 63% (n = 5 / 8) had butyric acid present compared to 11% (n = 1 / 9) of samples in the target DM. Overall, these data suggest the consequence of packing small grain silages when they are too wet is a tripling of the loss of estimated TDN during fermentation.

On average, 57% of the silage samples had an inoculant added, with almost all (87%) those that stored silage in a pile inoculating the silage and the minority of those that bagged the silage inoculating (Table 2). When all the silage samples were separated based on DM content at packing and then separated based on whether samples were inoculated, there were too few samples to conduct a statistical analysis. However, it is interesting to note that for silage packed too wet, the energy loss during fermentation when an inoculant was used was 5.9 TDN units (n = 5) and when an inoculant was not used the energy loss was 11.2 TDN units (n = 3). However, for samples within target DM range, samples in which an inoculate was used had an energy loss of 2.3 TDN units (n = 5) vs. 1.1 TDN units (n = 3) when an inoculant was not used. An accurate conclusion with the inoculants cannot be made due to the small sample size, further research in this area will need to take place.

Conclusion

Packing density and moisture management appear to be a challenge for producers making small cereal silages. When comparing the total digestible nutrient (TDN) content of the small cereal forage at harvest to the post-fermentation sample there appeared to be an increase in the amount of TDN lost during fermentation for the samples that were too wet when packed. Many producers did not appear to wilt the small cereals long enough to reach the target dry matter of 30 to 35%, resulting in increased incidences of clostridial fermentation and large losses in the energy content of the silage.

Alexa Johnson, graduate student.

Mary Drewnoski, associate professor, animal science, Lincoln, NE.

Daren Redfearn, professor, agronomy and Horticulture, Lincoln, NE.

Susan VanderPlas, assistant professor, statistics, Lincoln, NE.

Jenny Rees, extension educator, York, NE.

Ben Beckman, extension educator, Hartington, NE.

Erin Laborie, extension educator, Beaver city, NE.

Todd Whitney, extension educator, Holdrege, NE.

Kim Clark, extension educator, Lincoln, NE.

Brad Schick, extension educator, Fullerton, NE.

Gary Lesoing, extension educator, Auburn, NE.

Connor Biehler, extension educator, Ithaca, NE.

Rethinking Corn Residue

Effects of Grain Yield on Quality and Quantity of Residue

Kaylee E. Wheeler
Jessica Miller
Sadie Ference
Stephan Geu
Bill Struckmeyer
Amanda Easterly
Cody Creech
Brian Maust
Daren Redfearn
Jay Parsons
Mary E. Drewnoski

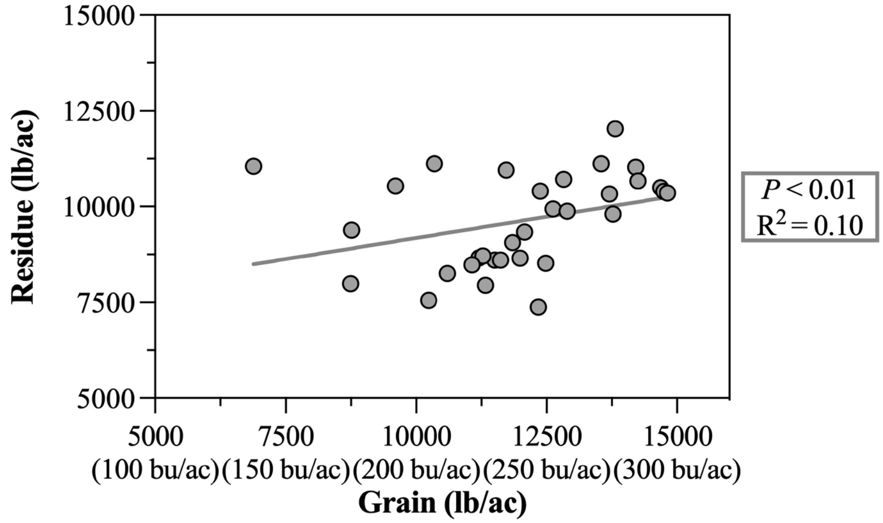


Fig. 1. Pounds of corn grain compared to pounds of residue produced per acre. Linear regression equation for leaf (Y = 0.06187*X + 5.312) proportion.

Summary with Implications

A two-year experiment evaluated the effects of corn grain yield on the resulting quality and quantity of corn residue. Among the wide variety of corn hybrids, locations, and growing conditions, observed grain yields ranged from 120 to 350 bushels per acre. As corn yield increased, the total pounds of residue increased. However, the amount of reside relative to grain decreased. Within the residue, the proportion of leaf increased from 10 to 28% as corn yield increased while husk remained unchanged at 13%. Overall, the yield of leaf and husk per bushel of corn grain was not affected by grain yield and averaged 12 lb/bu. As the grain yield increased, there was an increase in proportion of leaf, but there was a decrease in total residue per bushel, resulting in no change of leaf quantity per bushel. However, as yield increased, the digestibility of leaf and husk declined. Given the decrease of residue quality in higher yielding fields, impacts of grain yield on cattle performance should be evaluated.

Introduction

Corn residue grazing offers producers an economical winter feed source and can reduce the need to purchase feed. Grazing corn residue has unique challenges due to all forage being present at the beginning of grazing as well as the forage no longer being rooted in the ground. This means that corn residue is very susceptible to grazing selection and disappearance. Cattle will consume any remaining grain first along with husk, followed by more leaf as grain availability declines (*2004 Nebraska Beef Cattle Report, pp. 13–15*). Minimal cob and stalk are consumed. Despite the utility of corn residue, cattle producers have reported variable cow performance even when grazing corn residue at current stocking recommendations of one animal unit month per acre per 100 bushels of corn grain harvested. This recommendation is based off the assumption that there are 16 lb of leaf and husk (dry matter basis) available for every bushel of corn grain produced. This recommendation estimates a 50% utilization rate, meaning 8 lbs of leaf and husk are assumed to be grazed by the animal. The objectives of this experiment were to investigate the correlation of grain yield to residue yield, plant proportions and husk and leaf digestibility to determine how grain yield impacts the feed value of corn residue.

Procedure

A two-year experiment was conducted at a variety of locations across Nebraska including experiment stations and producer farms (7 site years total). This experiment investigated the correlation of corn yield with the quality and quantity of corn residue (husks and leaves). In Year 1 (2021), 24 different varieties were planted in four locations across Nebraska. Of the 24 varieties planted, seven were planted in two or more locations, yielding 32 samples in year 1. Of the locations, three were dryland and one was irrigated. In Year 2 (2022), 26 different varieties were planted in three locations across Nebraska. Of the 26 varieties planted, five were planted in two or more locations, yielding 31 samples in year 2. Of these locations, one was dryland and two were irrigated. Six varieties were planted in both Year 1 and 2.

In Year 1, leaf and husk samples were collected from each plot (n = 4 replication plots per variety per location) for quality analysis. In Year 2, 12 whole plants were harvested above anchor roots from each plot (n = 4 replication plots per variety per location) at the time of grain harvest. Whole plants were separated by plant part into grain, cob, leaf, husk and stalk. Each plant part was dried (140°F) and dry matter (DM) amounts were determined. After drying, all leaf and husk samples were ground

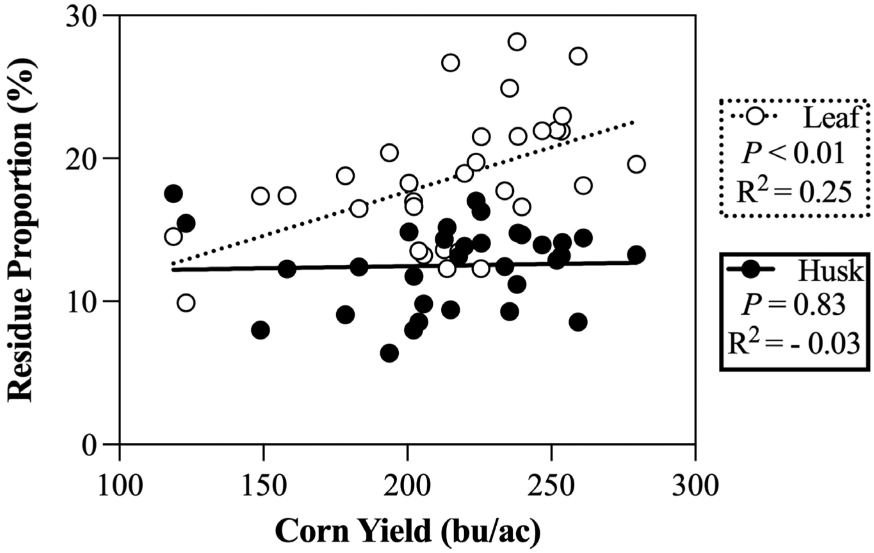


Fig. 2. Proportion of corn leaf and husk within total corn residue compared to corn yield. Linear regression equation (Y = 0.2208*X + 6975).

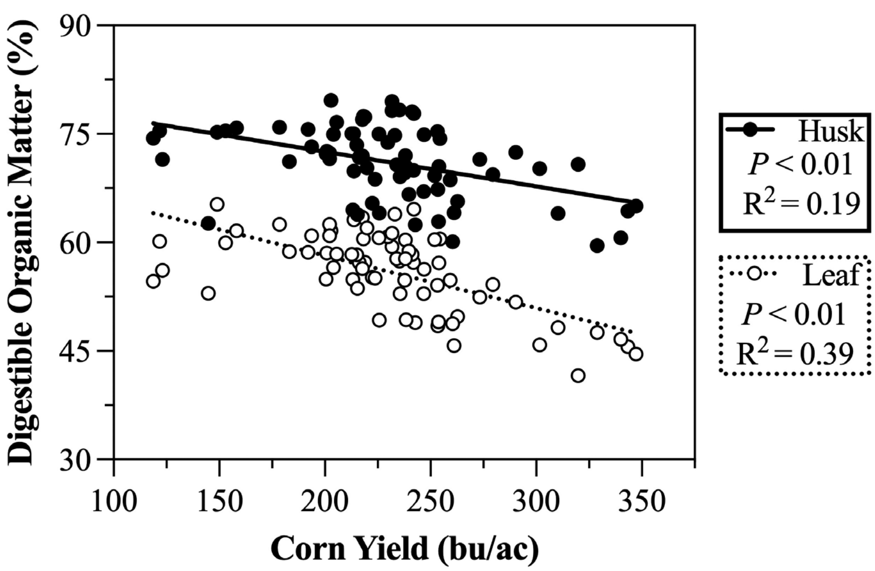


Fig. 3. Digestible organic matter of corn leaf and husk compared to corn grain yield. Linear regression equations for husk (Y = -0.04790*X + 82.12) and leaf (Y = -0.07247*X + 72.66) digestibility.

through a 1mm screen to be analyzed for digestible organic matter (DOM) using the in vitro method. From the determined in vitro organic matter digestibility (IVOMD), samples were adjusted using standards with known in vivo digestibility and DOM was calculated for all leaf and husk samples. Corn grain yield was estimated by harvesting the middle two rows of the plot.

Statistical analysis was conducted using the regression procedure to determine correlations of corn grain yield to residue yield, proportions, and digestibility using plot as the experimental unit.

Results

Observed corn grain yield across the two years, locations, and varieties ranged from 120 to 350 with an average of 231 and a median of 232 bushels per acre. As corn grain yield increases, the proportion of grain relative to residue increased ($P < 0.01$). Thus, as expected, grain proportion increased with increased grain yield from 38% to 63% (Figure 1). Although total pounds of residue increased with grain yield, there was less residue produced per bushel of corn grain produced.

The proportion of leaf within the residue increased ($P < 0.01$) with grain yield from 10% to 28% with an average of 19% (Figure 2). In contrast, the proportion of husk within the residue remained unchanged ($P = 0.83$) across the range of yields with an average of 13% (Figure 2). Previous reports did not include corn grain yield but have estimated residue proportions to be 27% leaf and 12% husk (*2004 Nebraska Beef Cattle Report, pp. 13–15)*, 30% leaf and 11% husk (*2011 Nebraska Beef Cattle Report, pp. 33–34*), or 22% leaf and 13% husk (*2015 Nebraska Beef Cattle Report, pp. 59–61)*. Although actual grain yields were not reported, these reports evaluated irrigated corn in Eastern, Nebraska, thus average yields can be assumed near 150–200 bushels per acre. Additionally, the reported plant proportions support the results observed in this experiment of about 13% husk with varying amounts of leaf within the residue.

Pounds of husk and leaf per bushel did not vary with corn grain yield ($P = 0.44$). Thus, it is variable but grain yield is not a driving factor. It is generally expected that 13 to 16 pounds of husk and leaf are produced per bushel of grain. The observed range in this experiment was 8 to 20 pounds of husk and leaf per bushel with an average of 12 lb/bu. Thus, the expected range falls within the observed range (Table 1).

The digestibility of both leaf and husk decreased ($P < 0.01$) as yield increased. In leaf samples, DOM decreased from 65% in lower yielding hybrids to just 41% in higher grain yielding hybrids (Figure 3) with the average being 56%. In husk samples, DOM decreased from 80% to 60% with an average of 71% (Figure 3). It has also been reported that leaf DOM ranges from 30 to 34% with husk at 58% (*2017 Nebraska Beef Cattle Report, pp. 60–61*). Another report estimated leaf DOM to be 40% and husk to be 56% at a corn yield of 240 bushels per acre (*2016 Nebraska Beef Cattle Report, pp. 71–73*). These two reports estimate leaf and husk to be 15% below the digestibility observed in this experiment. However, the results from this experiment are consistent with in vivo digestibility estimates (2016 Nebraska Beef Cattle Report, pp. 74–75 and pp. 76–78).

Table 1. Estimate of Residue and Nutrient Yield

	Estimated Range [a]	P Value of Correlation with Yield	Mean	Max	Min
		Pounds of Residue per Bushel			
Husk	2.8–3.5	0.75	5.0	12.1	2.8
Leaf [b]	10.2–12.5	0.39	7.2	10.3	4.3
Husk + Leaf	13–16	0.44	12.3	19.8	8.4
		Pounds of Digestible Organic Matter (DOM) per Bushel			
Husk	1.7–2.2	0.69	3.5	8.6	2.0
Leaf [b]	4.5–5.5	0.62	4.1	5.6	2.6
Husk + Leaf	6.2–7.7	0.28	7.6	13.0	5.4

[a] Ranges are estimated from Nebraska Extension publication EC278, Grazing Crop Residues with Beef Cattle (https://extensionpublications.unl.edu/assets/pdf/ec278.pdf).

[b] Leaf samples include the leaf sheath.

As observed with residue yield, pounds of DOM per bushel also did not vary with corn grain yield ($P = 0.28$). It is generally expected, based on previous reports, that husk and leaf will yield 6.2 to 7.7 pounds of DOM per bushel of grain. The observed range in this experiment was 5.4 to 13 pounds of DOM from husk and leaf per bushel of grain with an average of 7.6. Again, the expected range falls within the observed range of this study (Table 1).

Given the dilution of nutrients in higher yielding fields, it stands to reason that current recommendations may need to be adjusted. Current stocking recommendations are calculated based on grain yield with higher stocking rates on higher yielding fields. The decline in nutrient concentration could impact dry matter intake and thus cow performance when grazing corn residue. Adjusting stocking rates or providing supplementation for cows grazing higher yielding fields could combat this decline, and these strategies need further evaluation.

Conclusion

Cattle select leaf and husk in the greatest amount. The pounds per bushel of leaf and husk, does not appear to change with corn grain yield. However, the digestibility of leaf and husk declined as grain yield increased. Yet, the overall yield of digestible nutrients from leaf and husk (lbs of DOM per bushel of corn) did not change with grain yield. The decrease in digestibility could negatively impact cow performance in higher yielding fields by limiting intake and future research needs to evaluate the effect of corn yield on performance of cows grazing corn residue.

Kaylee E. Wheeler, graduate student.

Jessica Miller, research technician.

Sadie Ference, undergraduate student, Animal Science, Lincoln NE.

Stephen Geu, research technician.

Bill Struckmeyer, research technician.

Amanda Easterly, Research Assistant Professor, Sidney, NE.

Cody Creech, Associate Professor and Dryland Cropping Systems Specialist.

Brian Maust, Research Technologiest, Scottsbluff, NE.

Darel Redfearn, Professor ,Agronomy and Horticulture, Lincoln, NE.

Jay Parsons, Professor, Agricultural Economics, Lincoln, NE.

Mary E. Drewnoski, Associate Professor, Animal Science, Lincoln, NE.

Effect of Biochar on Enteric Methane Production and Cattle Performance

Hanna Cronk
Holly Heil
Rebecca McDermott
Mitch Norman
Galen Erickson
Andrea Watson

Summary with Implications

Methane is a more potent greenhouse gas than carbon dioxide. Because ruminant animals, including cattle, emit methane, strategies are actively being sought to reduce these emissions. Pistachio shell-sourced biochar was included at 0.5% of a finishing cattle diet to determine effects on methane emissions and cattle performance. Eight pens of cattle were rotated through a 2-chambered emissions barn to analyze methane and carbon dioxide produced by the cattle. Biochar tended to increase methane emissions on a g/d basis with no effect on methane emissions as g/lb of feed intake and no differences in carbon dioxide emissions. There were no differences in cattle performance and most carcass characteristics (daily gain, feed intake, feed:gain, hot carcass weight, ribeye area, marbling) between treatments. The control group did have increased 12th rib fat and yield grade scores compared to the biochar group. Feeding biochar at 0.5% of the diet did not impact enteric methane or cattle performance.

Introduction

Methane (CH_4) is produced in ruminants by microbial fermentation in the rumen. Microbes break down polysaccharides into volatile fatty acids (VFA) to use as energy; however, the by-products of VFA production are carbon dioxide, methane, and hydrogen. Removing methane from the rumen via eructation is important in order for fermentation to continue. Strategies to reduce methane emissions from ruminants has become a widely researched topic. Biochar is produced from cellulose-rich organic matter that has undergone pyrolysis or gasification. Often, biochar is made from wood waste, nut shells, or crop residues, like rice husks. Biochar has been proposed as a potential feed additive to reduce methane emissions; however, the manner of how biochar works to reduce enteric methane is unclear. Some research has speculated that biochar promotes biofilm growth within the rumen that aids microbial growth and crossfeeding, which could lower methane emissions.

The objective of this study was to determine if feeding biochar impacts finishing beef cattle performance and to evaluate the impact of biochar in the diet on enteric methane emissions from beef cattle.

Table 1. Diet composition for finishing beef steers fed biochar

	CON	BIO
Ingredient, % DM		
Dry Rolled Corn	61	60.5
Sweet Bran	30	30
Wheat Straw	5	5
Supplement[1]	4	4
Biochar	0	0.5
Nutrient Analysis, %		
DM	90.1	89.6
OM	93.7	93.2
CP	13.9	13.8
NDF	23.1	23.0

[1] Treatments include a control (CON) group fed no biochar and a biochar (BIO) group fed 0.5% DM of biochar replacing DRC in the diet

[2] Supplement contained 1.65% limestone, 0.4% urea (to meet RDP requirements), 0.30% salt, 0.10% tallow, 0.05% trace mineral premix, 0.015% Vitamin ADE, Rumensin targeted at 30 g/ton (Elanco Animal Health, Greenfield, IN), and Tylan targeted at 8.8 g/ton (Elanco Animal Health) in a fine ground corn carrier

Procedure

A 169-d finishing experiment, utilizing 128 crossbred beef steers was completed at the Eastern Nebraska Research, Extension and Education Center (ENREEC) near Mead, NE. This experiment utilized 2 treatments with 16 pens (8 pens/treatment, 8 steers/pen). Steers were limit-fed a diet consisting of 50% alfalfa hay and 50% Sweet Bran (Cargill Wet Milling; Blair, NE; DM basis) at 2% body weight (BW) for five consecutive days before the start of the experiment. Cattle were then weighed across two consecutive days to establish initial body weight (765 ± 20 lb).

Two treatments were evaluated using a base diet (CON) and a biochar (BIO) diet (Table 1). Biochar replaced 0.5% of dry rolled corn in the diet for the BIO treatment group. Biochar utilized for this experiment was provided by VGrid Energy Systems, Inc. (San Pablo, CA) and was sourced from pistachio shell waste. Biochar was processed to a small particle size to ensure less sorting in the bunk. Samples of biochar were collected weekly and composited to send to Control Laboratories (Watsonville, CA) for chemical analysis. The dry matter of the biochar was 88.2%. On a DM basis, biochar carbon content was 83.9% with a surface area of 427 m^2/g, bulk density of 6.79 lb/ft^3, total N content of 0.69%, ash content of 6.7%, and pH of 9.41. The biochar particle size ranged from less than 0.5 mm (1.4% of biochar) to 4 to 8 mm (3.6% of biochar), with most of the biochar ranging in size from 1 to 4 mm (90% of biochar).

Table 2. Effect of biochar on emissions from cattle

	Treatments[1]			
	CON	BIO	SEM	*P*-Value
Number of Pens	4	4		
DMI, lb/d[2]	27.5	27.0	1.21	0.77
CH_4, g/d	176	194	5.97	0.09
CH_4, g/lb DMI	6.45	7.40	0.56	0.28
CO_2, g/d	10,691	10,854	384.7	0.78
CO_2, g/lb DMI	390	410	13.34	0.34

[1] Treatments include a control (CON) group fed no biochar and a biochar (BIO) group fed 0.5% DM of biochar replacing DRC in the diet

[2] Dry matter intake represents the 5-day period intake while in the methane barn.

Table 3. Effect of biochar on cattle performance and carcass characteristics

	Treatments[1]			
	CON	BIO	SEM	*P*-Value
Number of Pens	8	8		
Cattle Performance[2]				
Final BW, lb	1550	1532	14.7	0.40
DMI, lb/d	29.0	29.2	0.30	0.76
ADG, lb	4.64	4.54	0.08	0.39
Feed: Gain	6.32	6.37	—	0.71
Carcass Characteristics				
HCW, lb	976	965	9.25	0.39
LM area, in^2	14.6	14.7	0.15	0.82
Yield Grade[3]	3.80	3.68	0.04	0.06
12th Rib Fat, in	0.72	0.68	0.02	0.07
Marbling[4]	575	590	16.2	0.51

[1] Treatments include a control (CON) group fed no biochar and a biochar (BIO) group fed 0.5% DM of biochar replacing DRC in the diet

[2] All performance data shown on a carcass-adjusted basis using a common 63% dress

[3] Yield Grade calculated from the USDA Yield Grade equation

[4] Marbling Score 400-Small00, 500 = Modest00

Steers were implanted with Revalor-XS (Merck Animal Health USA, Summit, NJ) on day 0 of the experiment. Interim individual body weights were taken on day 90 of the experiment. Steers were weighed in the morning before feeding and body weights were shrunk 4% to account for feed and water gut fill. On days 139 to 167, Optaflexx (ractopamine hydrochloride; Elanco Animal Health, Greenfield, IN) was included in the diet at 300 mg/steer daily. Steers were fed for 169 days before harvest. Carcass-adjusted final BW was calculated from a common 63% dress. Carcass adjusted final BW was used to determine average daily gain (ADG) and Feed:Gain (F:G).

Gas emissions were analyzed using the UNL ENREEC emissions barn equipped with a negative pressure system to monitor and record CH_4 and carbon dioxide (CO_2) production. Emissions were analyzed for 8 consecutive weeks. Eight pens, 4 control pens and 4 biochar pens, were selected randomly to enter the emissions barn for monitoring. On the second cycle through the emissions barn, pens were on the opposite chamber of the emissions barn to account for any chamber effects. Manure CO_2 and CH_4 emissions were measured from the accumulation of 5 days of manure buildup and were calculated for the remainder of Monday after cattle were removed from the barn. Barns were cleaned using a skid steer on Tuesday to develop a baseline emission level. Baseline emissions were subtracted from manure emissions and final values were divided over 5 days and 8 steers to account for individual animal emissions.

Data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc., Cary, N.C.) as a generalized randomized design, with pen as the experimental unit and treatment as a fixed effect.

Results

Emissions

Gas emissions of CH_4 and CO_2 are reported as g/d and g/lb of DMI (Table 2). Weekly feed intakes for each treatment group rotated through the emissions barn were averaged and used to calculate dry matter intake (DMI, lb/d) while in the emissions barn. Dry matter intake between the control and biochar groups did not statistically differ while in the emissions barn ($P = 0.77$). On a g/d basis, biochar tended to increase CH_4 emissions ($P = 0.09$). On a g/lb of DMI basis, there were no statistical differences between the control and the biochar groups ($P = 0.28$). For CO_2, there were no statistical differences between the control and biochar groups for g/d ($P = 0.78$) or g/lb of DMI ($P = 0.34$).

Performance

For day 90 interim performance, there were no statistical differences between the control and biochar treatment for BW, ADG, F:G, or DMI ($P \geq 0.23$). For final carcass adjusted performance, there were no statistical differences between the control and biochar treatment for carcass adjusted final body weight, carcass adjusted ADG, carcass adjusted F:G, or DMI ($P \geq 0.39$).

Carcass Characteristics

Hot carcass weight was not statistically different between the biochar and control treatments ($P = 0.39$). For carcass quality measures of LM area and marbling, there were no statistical differences between treatments ($P \geq 0.51$). The control treatment tended to have greater amounts of 12th rib fat ($P = 0.07$) and greater YG ($P = 0.06$) compared to the biochar treatment.

Conclusion

Utilizing a pistachio shell-sourced biochar in finishing beef cattle diets did not reduce emissions of CH_4 or CO_2 measured as g/d or g/lb of DMI and did not impact performance of steers. When fed at 0.5% of a corn based finishing diet, biochar was not an effective mitigator of enteric methane production from cattle.

Hanna Cronk, Graduate Student.

Holly Heil, Graduate Student.

Rebecca McDermott, Research Technician.

Mitch Norman, Research Technician.

Galen Erickson, Professor.

Andrea Watson, Research Associate Professor, Animal Science, University of Nebraska, Lincoln.

Experiment funded by Nebraska Center for Energy Sciences Research (NCESR), though funds provided by Nebraska Public Power District (NPPD).

Evaluation of Gas Emissions from Cattle on Different Diet Adaptation Strategies Using Either Forage or RAMP

Cindy D. Mansfield
Rebecca L. McDermott
Braden C. Troyer
Mitchell M. Norman
Maggie Youngers
Andrea K. Watson
Rick Stock
Galen E. Erickson

Summary with Implications

A 173-day finishing experiment was conducted to evaluate the effects of feeding RAMP (Cargill Corn Milling, Blair, NE) during diet adaptation compared to a traditional forage adaptation program on methane and carbon dioxide emissions, animal performance and carcass traits in beef steers. Cattle were monitored using a calorimetry emission barn to quantify production of methane and carbon dioxide during step 1 of grain adaptation and at two subsequent times while fed a common finishing diet. Feeding RAMP reduced methane by 12% during the initial diet (step 1) compared to a traditional diet that contained 43% forage. When cattle were fed the same finishing diet, there was a 9% reduction in methane due to carryover effects from feeding RAMP during grain adaptation. Cattle fed RAMP tended to increase hot carcass weight by 13 pounds. These data suggest feeding RAMP during grain adaptation instead of forage could be a strategy to reduce methane emissions. The performance benefits from RAMP would further decrease methane production per pound of gain.

Introduction

Reducing greenhouse gas emissions in agriculture has become a consumer priority, which means beef producers must try to decrease enteric methane without having negative effects on beef production. When ruminants digest cellulose, hemicellulose, starches, and sugars, then volatile fatty acids (VFA) are produced. But, ruminal fermentation results in some other byproducts such as methane, carbon dioxide, and hydrogen. These naturally produced gases need to be released from the rumen, and when released as methane, are considered to be digestible energy losses. Therefore, decreasing the loss of energy could result in a decrease in methane. A complete starter feed called RAMP (Cargill Corn Milling, Blair, NE) is a common approach in the Southern Plains, and consists of high levels of Sweet Bran (Cargill Corn Milling, Blair, NE) and low levels of forage, minerals, and vitamins. Sweet Bran is a highly digestible feed (*2022 Nebraska Beef Cattle Report*, pp 42–45) that has more energy than forages. Since corn milling byproducts have an increased energy value compared to forages, replacing forages during grain adaptation could lead to less gross energy that is lost. Therefore, the objective of this study was to determine the effects of utilizing RAMP compared to a traditional diet adaptation program on methane and carbon dioxide emissions of finishing steers during the grain adaptation and finishing phase, and the effects on performance and carcass characteristics during the entire feeding period (adaptation and finishing).

Procedures

A finishing experiment was conducted at the Eastern Nebraska Research, Extension, and Education Center near Mead, NE. Sixty-four steers (initial BW = 764 lb: ± 15 lb) were utilized to evaluate feeding RAMP during diet adaptation instead of a traditional forage program on methane (CH_4), carbon dioxide (CO_2), performance, and carcass characteristics. Cattle were limit-fed a common diet of 50% alfalfa hay and 50% Sweet Bran on a DM basis at 2% of body weight (BW) for 5 d to equalize gut fill. Weights were taken for two consecutive days before feeding to establish initial BW. Steers were blocked by BW into four weight blocks (4 paired replications), stratified within BW, and assigned randomly to pens (n=8 pens; 8 steers/pen). The four paired replications consisted of two treatments which were fed either 100% RAMP or 43% forage during step 1 (Table 1). The RAMP treatment consisted of cattle fed 100% RAMP during step 1 and then adapted to a common finisher diet consisting of 65.5% steam-flaked corn (SFC), 22.5% Sweet Bran, 8% wheat straw, and 4% supplement (DM basis). The second treatment was traditional forage adaptation program (CON) whereby cattle were fed 30.5% SFC, 22.5% Sweet Bran, 8% wheat straw, 35% alfalfa hay, and 4% supplement (DM basis) during step 1 and then adapted to the common finisher diet (Table 1). All cattle were fed 4 step-up diets over 22 d, with step 1 fed 7 d while step 2, 3, and 4 were fed for 5 d each.

Cattle were implanted with Revalor-IS on d 1 and reimplanted with a Revalor-200 on d 76 of the trial (Merck Animal Health, Summit, NJ). Cattle were harvested on d 173 at Greater Omaha (Omaha, NE) and liver abscesses and hot carcass weight (HCW) were recorded on the day of slaughter. Carcass adjusted final BW was calculated using a common dressing percent of 63%. Longissimus muscle (LM) area, 12th rib back fat, and USDA marbling scores were recorded after a 48-hr chill. Yield grade was calculated using an assumed 2% KPH (kidney, pelvis, and heart fat).

Each of the four paired replications started step 1 of the step-up diet 7 d apart, starting with the heavy weight block (replication 1) until the lightest weight block (replication 4) for a total of 21 d between the start of replication 1 and replication 4. Replications were limit-fed 8 lb of grass hay and 8 lb of Sweet Bran (DM basis) until 5 d before starting step 1 diets. Feed offerings were increased for 5 d prior to step 1 diets to achieve ad libitum intakes prior to being fed step 1 and entering the emissions barn. Cattle were fed their treatment diet for 1 d prior to entering the barn on step 1. Cattle

Table 1. Dietary composition (% of DM) for steers fed RAMP versus a traditional forage adaptation program (CON)

	RAMP Diet Treatment[7]				
Ingredient	RAMP-1	RAMP-2	RAMP-3	RAMP-4	Finishing
RAMP[1]	100	75	50	25	-
Steam Flake Corn	-	16.5	32.5	49.0	65.5
Sweet Bran[2]	-	5.5	11.5	17.0	22.5
Wheat Straw	-	2	4	6	8
Alfalfa hay	-	-	-	-	-
Supplement [2]	-	1	2	3	4
Fine Ground Corn	-	0.264	0.529	0.793	1.057
Limestone	-	0.413	0.825	1.238	1.650
Tallow	-	0.025	0.050	0.075	0.100
Urea	-	0.200	0.400	0.600	0.800
Salt	-	0.075	0.150	0.225	0.300
Beef Trace Premix[3]	-	0.013	0.025	0.038	0.059
Vitamin A-D-E Premix[4]	-	0.004	0.008	0.011	0.015
Rumensin-90 Premix[5]	-	0.004	0.008	0.012	0.017
Tylan-40 Premix[6]	-	0.003	0.006	0.008	0.011
	CON Diet Treatment[7]				
Ingredient	CON-1	CON-2	CON-3	CON-4	Finishing
Steam Flake Corn	30.5	40.5	50.5	58.0	65.5
Sweet Bran	22.5	22.5	22.5	22.5	22.5
Wheat Straw	8	8	8	8	8
Alfalfa hay	35	25	15	7.5	-
Supplement [2]	4	4	4	4	4
Fine Ground Corn	1.057	1.057	1.057	1.057	1.057
Limestone	1.650	1.650	1.650	1.650	1.650
Tallow	0.100	0.100	0.100	0.100	0.100
Urea	0.800	0.800	0.800	0.800	0.800
Salt	0.300	0.300	0.300	0.300	0.300
Beef Trace Premix[3]	0.059	0.059	0.059	0.059	0.059
Vitamin A-D-E Premix[4]	0.015	0.015	0.015	0.015	0.015
Rumensin-90 Premix[5]	0.017	0.017	0.017	0.017	0.017
Tylan-40 Premix[6]	0.011	0.011	0.011	0.011	0.011

[1]RAMP, Cargill Corn Milling, Blair, NE

[2]Sweet Bran, Cargill Corn Milling, Blair, NE

[3] Premix contained 6.0% Zn, 5.0% Fe, 4.0% Mn, 2.0% Cu, 0.29% Mg, 0.2% I, 0.05% Co

[4] Premix contained 30,000 IU vitamin A, 6,000 IU vitamin D, 7.5 IU vitamin per gram

[5] Supplement formulated to provide 30g/ton of Rumensin (Elanco Animal Health, DM Basis)

[6] Supplement formulated to provide 8.8g/ton of Tylan (Elanco Animal Health, DM Basis)

[7] Steers were on step 1 for 7 days and on step 2, 3, and 4 for 5 days each

were monitored for CH_4 and CO_2 emissions during three phases: step 1 of adaptation phase, early finishing phase (one week after starting the finishing diet), and later finishing phase (13 weeks after starting the finishing diet).

Emissions were measured with the pen scale emissions barn (*2019 Nebraska Beef Cattle Report*, pp 60–62). The barn uses a negative air pressure system equipped with LI-COR 7700 and LI-Cor 7500 analyzers (LI-COR, Lincoln, NE) that quantify concentrations of CH_4 and CO_2. The barn contains two separate enclosed pens with air flow controlled, and are designed so no emission crossover between pens with the barn. Paired replication remained paired through the duration of the experiment. Cattle entered the chambers at 0700 on d 1 (Wednesday) and remained in the chamber until d 5 (Monday) at 0700, then returned to their respective home pen. Each day was approximately 24 hours, from feeding to feeding. Methane and carbon dioxide from

Table 2. Effects of RAMP versus a traditional starter feedlot diet (CON) on gas emissions of steers during step 1

	Treatments[1]			
	CON	RAMP[2]	SEM	*P*-value
Gas emissions[3]				
DMI, lb/d[4]	22.7	22.7	0.81	0.95
CH_4, g/d	174	153	2.5	0.03
CH_4, g/lb of DMI	7.9	6.9	0.45	0.25
CO_2, g/d	7960	8692	83.6	0.03
CO_2, g/lb of DMI	362.5	396.9	18.16	0.31
CH_4:CO_2	0.0217	0.0177	0.0004	0.02

[1] Treatments included cattle adapted with a traditional forage diet or with RAMP and then fed the same common finisher diet
[2] RAMP is a complete starter feed (Cargill Corn Milling, Blair, NE)
[3]Emission were measured during step 1 of step-up diets
[4]Dry matter intake (DMI) was observed intake while in emission chambers

Table 3. Effects of RAMP versus a traditional forage adaptation program (CON) on gas emissions of steers during the finishing period

	Treatments[1]			
	CON	RAMP[2]	SEM	*P*-value
Gas emissions[3]				
DMI, lb/d[4]	26.9	26.0	0.46	0.34
CH_4, g/d	175	159	3.50	< 0.01
CH_4, g/lb of DMI	6.6	6.1	0.13	0.03
CO_2, g/d	10312	10338	96.1	0.85
CO_2, g/lb of DMI	386.9	396.7	7.57	0.39
CH_4:CO_2	0.0170	0.0153	0.0003	<0.01

[1] Treatments included cattle adapted with a traditional forage diet or with RAMP and then fed the same common finisher diet
[2]RAMP is a complete starter feed (Cargill Corn Milling, Blair, NE)
[3]Emission were measured 1 week on finishing diets and at 13 weeks on finishing diets
[4]Dry matter intake (DMI) was used to unitize reported emissions and was averaged from the weekly intakes of each treatment during rotation through the respective emission chambers

manure from the previous five days while cattle were in the barn were measured from 0700 h on d 5 (Monday) to 0700 h on day 6 (Tuesday) to adjust for only enteric emissions and exclude any from manure. After 24 h of manure collection, the manure was removed via skid steer on d 6 (Tuesday). After the manure was removed, CO_2 and CH_4 were measured until the next morning to get a baseline measurement, which was considered d 7, which was the final day in one rotation through the emissions barn. Manure emission levels of CO_2 and CH_4 were subtracted from baseline emission levels of CO_2 and CH_4 to determine the actual cattle production of CH_4 and CO_2 without manure contributions.

Data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) as a randomized complete block design. Pen was the experimental unit. For performance data and for emissions for step 1 of the step-up diet, treatment and BW block were fixed effects. The early and late finishing periods had treatment, BW block, cycle (1 week or 13 weeks on finishing diets), and chamber as fixed effects. Significance was declared at $P \leq 0.05$ and a tendency at $P \leq 0.10$.

Results

No differences in DMI were observed during step 1 of the grain adaptation phase ($P = 0.95$; Table 2). Feeding RAMP during step 1 decreased CH_4 as g/d ($P = 0.03$) by 12% and decreased CH_4:CO_2 ratio ($P = 0.02$) by 18%. Numerically, RAMP decreased CH_4/ lb of DMI by 12%; however, due to variation, the decrease in CH_4/ lb of DMI was not significant ($P = 0.25$). Steers fed RAMP had increased CO_2 as g/day ($P = 0.03$) because of the increased digestibility of the RAMP diet compared to the CON step 1 diet. No significant differences were observed between treatments when CO_2 was expressed as g per lb of DMI ($P = 0.31$).

No differences in DMI were observed due to different adaptation treatments during the 2 finishing period phases ($P = 0.34$; Table 3). Feeding RAMP during the adaptation phase compared to CON adaptation reduced CH_4 on a g/d basis by 9% ($P < 0.01$) and by 8% as g/lb of DMI ($P = 0.03$) during the finishing phase when both treatments were fed the same finishing diet. There was a decrease in the CH_4:CO_2 ratio for the RAMP treatment ($P < 0.01$), which was primarily driven from the decrease in CH_4. The decrease in methane in the finishing phase was a carryover effect from the grain adaptation phase as both treatments were fed the same finishing diet for 1 and 13 weeks prior to measurement.

There were no significant differences in initial BW between treatments as designed ($P = 0.30$; Table 4). During the entire 173 d trial, DMI ($P = 0.80$) and ADG ($P = 0.14$) did not differ among treatments. Cattle adapted with RAMP tended ($P = 0.10$) to have a greater carcass adjusted final BW (1574 lb) compared to the CON treatment (1553 lb; $P = 0.10$). The hot carcass weight was increased by 13 lb for RAMP (991 lb) compared to CON (978 lb; $P = 0.10$) which is similar to the 11 to 19 lb increases observed in other studies designed to better assess performance changes (*2012 Nebraska Beef Cattle Report*, pp 85–86). No significant differences ($P \geq 0.40$) were observed between treatments for marbling, 12th rib back fat, or in LM area. Liver abscess prevalence averaged 47% for both treatments but all abscesses were classified as A- (mild) except for 1 animal.

Conclusion

These data suggest that the complete starter diet, RAMP, was a more digestible diet compared to a traditional forage

Table 4. Effects of RAMP versus a traditional forage adaptation program (CON) on performance and carcass characteristics on fattening steers

	Treatments[1]			
	CON	RAMP[2]	SEM	*P*-value
Performance				
Initial BW, lb	784	786	1.1	0.30
Carcass Adjusted Final BW, lb[3]	1553	1575	6.4	0.10
ADG[4], lb	4.80	4.91	0.04	0.14
DMI, lb/d	25.9	25.8	0.44	0.80
Feed:Gain	5.41	5.24	-	0.24
Carcass characteristics				
HCW, lb	978	991	4.2	0.10
Marbling[5]	608	592	11.1	0.40
LM area, in^2	15.2	14.8	0.40	0.46
12^{th} rib fat, in	0.71	0.70	0.026	0.80
Liver Abscesses, %	47	47	-	-

[1]Treatments included cattle adapted with a traditional forage diet or with RAMP and then fed the same common finisher diet

[2]RAMP is a complete starter feed (Cargill Corn Milling, Blair, NE)

[3]Carcass adjusted final BW was determined from hot carcass weight (HCW) divided by common dressing percentage of 63%

[4]The average days on feed 162 days

[5]Marbling score: 400=small^{00}, 500 = Modest^{00}, 600 = Moderate^{00}, minimum required for U.S. Low Choice

diet program that is used during grain adaptation. Adapting cattle with RAMP reduced methane (g/d) by 12% during grain adaptation. Methane was reduced by 9% (g/d) while cattle were on a common finishing diet due to carryover effects from adapting cattle with RAMP. Using RAMP during grain adaptation could be a strategy to reduce methane emissions. The performance benefits from RAMP would further decrease methane per pound of gain.

Cindy D. Mansfield, graduate student.

Rebecca L. McDermott, research technician.

Braden C. Troyer, research technician.

Mitchell M. Norman, feedlot manager.

Maggie Youngers, Cargill Corn Milling, Blair, NE.

Andera K. Watson, research associate professor, Animal Science, Lincoln.

Rick Stock, expert in residence, Animal Science, Lincoln.

Galen E. Erickson, professor, Animal Science, Lincoln

Acknowledgments; Funding provided by Cargill Corn Milling, Blair, NE.

Nebraska Producer Perceptions on the Role and Implications of Negotiation in Fed Cattle Transactions

TaraLee M. Hudson
Elliott J. Dennis
Brad D. Lubben
James C. MacDonald

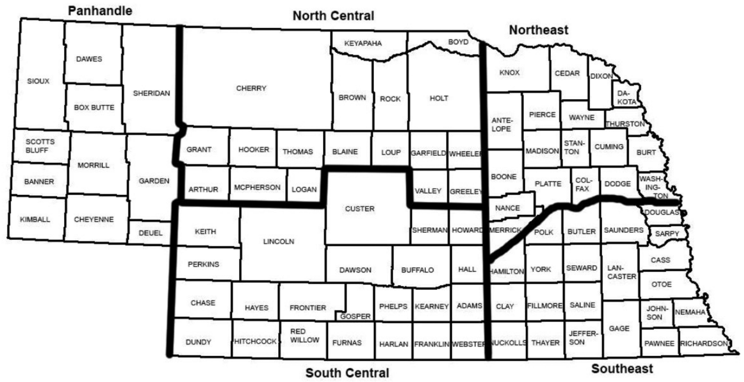


Fig. 1. 2019–2020 Cattle Feeders Directory Map

Summary with Implications

A survey of ten feedlot operators, as identified through the Nebraska Department of Agriculture's (NDA) 2019–2020 Cattle Feeder's Directory was conducted to identify the important concepts related to negotiated transactions and price discovery within the fed cattle market. The surveyed feedlots account for approximately 10 percent of the cattle on feed identified within the directory, on a one-time capacity basis. Conducted in April of 2023 via phone conversation, the questions were related to 1) negotiated cash transactions, 2) the bidding process, and 3) thinning cash trade. Such results lend insight into the marketing practices that currently dominate the fed cattle industry and reveals relevant mechanisms for price discovery. Serving as a proxy for the industry in Nebraska, the survey results implicate future opportunities for a more specific investigation addressing the effectiveness of cattle marketing strategies and their impact on profitability throughout the entire beef value chain.

Introduction

Beef production within recent years has been characterized by uncompetitive outcomes within most sectors of the industry. Repeated Black Swan Events in 2019, 2020, and 2021 has reignited concerns among industry stakeholders regarding current levels of negotiated cash trade and consolidation within the beef packing sector. A Black Swan Event is a label given to describe an unpredictable occurrence that subsequently results in unprecedented price volatility. Such concern has prompted both legislative and voluntary initiatives addressing market transparency and price discovery.

The sale of slaughter-ready cattle in today's fed cattle market is predominantly characterized by four types of transactions including, (1) negotiated cash, (2) negotiated grid, (3) formula trade, and (4) forward contract. In a competitive market environment where perfect information is not available to all market participants, negotiated transactions become critically important in generating new information. The act of negotiating a transaction price contributes to price discovery in that either party utilizes the knowledge that they may have about current supply and demand to arrive at an "ideal" market price. The importance of price discovery within a non-perfect competitive market yields several implications for thinning cash trade within the fed cattle market.

Given that the interaction between the buyer and the seller, or lack thereof, serves as a critical source of information within the market, effort has been devoted to better understand the bidding process and its role within the market. The objective of this survey was to examine the motivations and implications which drive negotiated trade.

Procedure

Using the NDA's 2019–2020 Cattle Feeders Directory, ten feedlot operators were identified by their location, as designated by their directory listing. The NDA designates five cattle-feeding regions within the state of Nebraska: Panhandle, North Central, Northeast, South Central, and Southeast (Figure 1). Via phone conversation, survey participants were asked a series of questions pertaining to three key topics: 1) negotiated cash transactions, 2) the bidding process, and 3) thinning cash trade.

The surveyed feedlots account for approximately 140,000 of the 1.4 million head identified within the directory, on a one-time capacity basis. Participant responses were recorded anonymously via manual transcription.

Results

Negotiated Cash Transactions

Survey participants indicated that they utilize negotiation for the transaction of their fed cattle anywhere between zero and 100 percent of the time. Five respondents declared that they market 70 percent or more of their cattle via negotiated cash or negotiated grid transactions. Three respondents indicated that they utilize negotiation within their marketing strategy for 30 percent or less of all their cattle. One participant indicated that they do not take part in any form of negotiation for the sale of their cattle and has adopted this approach within the past four years. One participant noted that negotiation will typically occur for "commodity cattle" or "cattle that don't fit a program." Another participant specified that the transaction method varied between different cattle within their operation per the preference of the customer who has retained ownership of the cattle throughout the finishing process.

A consensus among survey participants suggested that feedlot operators wish to capture the maximum amount of value they can for each head, which negotiation allows but doesn't necessarily ensure. Several respondents commented about the leverage which currently exists for feedlot operators when negotiating with packer-buyers given the reduced supply of fed cattle, per the timing of the survey. Other participants noted that it is their personal preference to use negotiated grid and negotiated cash transactions and that they are "comfortable in the cash market given the quality of cattle" they are feeding. The same participant noted that "grids have more discounts" and implied that in these types of situations, it is more opportune to trade in the cash market.

Survey responses indicated a significant variation between participants regarding their experiences about which transaction types a packer will entertain. One participant noted that some packers do not allow negotiation for grid-based transactions whereas another participant mentioned that their relationship with their packer-buyers allows them to have an up-front discussion about alternative marketing transactions for their fed cattle.

An additional survey respondent commented about their efforts to design and establish their own grid which various packers would be able to bid. However, integrating this type of transaction was very challenging due to the corporate nature of current beef processors. In their experience, this participant indicated that many packer-buyers were willing to bid on the base price for the grid transaction but first had to have higher approval for the grid and its corresponding values.

Bidding Process

Regarding the acquisition of cash bids from packing facilities, the general feedback provided by participants indicated that they assemble a "show list," known as a listing of cattle within their feedlot that they believe are market ready. Survey respondents also noted that a packer-buyer will typically travel to each feedlot within the week to evaluate the pens of cattle that appear on the show list and provide a bid as to what they believe the value of the cattle are. One participant mentioned that they disperse their show list via text message to their regular packer representatives every Monday morning. Two other respondents acknowledged their use of a third-party consultant for the acquisition and negotiation of cash bids.

Each survey participant indicated that the most important factor in their evaluation of a cash bid is the price value. The next most important factor is the relationship that the feedlot operator has with the packer. One survey participant stated that, "[I] have to be comfortable doing business with them." The third most significant consideration acknowledged by the surveyed feedlot operators was the location or the cattle's proximity to the slaughter facility. Another important consideration is their current knowledge about the number of cattle that have been traded within the past week, specifically within their region. Other factors include the operators' current hedged position within the futures market and how those bids may equate to profit within their marketing strategy. One respondent indicated that an important factor within their decision-making framework is the timing of payment, which builds upon the concept of the relationship between the feedlot and the packer.

To better gauge the level of competition within the fed cattle market throughout Nebraska, survey participants were asked about the quantity of bids they may receive for a pen of cattle. The most predominant response from participants was an average of three to four bids for any lot of cattle. Two operators indicated that they may realistically only receive one bid, while two other operators indicated that they each receive seven or eight bids for any given pen of cattle, respectively. No survey respondents indicated a significant variation in the number of bids that they would receive during different times of the year. The same response was recorded for the number of bids concerning the type of cattle which are being offered.

Thinning Cash Trade

Survey participants provided varying perspectives regarding their opinions about the current volume of negotiated cash sales occurring within the fed cattle market. Several respondents indicated that they would like to see more robust cash trade and that they are not satisfied with the current volume of negotiated transactions. One feedlot operator acknowledged the need for more cash trade given the lower volume of cattle being traded within the market due to the cyclical decline in cattle on feed. Several other respondents indicated that they feel comfortable with the current level of negotiated trade.

None of the surveyed operators indicated that their current feedlot is impacted by the relatively low volume of negotiated cash transactions. One respondent provided a unique perspective about the implications of a thin market, noting that these conditions do not negatively impact the cattle feeder, but rather, harm the cow/calf producer. This comment was in reference to the segregated nature of the beef industry given that changes to the condition of the fed cattle market also potentially reflect to the conditions of the feeder cattle market. Regarding policy initiatives, multiple participants indicated their disfavor towards government intervention within the marketplace, in reference to recent proposals for establishing regionally mandated minimum volumes of cash trade within the fed cattle market. Other participants felt strongly about the need to improve competitiveness through the implementation of minimum cash trade volumes. An additional concern addressed by respondents related to the consolidation that has occurred throughout the beef industry.

Conclusion

The negotiation of a transaction price serves an important role in generating new information within a market through price discovery. Understanding the interaction between the feedlot operator and packer representative via the bid-and-ask process is critical in the exploration of this topic. The questions utilized in this survey reveal the relevant concerns of producers and thus strengthens our insight into these concepts.

The results improve our understanding of bidding and related price discovery mechanisms. As individuals who participate in the market daily, the responses of surveyed feedlot operators lend strong insight into current marketing strategies. The survey results provide direction for future research initiatives, specifically, to examine the relationship between market transactions and profitability at every level of the beef production chain.

TaraLee M. Hudson, graduate student.

Lincoln, Elliott J. Dennis, assistant professor, agricultural economics, Lincoln.

Brad D. Lubben, extension associate professor, Lincoln.

James C. MacDonald, professor, animal science, Lincoln.

Comparison of Corn Silage and Earlage in Finishing Diets when fed as a Roughage on a Neutral Detergent Fiber Basis

Garrett N. Lemon
Rebecca L. McDermott
Alfredo DiCostanzo
Galen E. Erickson
Pablo L. Loza

Summary with Implications

This finishing trial was conducted to evaluate the ability of earlage to serve as a roughage source compared to corn silage when both sources were balanced on an NDF basis. Steers were fed in a randomized block design with a 2×2 treatment arrangement, with one factor being NDF source (corn silage or earlage) and the other factor being inclusion ("normal" amount of roughage provided by corn silage or earlage as the only grain source and roughage source). No significant interactions were observed between roughage source and inclusion level on steer performance. Steers fed corn silage and grain had greater intakes and gains than steers fed earlage. Steers fed less NDF had more efficient feed conversion, and greater gain with heavier hot carcass weights.

Introduction

An ear of corn consists of approximately 80% grain with the remainder being comprised of the cob and husk. Earlage is a feedstuff made of these parts of the corn plant to produce a product that contains both roughage and a concentrate and harvested at high moisture to ensile. Roughage in a finishing diet is fed to help maintain rumen health and prevent acidotic upsets. Inclusion of roughage in the diet can increase dry matter intake (DMI) and average daily gain (ADG). More specifically, balancing a ration based on percentage of roughage in the diet can yield differences in performance when using different roughage sources at the same inclusion. Different roughages contain different proportions of neutral detergent fiber (NDF). Previous research shows that balancing roughage inclusion on an NDF basis in the diet can yield similar performance for cattle fed different roughage sources. Previous literature also indicates dietary NDF inclusion of 8–10% yields optimal gain and efficiency. The objective of this study was to determine the effects on performance and carcass characteristics of cattle fed earlage or corn silage as the source of roughage in the diet while balancing these on an equal NDF basis at two inclusion levels.

Procedure

A finishing trial was conducted at the Panhandle Research, Education, and Extension Center (PREEC) research feedlot near Scottsbluff, NE. Crossbred yearling steers (n=216; initial BW = 1037 lb ± 69 lb) were fed one of 4 experimental diets in a 2×2 factorial treatment arrangement. This trial was designed as a randomized block design with pen as the experimental unit. In the current experiment, NDF inclusion rates were obtained with corn silage representing "normal" dietary roughage inclusion (i.e., corn silage at 15% to supply 7.5% forage in the diet) and then earlage to match that amount of forage NDF provided by corn silage. The other inclusion of roughage was based on the amount of roughage supplied if earlage was the only grain source in the diet. As a result, forage NDF was approximately doubled (14.8% using that approach (74% earlage compared to 30% corn silage). Treatments were designed to evaluate the feeding performance (ADG, DMI, and feed efficiency) and carcass characteristics of cattle fed corn silage or earlage as the sole roughage source, with diets matched in NDF content. Treatments included corn silage at normal NDF inclusion, corn silage at 2X normal NDF inclusion, earlage at normal NDF inclusion DM, and earlage at 2X normal NDF inclusion (Table 1). The forage percentage of each diet was calculated assuming earlage was 20% forage from cob and husk, and silage was 50% forage and 50% grain. The normal inclusion treatment used these forage percentages to provide 7.5% roughage from silage and then matched the inclusion based on equal dietary forage contributed by either roughage source. The 2X normal inclusion of forage was formulated by using earlage as the only grain and roughage source and was 74% of the diet. This diet provided 14.8% forage, so 29.6% silage was included to equalize forage to 74% earlage. Subsequently, based on the initial two formulations, diets were formulated to compare corn silage and earlage when balanced for dietary forage content at two different inclusion levels. Corn silage was harvested, packed, and stored in an uncovered bunker prior to the initiation of the experiment, and contained an average starch content of 34% and averaged 38.0% NDF. Earlage was purchased and delivered to the feedlot as needed throughout the trial. The earlage was stored unpacked and uncovered in a bunker and had an average starch content of 55%, and averaged 20.2% NDF. High moisture corn was stored in an uncovered bunker, and dry rolled corn was supplied in both corn silage diets and the low inclusion (7.5%) earlage diet as a 50:50 blend on a DM basis. Wet distillers grains plus solubles were included at 20% (DM basis), reflecting the most commonly used diet inclusion levels in the industry. A liquid supplement was included at 6% and was formulated to provide 360 mg/steer of monensin (Rumensin, Elanco Animal Health) and 90 mg/steer of tylosin® (Tylan Elanco Animal Health) daily. Feed was offered once a day to target ad libitum intake. A Revalor-200 (Merck Animal Health) implant was administered to all animals on day 0 Initial BW was determined by an average of weights collected on day 0 and 1 while consuming a corn silage diet targeting 2.2% of BW for 30+ days prior to trial initiation to equalize gut fill. Twenty-four pens with 9 steers/pen were used in this trial. Cattle were stratified by weight from day 0 and were subjected to blocking

Table 1. Diet composition of steers fed either earlage or silage at different NDF inclusion levels (% diet DM)

	Treatments[1]			
	Corn Silage		Earlage	
Ingredient	Normal (7.5%)	2X (14.8%)	Normal (7.5%)	2X (14.8%)
Earlage	0	0	37.5	74
Corn silage	15	29.6	0	0
High-moisture corn	29.5	22.2	18.5	0
Dry-rolled corn	29.5	22.2	18.5	0
Wet distiller's grains	20	20	20	20
Supplement[2]	6	6	6	6
Nutrient Analysis				
%NDF from roughage, DM basis[3]	5.7	11.2	7.5	14.8
%Total NDF	19.2	23.2	18.9	22.7
%Total Starch	47.1	41.8	46.8	41.2
%CP, DM basis[4]	12.3	12.2	12.6	12.6

[1]Normal = 7.5% NDF, 2X = 14.8% forage inclusion on DM basis

[2]Supplement (Midwest PMS LLC.) was formulated to meet requirements of vitamins and minerals, and approximately 0.92% of the diet as urea on a DM basis

[3]NDF percentage in the diet is calculated from NDF supplied by roughage in the diet

[4]Values presented for CP include values from all feeds given in the diet except the supplement

criteria based on initial body weight and to reduce BW variation. All blocks started on the same day and were fed for 120 days. Three body weight blocks were used (light, medium, and heavy), with 2 treatment repetitions within each block. Live body weights were collected 1 day prior to cattle shipment to a commercial abattoir. Upon harvest, hot carcass weights (HCW), and liver abscess scores were recorded. Carcass adjusted final body weights were calculated using a common 63% dressing percentage. Following a 48-hr chill, *Longissimus* muscle (LM) area, 12th rib fat thickness, marbling score, and USDA quality and Yield grades were collected. Net energy values were calculated using DMI and ADG data with the heaviest pen average as the target end weight for each block and choice as the target finishing quality grade.

Data were analyzed using the Mixed procedure of SAS. Pen was the experimental unit and treatment and block were fixed effects. Interactions between roughage source and inclusion were tested. When interactions were not significant, main effects for either roughage source or inclusion were evaluated. Liver abscess incidence data were analyzed using the GLIMMIX procedure of SAS as a binomial distribution.

Results

Upon lab analysis for NDF content of earlage and corn silage, NDF content of corn silage was 38.0%, which is on the lower end of NDF values presented in the NRC (43 ± 5.50). This provided 5.3% NDF from corn silage at the normal inclusion and 10.4% NDF at the matched 2X normal inclusion of forage. Earlage was 20.2% NDF which reflects NRC values for earlage NDF (21 ± 5.6) and provided 7.5% NDF at the matched normal inclusion of forage and 14.9% NDF at the 2X normal inclusion. Differences in NDF content of these two roughage sources led to greater differences in forage NDF at both inclusions.

When evaluating the interaction between roughage source and inclusion (Table 2), no interaction was observed for gain, intake, feed conversion, or carcass characteristics ($P \geq 0.13$) except for a tendency present with marbling score ($P = 0.08$). Cattle fed corn silage at 15 or 30% of the diet had equal ($P > 0.33$) marbling scores (526) which was equal to the lower inclusion of earlage (529). When the only grain source was earlage, marbling was lowest (493; $P < 0.09$). A tendency for an interaction was also observed for percentage of animals with liver abscesses ($P = 0.09$). When examining forage type, liver abscess percentage did not differ ($P = 0.27$) among inclusion levels of dietary NDF. Liver abscess prevalence was greater (P = 0.09) for cattle fed earlage compared to corn silage when fed at the normal inclusion of NDF, but was not different between roughage sources at the 2X normal NDF inclusion. The prevalence of A+ liver abscesses among all animals was 8%, and of animals with a liver abscess, A+ liver abscess accounted for 15% of those. No other interactions were observed so the main effects of roughage type and inclusion level will be discussed.

When analyzing main effects for roughage source, greater intakes were observed in cattle fed corn silage which led to those cattle also having greater ADG ($P \leq 0.01$) than those fed earlage. The steers fed corn silage consumed more which allowed them to gain more, resulting in similar F:G ($P = 0.36$) between the two roughage sources. Hot carcass weights were significantly greater when cattle were fed corn silage as the roughage source ($P = 0.02$).

Feed conversion was impacted by NDF inclusion from roughage. Cattle that were fed the 7.5% roughage were 6% more efficient ($P < 0.01$) when compared to the 14.8% forage and tended to have greater ADG ($P = 0.10$) treatments while DMI between inclusion was similar ($P = 0.11$). Hot carcass weight was also greater in steers fed the normal inclusion of dietary NDF (P = 0.03). No other significant differences were observed for the main effects of roughage type or NDF inclusion.

Net energy utilization for maintenance (NEm), gain (NEg), and metabolizable energy were also analyzed using calculations with values derived from the NRC. Significant differences were present for all net energy calculations ($P < 0.01$). The normal forage inclusion (7.5%) for both roughages showed greater energy concentrations for NEm, NEg, and ME compared to 2X inclusion. However, these calculations that are based on feed conversion are not good reflections of intake and gain responses, and usually favor lower intakes. Cattle fed less roughage had greater calculated energy concentrations, similar to the F:G response. Cattle fed silage were equivalent to cattle fed earlage for calculated energy concentration, which also is similar to the F:G responses observed. Using net energy

Table 2. Carcass adjusted performance of cattle fed corn silage or earlage at equal NDF inclusions

	Treatments					*P*-values		
	Corn Silage		Earlage					
Item	Normal (7.5%)	2X (14.8%)	Normal (7.5%)	2X (14.8%)	SEM	Roughage* Inclusion[1]	Roughage source	Inclusion
Performance								
Initial BW, lb	1038	1036	1037	1038	1.4	0.26	0.73	0.73
Final BW, lb[2]	1456	1423	1420	1394	12.5	0.80	0.02	0.03
DMI, lb/d	29.8	31.0	29.0	29.0	0.39	0.13	<0.01	0.11
ADG, lb	3.99	3.79	3.70	3.58	0.092	0.65	0.01	0.10
F:G	7.45	8.18	7.82	8.11	—	0.18	0.35	<0.01
Net Energy Utilization[3]								
NEm, Mcal/lb	0.74	0.69	0.73	0.69	0.012	0.33	0.46	<0.01
NEg, Mcal/lb	0.47	0.42	0.45	0.42	0.010	0.29	0.39	<0.01
ME, Mcal/lb	1.16	1.09	1.13	1.09	0.014	0.30	0.41	<0.01
Carcass Characteristics								
HCW, lb	917	897	895	878	7.9	0.81	0.02	0.03
Dressing, %	60.1	60.0	60.1	60.0	0.37	0.71	0.20	0.20
LM Area, in²	13.4	13.3	13.1	13.5	0.17	0.14	0.82	0.25
Marbling Score[4]	523	527	529	493	11.0	0.05	0.22	0.17
12th rib fat, in	0.66	0.61	0.60	0.60	0.022	0.38	0.15	0.28
Calculated YG[5]	3.53	3.42	3.46	3.48	0.080	0.39	0.96	0.60
Liver Abscess, %[6]	35	46	52	38	—	0.09	0.27	0.86

[1]Interaction between roughage type and inclusion level

[2]Final BW is HCW adjusted to a common dressing percentage of 63%

[3]Calculated using values from the Beef NRC (2016)

[4]Fat marbling is scored as 400+ = slight, 500+ = modest, 600+ = moderate etc.

[5]Calculated yield grade = 2.5 + (2.5*fat thickness)—(0.32*LM area) + (0.2*2.5) + (0.0038*HCW)

[6]Liver abscess data was analyzed as a binomial distribution

calculations from performance illustrates that the responses are similar to F:G observations. Cattle fed silage as a roughage source consumed more and gained more than cattle fed earlage, which is not accounted for in these calculations of energy concentration.

Conclusion

Feeding earlage as the sole roughage and grain source or at approximately half of the grain and normal inclusion of roughage in a finishing diet resulted in lower intake and gain but did not impact feed conversion compared to feeding silage and grain. Feeding 2X the normal amount of NDF used in these diets did not significantly affect ADG but feed conversion was negatively impacted with more roughage.

Garrett N. Lemon, graduate student.

Rebecca L. McDermott, research technician.

Alfredo DiCostanzo, beef systems extension educator, West Point.

Galen E. Erickson, professor, Animal Science, Lincoln.

Pablo L. Loza, professor, Animal Science, Panhandle Research and Extension Center, Scottsbluff.

Impact of Feeding New Fractionated Distillers Grains (Fiber plus Syrup) on Feedlot Cattle Performance and Carcass Characteristics

Debora G. Sousa
Rebecca L. McDermott
Mitch M. Norman
James C. MacDonald
Rick Stock
Ryan A. Mass
Galen E. Erickson

Summary with Implications

Fractionation processes are being explored to supply higher protein distillers grains for premium markets. Resulting distillers grains after a fraction is isolated will still be marketed as a cattle feed so knowing the impact on performance is important. This study evaluated feeding wet or dry conventional distillers grains with wet and dry fractionated distillers (fiber plus syrup) fed at 0, 20, or 40% of diet DM. When compared to the corn control, intake and gain increased for each of the four distillers types were fed, but feed conversion was poorer (i.e., increased) for dry distillers grains and dry fiber plus syrup whereas feed conversion was equal across 0, 20, or 40% inclusion for wet distillers grains and wet fiber plus syrup. Fractionation process did impact feed conversion by decreasing 3% when fed at 20 or 40% compared to conventional distillers grains plus solubles and as expected, dry byproducts perform poorer than wet byproducts.

Introduction

Changes in production in the ethanol industry to produce differentiated feeds and improve ethanol production efficiency have resulted in new distillers grains type feeds available for use in cattle feeding. Partial grain fractionation technology consists of separating the corn kernel into germ, endosperm, and bran. The germ is used for oil extraction, the bran for cattle feed, and the endosperm after fermentation will result in a high-protein, lower-fat product called high-protein DDGS. The remaining syrup plus fiber can be dry or wet and can also be used for cattle feeding but there are not many studies investigating the effects of these by-products on the performance of feedlot cattle. The hypothesis was that feeding steers with fiber plus syrup (F+S) would not negatively affect cattle performance. The objective of this study was to evaluate the energy value of dry and wet fiber plus syrup compared to traditional wet and dry distillers grains plus solubles using cattle finishing performance.

Procedure

The experiment was conducted at the Eastern Nebraska Research, Extension, and Education Center near Mead, NE. Six hundred crossbred steers (initial BW= 660 lb; SD = 45 lb) were fed for an average of 182 days. The steers were allocated in 40 pens with 15 steers per pen, the treatments were randomly allocated to pens with the control treatment having 8 pens (120 steers) and each treatment (20 and 40% inclusion of four different distillers byproducts) containing byproducts having 4 pens (60 steers) each. The experiment was conducted in a randomized block design, with three BW blocks: heavy, medium, and light, where initial BW was used as a blocking factor. The initial live weight was determined using the average weights from two consecutive days. Before weighing, the steers were limit-fed at 2% of body weight for 5 days, during which time the diet was comprised of 50% alfalfa hay and 50% Sweet Bran (DM basis) to equalize gut fill. Pen was considered the experimental unit and the treatments were assigned randomly to pens. On day 1, the steers received a Revalor-IS implant (80 mg trenbolone acetate and 16 mg of estradiol; Merck Animal Health) and were re-implanted on days d 52 or 55 with Revalor-200 implant (200 mg trenbolone acetate and 20 mg of estradiol; Merck Animal Health). Cattle were supplemented with 300 mg ractopamine/steer daily (Optaflexx; Elanco Animal Health) for the last 28 days of the feeding period.

The treatment design was a 4×2+1 factorial, with one factor being four distillers grains types and other factor was the inclusion at 20% or 40%, along with a corn control. Byproduct types were dry distillers grains plus solubles (DDGS; NDF= 36.8%; CP= 30.22; Ether extract= 9.5%), wet distillers grains plus solubles (WDGS; NDF= 45%; CP= 31.7%; Ether extract= 9.3%), dry fiber plus solubles (Dry F+S; NDF= 41.1%; CP= 21.84%; Ether extract= 8.4%),), and wet fiber plus solubles (Wet F+S; NDF= 49.7%; CP= 22.67%; Ether extract= 8.5%),). All distillers were produced at one plant (ICM, St. Joseph, MO). The fractionated products were produced using the prefractionation process utilized by ICM whereby high protein distillers grains is produced resulting in a feed product labeled fiber plus syrup. In that process, distillers grains are produced that are lower in protein and greater in fiber, but also allows for more solubles to be applied to the isolated fiber product. Due to the production process, not all of the solubles could be added to Wet F+S, so those diets included distillers solubles (syrup) at the ratio needed to match Dry F+S. All materials were received from the same plant, twice over the feeding period and stored. Wet products (WDGS and Wet F+S) were stored in silo bags and dry products stored in a commodity shed under roof. Diets also contained a blend of high-moisture corn and dry-rolled corn along with roughage and supplement (Table 1).

Cattle were harvested at a commercial abattoir located in Omaha, NE. On the day of slaughter, hot carcass weight (HCW) and liver score data were collected whereas 12th rib fat, LM area, and USDA marbling score were collected 46 hours after slaughter. Data were analyzed using the MIXED procedure of SAS with pen as experimental unit. Orthogonal contrast statements were used to separate linear and quadratic effects of distillers grains type inclusion in the diet.

Table 1 Diets fed to finishing steers to evaluate energy of new fiber plus syrup distillers fed wet or dry compared to dry distillers grains plus solubles (DDGS) or wet distillers grains plus solubles (WDGS).

	Treatments[1]								
		DDGS		Dry F+S		WDGS		Wet F+S	
Ingredient, % DM[2]	Control	20%	40%	20%	40%	20%	40%	20%	40%
HMC	39	30	20	29.5	20	30	20	29.5	20
DRC	39	30	20	29.5	20	30	20	29.5	20
Corn silage	15	15	15	15	15	15	15	15	15
DDGS	-	20	40	-	-	-	-	-	-
Dry FS	-	-	-	20	40	-	-	-	-
WDGS	-	-	-	-	-	20	40	-	-
Wet FS	-	-	-	-	-	-	-	17	34
Syrup	-	-	-	-	-	-	-	3	6
Empyreal	2	-	-	1	-	-	-	1	-
Supplement 1[3]	5	1.67	-	2.5	-	1.67	-	2.5	-
Supplement 2[3]	-	3.33	5	2.5	5	3.33	5	2.5	5
Analyzed composition									
CP	12.00	13.15	16.73	12.69	13.38	13.44	17.33	13.72	15.44
NDF	14.57	19.94	25.22	20.75	26.94	21.58	28.50	20.98	27.39
Ether extract	3.51	4.81	5.99	3.47	3.93	4.77	5.91	4.53	5.55
S	0.13	0.23	0.34	0.24	0.35	0.22	0.33	0.25	0.38

[1] Treatments were due to byproduct type and inclusion in the diet; Control= control diet with no DDGS, WDGS, dry FS or wet FS inclusion; DDGS 20% = inclusion of 20% dry distillers grain solubles; DDGS 40% = inclusion of 40% dry distillers grain solubles; Dry F+S 20% = inclusion of 20% dry fiber plus syrup; Dry F+S 40% = inclusion of 40% dry fiber plus syrup; Wet F+S 20% = inclusion of 20% wet fiber plus syrup; Wet F+S 40% = inclusion of 40% wet fiber plus syrup; WDGS 20% = inclusion of 20% wet distillers grain solubles; WDGS 40% = inclusion of 40% wet distillers grain solubles (DM basis).

[2]HMC=high-moisture corn, DRC=dry-rolled corn, dry FS = dry fiber plus syrup, wet FS = wet fiber plus syrup, Empyreal is branded corn gluten meal to provide rumen undegradable protein (Cargill milling), DDGS= dry distillers grain solubles, WDGS= wet distillers grain solubles.

[3]Supplement 1 contained 1.2% urea and 1.63% fine ground corn in the diet. Supplement 2 contained no urea and 2.83% fine ground corn. Both supplements provided Rumensin (30 g/ton of DM), Tylan (8.8 g/ton of DM), tallow, minerals, vitamins, salt, and limestone.

Table 2. Effect of new fiber plus syrup fed compared to wet or dry distillers inclusion on performance and carcass characteristics of finishing steers.

	Treatments[1]							
	DDGS		Dry F+S		WDGS		Wet F+S	
Item	*Linear P-value*	*Quadratic P-value*	*Linear P-value*	*Quadratic P-value*	*Linear P-value*	*Quadratic P-value*	*Linear P-value*	*Quadratic P-value*
Performance								
Initial BW, lb	0.71	0.82	0.14	0.32	0.35	0.79	0.63	0.94
Final BW, lb[2]	0.03	0.29	0.11	0.13	0.08	0.22	0.01	0.50
DMI, lb/d	<0.01	0.64	<0.01	0.05	0.07	0.13	<0.01	0.07
ADG, lb	0.03	0.31	0.08	0.17	0.09	0.21	0.01	0.51
F:G[3]	0.10	0.34	<0.01	0.89	0.45	0.69	0.45	0.46
Carcass characteristics								
HCW, lb	0.03	0.29	0.11	0.13	0.08	0.22	<0.01	0.50
12th rib fat, in	0.36	0.48	0.33	0.41	0.33	0.90	0.96	0.93
LM area, in[4]	0.02	0.86	0.02	0.10	0.08	0.60	0.03	0.19
Marbling score	0.71	0.81	0.60	0.24	0.10	0.82	0.15	0.83
Yield Grade	0.70	0.54	0.25	0.54	0.25	0.84	0.70	0.84

[1] Treatments were due to byproduct type and inclusion in the diet; DDGS 20% = inclusion of 20% dry distiller's grain solubles; DDGS 40% = inclusion of 40% dry distiller's grain solubles; Dry F+S 20% = inclusion of 20% dry fiber plus syrup; Dry F+S 40% = inclusion of 40% dry fiber plus syrup; Wet F+S 20% = inclusion of 20% wet fiber plus syrup; Wet F+S 40% = inclusion of 40% wet fiber plus syrup; WDGS 20% = inclusion of 20% wet distiller's grain solubles; WDGS 40% = inclusion of 40% wet distiller's grain solubles (DM basis).

[2] Final BW calculated as HCW divided by a common dressing percentage of 63%.

[3]Analyzed as G:F, the reciprocal of F:G

[4] LM area = longissimus muscle (ribeye) area

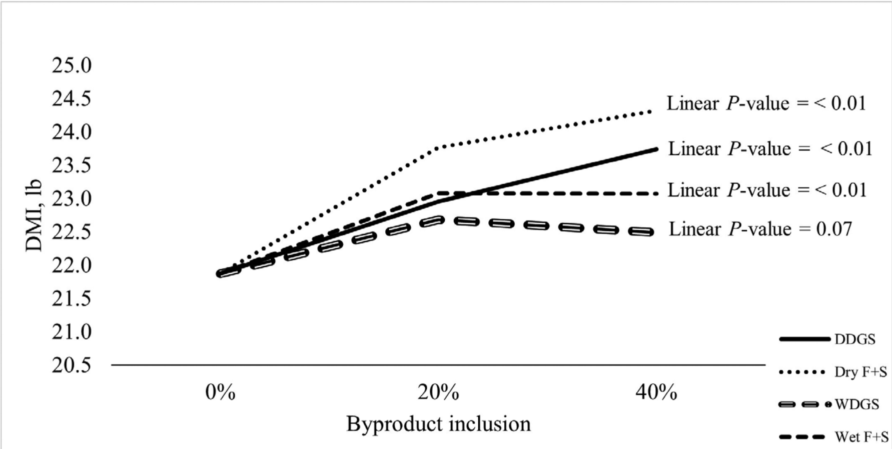


Fig. 1. Effect of byproduct type (DDGS, Dry F+S, WDGS and Wet F+S) and inclusion (0%, 20% or 40%) on DMI.

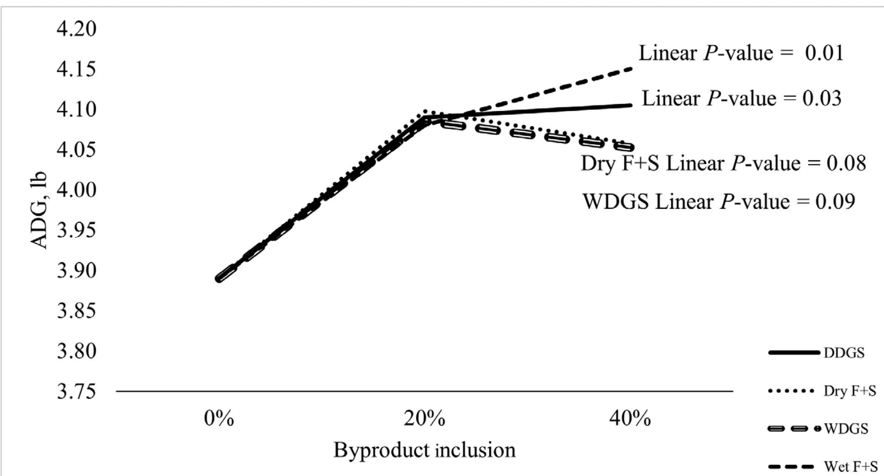


Fig. 2. Effect of byproduct type (DDGS, Dry F+S, WDGD and Wet F+S) and inclusion (0%, 20% or 40%) on ADG.

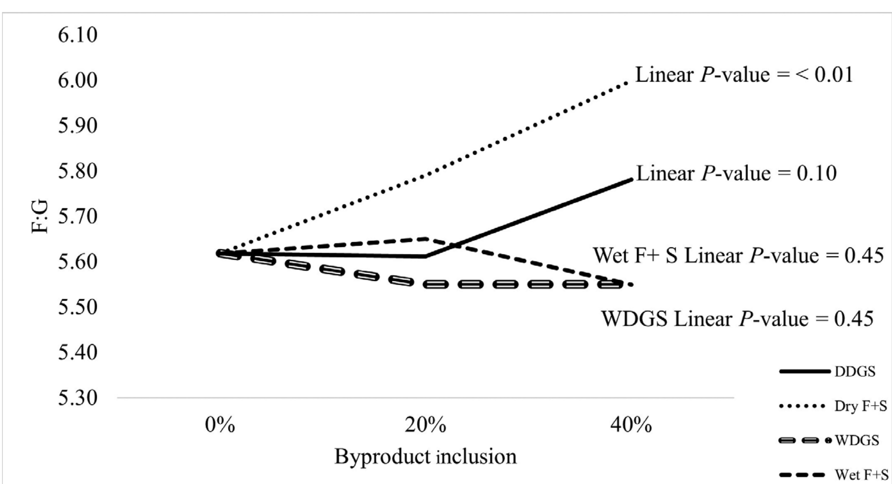


Fig. 3. Effect of byproduct type (DDGS, Dry F+S, WDGD and Wet F+S) and inclusion (0%, 20% or 40%) on feed to gain ratio. The linear interaction of byproduct type and inclusion was analyzed as Gain:Feed.

The factors included in the model were byproduct type (DDGS, Dry F+S, WDGD and Wet F+S) and inclusion (20% or 40%). Pen was considered the experimental unit and block treated as a fixed effect. To evaluate the interaction between processing method, moisture, and inclusion, a separate statistical analysis (ANOVA) was performed using the MIXED procedure (SAS Inst. Inc.). For this analysis, the control treatment was ignored, and the data were analyzed as a 2×2×2 factorial, where the factors were processing method (ICM or Traditional), moisture (dry and wet), and inclusion (20% or 40%).

Results

A quadratic effect was observed for DMI in the Dry F+S treatment ($P = 0.05$) where intake increased for 20% and 40% inclusion compared to control (Table 2). A linear increase in DMI was observed as DDGS ($P < 0.01$), Dry F+S ($P < 0.01$), and Wet F+S ($P < 0.01$) were added to diets and tended to increase linearly for WDGS ($P = 0.07$; Figure 1). Feeding DDGS ($P = 0.03$) and Wet F+S ($P = 0.01$) linearly increased ADG whereas feeding Dry F+S ($P = 0.08$) and WDGS ($P = 0.09$) tended to linearly increase ADG relative to the control (Figure 2). Despite increased ADG, F:G linearly increased as Dry F+ S ($P < 0.01$) replaced corn and tended to increase for DDGS ($P = 0.10$) as well (Figure 3). Due to proportional increases in DMI and ADG, no changes in F:G were observed for steers as Wet F+S ($P = 0.45$) or WDGS ($P = 0.45$) replaced corn at 20 to 40%. Based on F:G, WDGS and Wet F+S appear similar whereas both dry byproducts performed similar but worse than the corn they replaced. A linear effect was observed for HCW and LM area, where DDGS ($P = 0.03$) and Wet F+S ($P = 0.01$) treatments showed a linear increase in HCW with increasing inclusion of DDGS or Wet F+S, and tended to for inclusion of Dry F+S ($P = 0.11$) and WDGS ($P = 0.08$). A linear increase for LM area was observed as inclusion of DDGS ($P = 0.02$), Dry F+S ($P = 0.02$), and Wet F+S ($P = 0.01$) increased and tended to increase with inclusion of WDGS ($P = 0.08$). No linear or quadratic effects were observed for 12th rib fat, YG, and marbling score due to increasing inclusion of any of the distillers byprod-

Table 3. Interaction effect between moisture and inclusion of byproducts on performance and carcass characteristics of finishing steers.

	Moisture × Inclusion[1]					
	Dry		Wet			
Item	20%	40%	20%	40%	SEM	*P*-value
Performance						
Initial BW, lb	660	659	660	661	0.5	0.22
Final BW, lb[2]	1404	1400	1402	1406	9.2	0.63
DMI, lb/d	23.3[b]	24.0[c]	22.9[a]	22.8[a]	0.16	0.03
ADG, lb	4.09	4.08	4.08	4.10	0.050	0.75
F:G[3]	5.71[b]	5.88[c]	5.59[ab]	5.55[a]	-	0.04
Carcass characteristics						
HCW, lb	885	882	883	886	5.8	0.64
12th rib fat, in	0.56	0.56	0.56	0.55	0.013	0.85
LM area, in[4]	14.4	14.6	14.1	14.5	0.13	0.36
Marbling score	499	496	484	486	8.9	0.72
Yield Grade	3.41	3.39	3.39	3.37	0.036	0.86

[1] Byproducts moisture: dry or wet, Byproducts inclusion: 20% and 40%.

[2] Final BW calculated as HCW divided by a common dressing percentage of 63%.

[3] Analyzed as G:F, the reciprocal of F:G

[4] LM area = longissimus muscle (ribeye) area

Table 4. Main effects of ICM or traditional processing method on performance and carcass characteristics of finishing steers.

	Processing Method[1]			
Item	ICM	Traditional	SEM	*P*-value
Performance				
Initial BW, lb	660	660	0.4	0.62
Final BW, lb[2]	1404	1402	6.6	0.86
DMI, lb/d	23.5	22.9	0.12	<0.01
ADG, lb	4.09	4.08	0.036	0.79
F:G[3]	5.75	5.62	-	0.03
Carcass characteristics				
HCW, lb	884	883	4.1	0.86
12th rib fat, in	0.56	0.56	0.010	0.93
LM area, in[4]	14.4	14.4	0.09	0.67
Marbling score	504	478	6.4	0.01
Yield Grade	3.39	3.39	0.026	0.86

[1] Processing method of byproducts, ICM method= wet and dry F+S; traditional method= DDGS and WDGS

[2] Final BW calculated as HCW divided by a common dressing percentage of 63%.

[3] Analyzed as G:F, the reciprocal of F:G

[4] LM area = longissimus muscle (ribeye) area

ucts. Feeding WDGS tended to decrease marbling score linearly as WDGS inclusion increased ($P = 0.10$) with no impact due to other byproducts.

For the 2×2×2 factorial, there was an interaction between inclusion (20% or 40%) and moisture (dry or wet) for DMI ($P = 0.03$) and F:G ($P = 0.04$). When dry byproduct inclusion increased, DMI increased ($P < 0.01$) whereas no difference was observed due to increasing inclusion of wet byproducts ($P = 0.67$). Steers fed dry byproducts had an increase in F:G as a result of increasing inclusion ($P = 0.02$), but there was no difference in F:G from steers fed wet byproducts ($P = 0.45$; Table 3). No other interactions were observed between inclusion, moisture content, or ethanol production process ($P > 0.62$), but there were main effects due to production process.

Steers fed byproducts produced by the traditional method had lower DMI than steers fed byproducts produced using the ICM fractionation method ($P < 0.01$). As there was no difference in ADG ($P = 0.79$), this resulted in slightly improved F:G of animals fed byproducts produced by the traditional method ($P = 0.03$; Table 4), which averaged 2.78% improvement for an average inclusion of 30% (average of 20 and 40%).

Conclusion

When compared to corn, feeding both types of distillers grains as either wet or dry increased gain, but either intake increased more resulting in poorer feed conversions in the case of dry distillers or the new dry fiber plus solubles, or did not impact feed conversion for both types of wet feeds as inclusion increased from 0 to 40%. When evaluating only 20 and 40% inclusion, gain was not impacted but feed conversion was poorer for dry byproducts compared to wet byproducts. The traditional distillers grains were slightly (3%) better than fractionated fiber plus syrup distillers byproducts due to slightly greater intakes and similar gain.

Debora G. Sousa, graduate student.

Rebecca L. McDermott, research technician.

Mitch M. Norman, research technician.

James C. MacDonald, professor, Animal Science, Lincoln.

Rick Stock, professor, Animal Science, Lincoln.

Ryan A. Mass, ICM Biofuels, Colwich, KS.

Galen E. Erickson, professor, Animal Science, Lincoln.

Acknowledgements to ICM Inc (Kolwich, KS) for supplying the distillers grains products used in this study.

Impact of Varying Inclusion of Modified Distillers Grains Plus Solubles Compared to Constant Inclusion on Feedlot Cattle Performance and Carcass Characteristics

Debora G. Sousa
Rebecca L. McDermott
Mitch M. Norman
James C. MacDonald
Rick A. Stock
Galen E. Erickson

Summary with Implications

An experiment was conducted to evaluate the effect of varying inclusion of modified distillers grains plus solubles on a weekly basis with two inclusions of grass hay on the performance of finishing steers. No interaction was observed between modified distillers grains plus solubles inclusion (0%, 25% constant, or 25% varying from 15–35%) and hay inclusion (6% or 12%). When evaluating the effect of hay inclusion on performance, cattle fed 6% grass hay had less dry matter intake than those fed 12% grass hay, and there was a tendency for gains to be greater for cattle fed 6% grass hay. Adding 25% modified distillers grains plus solubles to the diet improved gain and feed conversion. Interestingly, varying modified distillers grains plus solubles inclusion from 15 to 35% (averaged 25% over the whole feeding period) did not impact average daily gain or feed conversions if the variations were weekly and the average inclusion was 25% during the feeding period. As a result, adding extra roughage was unnecessary.

Introduction

The inclusion of distillers grains has been used extensively by the beef industry as a protein supplement (inclusions < 15%) or an energy source (inclusions > 15%). With increasing availability and competitive prices, inclusions increased for many feedyards as a replacement for corn with inclusions of 30% or more. More recently, the inclusion of distillers grains in beef finishing diets has been decreasing due to inconsistent supply or availability at a competitive price. In all previous research evaluating the energy value and economic opportunity for feeding distillers grains, inclusion never varied, which may not mimic what producers experience with varying supply over the feeding period for their cattle. Our hypothesis was that varying inclusion of MDGS in the diet would negatively impact cattle performance as varying MDGS in the diet also leads to varying corn content which may increase risk of acidosis. One solution to help with ruminal acidosis concerns with variable MDGS inclusion would be increasing roughage inclusion. Therefore, our objective was to evaluate if varying the inclusion of modified distillers grains plus solubles (MDGS) would impact performance compared to a constant inclusion, at either normal or elevated roughage inclusions.

Procedure

The experiment was conducted at the Eastern Nebraska Research, Extension, and Education Center near Mead, NE. Five hundred seventy-six crossbred steers (initial BW= 836 lb; SD = 52 lb) were fed for an average of 144 days. Before the study began, steers were restricted to 50% alfalfa hay and 50% Sweet Bran (DM basis) fed at 2% of body weight (BW) for 5 days to equalize gut fill. The initial BW was determined using the average of two weights collected across 2 days. The experiment was conducted in a randomized block design, with three body weight (BW) blocks: heavy, medium, and light, based on initial BW.

The treatment design was 2×3 factorial, with one factor being two inclusions of grass hay as the sole roughage source at 6% or 12%. The other factor was three inclusions or approaches to feeding MDGS. Inclusions were either 0 (0% MDGS) or 25% MDGS. Two treatments, both averaged 25% inclusion, but with either MDGS kept constant at 25% inclusion (25% constant), or inclusion varied from 15 to 35% by adjusting inclusion weekly so that at the end of the feeding period, inclusion averaged 25% of diet DM. For the variable inclusion (25% variable) either 15, 20, 25, 30, or 35% was fed. Inclusion variations occurred weekly, and each week's MDGS inclusion was randomly determined before the start of the experiment. Diet compositions are shown in Table 1. Pen was considered the experimental unit and the treatments were assigned randomly to pens, with each treatment replicated across 6 pens with 16 steers per pen, totalizing 36 pens.

On day 1, the steers received Revalor-IS (80 mg trenbolone acetate and 16 mg of estradiol; Merck Animal Health) and were re-implanted on days 52 or 55 with Revalor-200 (200 mg trenbolone acetate and 20 mg of estradiol; Merck Animal Health). Cattle in the heavy and medium blocks were supplemented with 300 mg ractopamine/steer daily (Optaflexx; Elanco Animal Health) for the last 28 days of the feeding period and the light block was supplemented during the last 42 days (all steers started on Optaflexx on the same day). Heavy and medium block cattle were fed for 137 days, light block cattle were fed for 151 days, and they were harvested at a commercial abattoir located in Omaha, NE. Hot carcass weight (HCW), and liver score data were collected during the harvest. 46 hours after slaughter. 12th rib fat, *longissimus* muscle (LM) area and USDA marbling score were collected, and yield grade (YG) was calculated.

Data were analyzed using the MIXED procedure of SAS 9.4 as a 2×3 factorial and pen was considered the experimental unit. The fixed effects included in the model were grass hay inclusion (6% and 12%) and MDGS inclusion (0% MDGS, 25% MDGS constant, 25% variable MDGS), grass hay × MDGS interaction, and block. If no interaction was detected, the main effects of roughage inclusion and MDGS inclusion are presented. If a significant interaction was observed, then simple effects of MDGS inclusion within each roughage inclusion are presented.

Table 1. Composition of experimental diets fed to steers consuming two inclusions of grass hay and three distillers' grains inclusion strategies

	Treatments[1]													
	6% Grass Hay							12% Grass Hay						
		25%	Variable MDGS						25%	Variable MDGS				
Item	0% MDGS	MDGS Constant	15%	20%	25%	30%	35%	0% MDGS	MDGS Constant	15%	20%	25%	30%	35%
Ingredient[1], %														
HMC	44	31.5	36.5	34	31.5	29	26.5	41	28.5	33.5	31	28.5	26	23.5
DRC	44	31.5	36.5	34	31.5	29	26.5	41	28.5	33.5	31	28.5	26	23.5
Grass Hay	6	6	6	6	6	6	6	12	12	12	12	12	12	12
MDGS	-	25	15	20	25	30	35	-	25	15	20	25	30	35
Supplement 1[2]	6	-	3	1.2	-	-	-	6	-	3	1.2	-	-	-
Supplement 2[2]	-	6	3	4.8	6	6	6	-	6	3	4.8	6	6	6

[1] HMC=high-moisture corn, DRC=dry-rolled corn, MDGS= modified distillers grains plus solubles.

[2] Supplement 1 provided 2.31% soybean meal and 1.5% urea in the diet. Supplement 2 provided no urea and fine ground corn was used as a carrier to replace the soybean meal. Both supplements provided Rumensin (30 g/ton of DM), Tylan (8.8 g/ton of DM), minerals, vitamins, salt, and limestone.

Table 2. Main effects of roughage inclusion on performance and carcass characteristics of finishing steers

	Treatments[1]			
Item	6% Grass Hay	12% Grass Hay	SEM	*P*- value
Performance				
Initial BW, lb	867	866	0.5	0.13
Final BW[2], lb	1546	1518	5.7	<0.01
DMI, lb/d	28.9	30.0	0.17	<0.01
ADG, lb	4.80	4.61	0.04	0.07
F:G	6.02	6.49	0.001	<0.01
Carcass characteristics				
HCW, lb	974	956	3.6	<0.01
12th rib fat, in	0.66	0.65	0.010	0.61
LM area, in²	14.9	14.7	0.09	0.07
Marbling score	485	488	6.4	0.70
Yield grade	3.41	3.41	0.022	1.00

[1] The treatments were due to grass hay inclusion in the diet. Grass Hay 6%= inclusion of 6% grass hay in the diet, Grass Hay 12%= inclusion of 12% grass hay in the diet (DM basis)

[2] Final BW calculated as HCW divided by a common dressing percentage of 63%.

Results

No interaction was observed between grass hay inclusion and MDGS treatment ($P \geq 0.37$) for any performance and carcass characteristics except for a tendency for F:G ($P = 0.09$). Cattle fed 6% hay tended to have similar F:G with all MDGS treatments (0% MDGS = 5.98, 25% MDGS constant = 6.02, MDGS variable = 6.02), but in treatments with 12% hay, the inclusion of MDGS improved F:G compared to 0% MDGS inclusion (0% MDGS = 6.66, 25% MDGS constant = 6.45, MDGS variable = 6.41). For all other variables, only main effects of either grass hay or MDGS treatment will be presented.

As expected, cattle fed 12% grass hay had greater dry matter intake (DMI; 30.0 lb/d) than steers fed 6% grass hay (28.9 lb/d; $P < 0.01$; Table 2). Steers fed 12% grass hay tended to have reduced ($P = 0.07$) average daily gain (ADG; 4.61 lb) compared to steers fed 6% grass hay (ADG =4.80 lb). Of the carcass traits, only HCW was significantly reduced ($P < 0.01$) for steers fed 12% grass hay (956 lb) compared to steers fed 6% grass hay (974 lb). There were no significant differences ($P \geq 0.61$) between 6 or 12% grass hay for other carcass characteristics (12th rib fat, marbling score, yield grade), except for a tendency ($P = 0.07$) for steers fed 12% grass hay to have reduced LM area.

Steers fed MDGS had greater ADG ($P < 0.01$; Table 3) than steers fed 0% MDGS, but there was no difference ($P = 0.29$) between steers fed 25% MDGS constant or variable MDGS. Steers fed 0% MDGS had lower DMI ($P < 0.01$) than steers fed MDGS, and there was a tendency ($P = 0.09$) for steers fed constant MDGS to have greater DMI than steers fed variable MDGS. Final BW and HCW were greater ($P < 0.01$) for steers fed MDGS than for steers fed no MDGS; there were no differences in final BW or HCW ($P = 0.23$) due to variable concentrations of MDGS. Both 12th rib fat and USDA yield grade were greater in the treatments containing MDGS ($P < 0.01$) than for 0% MDGS. No differences in marbling score were observed between constant and variable inclusion of MDGS ($P > 0.47$).

Conclusion

Feeding MDGS increased dry matter intake and average daily gain but was variable on whether feed conversion was improved depending on whether 6% or 12% hay was used. Varying inclusion of MDGS weekly in

Table 3. Main effects of MDGS inclusion on performance and carcass characteristics of finishing steers.

Item	Treatments[1]			SEM	F-test	*P*- value Constant *vs* Variable
	0% MDGS	25% MDGS Constant	25% MDGS Variable			
Performance						
Initial BW, lb	867	867	866	0.6	0.67	0.58
Final BW[2], lb	1494[b]	1556[a]	1545[a]	6.7	<0.01	0.22
DMI, lb/d	28.1[b]	30.3[a]	29.9[a]	0.20	<0.01	0.10
ADG, lb	4.44[b]	4.87[a]	4.80[a]	0.05	<0.01	0.29
F:G	6.32	6.21	6.21	0.001	0.29	0.85
Carcass characteristics						
HCW, lb	941[b]	980[a]	974[a]	4.2	<0.01	0.22
12th rib fat, in	0.60[b]	0.68[a]	0.69[a]	0.012	<0.01	0.50
LM area, in^2	14.7	14.9	14.8	0.11	0.52	0.53
Marbling score	464[b]	494[a]	501[a]	7.5	0.02	0.46
Yield grade	3.28[a]	3.47[b]	3.49[b]	0.026	<0.01	0.47

[a-b] Within a row, means without a common superscript differ (P < 0.05).

[1] The treatments were due to the MDGS (modified distillers grains plus solubles) inclusion in the diet. No MGDS= no inclusion of MGDS in the diet, MDGS Constant= constant inclusion of 25% MDGS in the diet, MDGS Variable= Weekly variation of MDGS, at levels of 15, 20, 25, 30, and 35% randomly distributed over the experimental period with an average of 25% inclusion in the total feeding period.

[2] Final BW calculated as HCW divided by a common dressing percentage of 63%.

finishing diets did not impact the performance of finishing cattle compared to constant inclusion when the variation occurred between 15 and 35% and the average inclusion was 25% during the feeding period. Given that performance was not hindered due to varying inclusion of MDGS, feeding more roughage was unnecessary as feeding more hay increased DMI, decreased gain, and reduced feed conversion.

Debora G. Sousa, graduate student.

Rebecca L. McDermott, research technician.

Mitch M. Norman, research technician.

Jim C. MacDonald, professor, Animal Science, Lincoln.

Rick Stock, professor, Animal Science, Lincoln.

Galen E. Erickson, professor, Animal Science, Lincoln.

Evaluation of Vivalto® on Growth Performance and Carcass Characteristics in Growing and Finishing Beef Steers

Garrett N. Lemon
Rebecca L. McDermott
Galen E. Erickson
Jeff Heldt
Pablo L. Loza

Summary with Implications

A finishing trial conducted at the Panhandle Research, Extension, and Education Center (PREEC) near Scottsbluff, NE evaluated the effect of Vivalto®, a B-vitamin complex, on the feeding performance and carcass characteristics of feedlot steers. The design of the study was a completely randomized block design with three treatments, control without Vivalto®, 1g Vivalto®/steer/day, and 2g Vivalto®/steer/day. Cattle fed the diets that included Vivalto® feed had lower intakes during the first 56 days than cattle that received no Vivalto® in the diet. No significant differences were observed for ADG, intake, feed efficiency and carcass characteristics of the entire feeding period. No significant differences in prevalence of liver abscesses were found between treatments and prevalence of A+ abscesses was also insignificant.

Introduction

B-vitamins are water-soluble vitamins necessary in most multicellular species to contribute to functions involving DNA methylation, co-enzymes for metabolic functions, and the conversion of consumed nutrients to usable forms of energy in the body. In ruminant species the microbiome contains species of bacteria that are capable of synthesizing B-vitamins such that supplementation may not be required. Previous research indicates that a version of these vitamins that escape rumen degradation and are readily available in the small intestine will increase milk production in dairy breeds. Few studies have been conducted to evaluate the effect of supplemental B-vitamins on beef cattle. B-vitamins deficiencies can occur with physiological and environmental stressors that may limit intakes that would affect the ability of the microbes to synthesize adequate amounts of these vitamins. The objective of this study was to evaluate the effect of Vivalto® (Trouw Nutrition, Isola Vicentina, Italy), a rumen-protected B-vitamin complex on "receiving/starting" (first 56 days on feed), finishing performance, carcass characteristics, and liver abscess on cattle not previously acclimated to the Upper Midwest region of the U.S.

Table 1. Diet composition (% DM basis) fed to steers to evaluated different Vivalto® inclusion levels

	Treatments[1]		
Ingredient	Control	1g Vivalto®	2g Vivalto®
Corn Silage	20	20	20
Dry-rolled corn	54	54	54
WDGS	20	20	20
Supplement[2]	6	6	6
Vivalto®	0	1g/hd/day	2g/hd/day

[1]Hay was added to step up diets starting at 30% after original formulation due to lack on intake by cattle due unfamiliarity with corn silage.

[2]Supplement (Midwest PMS LLC.) was formulated to provide vitamins, minerals, and 0.92% urea on a DM basis.

Procedure

Crossbred steers (n=300, initial BW 647 ± 51lb) procured from the southeast region of the United States were used in a completely randomized block design experiment. Treatments were diets with no Vivalto® (control), 1 g of Vivalto®/ head / day and 2 g of Vivalto® / head / day. Cattle were fed a corn silage diet at 2.2% of body weight to equalize gut fill for five days immediately before the start of the experiment. Thirty pens were used with 10 pens per treatment and 10 steers per pen. Cattle were weighed on 2 consecutive days and those two weights were averaged to get the initial body weight. Using weights from day 0, steers were stratified and blocked by body weight into light or heavy blocks, and randomly allocated cattle to pens within blocks. Treatments were assigned to pens randomly within block. The heavy block (initial BW 700lb ± 1.6) included 4 repetitions and the light block (initial BW 612lb ± 1.6) included 6 repetitions per treatment, respectively. The steers received a Revalor-IS (Merck Animal Health) implant on the second weigh day. All cattle received a similar diet (Table 1) of corn silage, dry-rolled corn, wet distiller's grains, and a liquid supplement. Alfalfa hay was added to the diet 2 days post-trial initiation at 30% with decreasing inclusion over 28 days due to low intakes and unfamiliarity with corn silage. The Vivalto® (none, 1g/hd/d, 2g/hd/d) was delivered to the feedtruck through a micro-machine (Animal Health International) to be mixed and delivered to the respective pen. Monensin (Rumensin, Elanco Animal Health) was delivered at 30g/ton and tylosin (Tylan, Elanco Animal Health) was delivered at 8.8 g/ton. For the final 28 days on feed, cattle were fed 300mg/steer/day of ractopamine (Optaflexx®, Elanco Animal Health). Individual animal weights were taken on day 28 and day 56 to track individual animal performance, pen weights we taken every 28 days thereafter. A terminal implant (Revalor-200, Merck Animal Health) was given on day 56, and cattle were fed for 239 days before being delivered to a commercial abattoir for harvest. Following harvest, hot carcass

Table 2. Linear and quadratic effects of finishing diets with or without Vivalto® at two rates of inclusion

	Treatments					
Item	Control	Vivalto® 1g	Vivalto® 2g	SEM	Linear	Quadratic
56-day Performance						
Initial BW, lbs	656	646	655	5.0	0.90	0.12
Ending BW, lb[1]	949	935	934	9.6	0.27	0.64
DMI, lbs/d	17.1	16.2	15.3	0.46	<0.01	1.00
ADG, lbs	2.68	2.48	2.38	0.129	0.12	0.76
F:G	6.36	6.51	6.36	—	1.00	0.65
Carcass Adj. Performance						
Initial BW	656	646	655	5.0	0.90	0.12
Final BW, lb[2]	1465	1500	1484	23.4	0.59	0.39
DMI, lbs/d	23.4	23.9	23.5	0.49	0.89	0.45
ADG, lbs	3.39	3.50	3.46	0.100	0.64	0.54
F:G	6.77	6.72	6.73	—	0.89	0.92
Carcass Characteristics						
HCW	923	945	935	14.8	0.59	0.39
LM Area, in^2	14.9	15.0	14.8	0.25	0.69	0.58
Marbling Score[3]	543	547	544	13.9	0.98	0.82
12th rib fat, in	0.57	0.63	0.59	0.025	0.64	0.13
Calculated YG[5]	3.07	3.26	3.20	0.118	0.44	0.39
Liver Abscess, %[6]	20	22	18	—	0.76	0.63
A+ Liver, %	9	5	9	—	0.94	0.29

[1]Weights used were individual animal weights averaged by treatment on day 56

[2]Final BW is HCW adjusted to a common dressing percentage of 63%

[3]Marbling scored as 400+ = slight, 500+ = modest, 600+ = moderate etc.

[4]Calculated yield grade = 2.5 + (2.5*fat thickness)—(0.32*LM area) + (0.2*2.5) + (0.0038*HCW)

[5]Liver abscess data was analyzed as a binomial distribution

weights (HCW) were recorded, and livers were scored, with "0" indicating no abscess presence "A-" indicating 1–2 small abscesses, "A" indicating 2–4 small active abscesses, and "A+" indicating 1 or more large active abscesses. After a 48-hour chill, *Longissimus* muscle area, 12th rib fat thickness, and USDA marbling scores were recorded.

Results

Performance and carcass characteristics were run as linear and quadratic functions using the MIXED procedure of SAS (Cary, NC) and liver data was evaluated as binomial distribution using the GLIMMIX procedure of SAS. P-values of ($P \leq 0.05$) were viewed as significant while P-values of ($P \leq 0.15$) were considered tendencies. Statistical analyses of cattle performance of during the initial 56 days on feed showed a significant difference ($P < 0.01$) for DMI. The control treatment had the greatest intakes (17.1 lb), with intakes decreasing linearly as Vivalto® increased in the diet. A tendency ($P = 0.12$) was present for a linear decrease in ADG also during the first 56 days on feed. The control cattle had the greatest daily gain (2.68 lb) with linear decrease as Vivalto® inclusion increased. However, when evaluating cattle feeding performance for the entire finishing period, no significant differences ($P \geq 0.45$) were observed between treatments. A quadratic tendency was present when evaluating carcass characteristics for 12th rib fat thickness ($P = 0.12$). The steers that were fed 1g of Vivalto® daily had greater fat thickness at the 12th rib than the control or the 2g Vivalto® groups. Analyses of liver abscess prevalence ($P \geq 0.63$) and severity ($P \geq 0.29$) showed no significant differences between treatment groups.

Conclusion

Supplementation with the B-vitamin complex Vivalto® did not significantly affect ADG, DMI, or feed efficiency throughout the finishing period. However, cattle fed Vivalto® during the "receiving/starting" phase experienced lower intakes when compared to cattle that received no Vivalto® in the diet. Carcass characteristics were not significantly different including percent animals with livers containing an abscess, and prevalence of livers containing A+ livers was also not statistically significant.

Garret N. Lemon, graduate student.

Rebecca L. McDermott, research technician, Department of Animal Science.

Galen E. Erickson, professor, Department of Animal Science.

Jeff Heldt, Beef technical lead, Selko USA, Scottsbluff.

Pablo L. Loza, professor, Department of Animal Science, Panhandle Research and Extension Center, Scottsbluff.

Micronutrients USA, Trouw Nutritioun, Isola Vicentina, Italy

Predicting Live Body Weight of Yearling Beef Heifers Using 3D Imaging

Dalton J. Anderson
Yijie Xiong
Andrea K. Watson
J. Travis Mulliniks

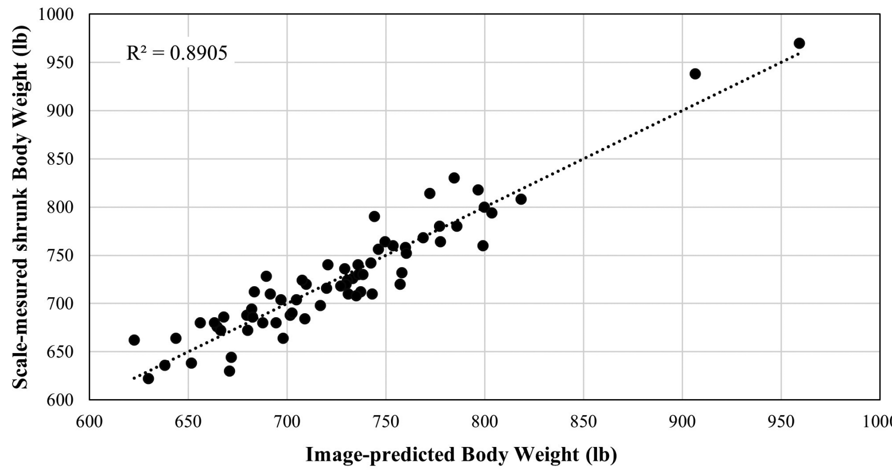


Fig. 1. Regression of scale-measured shrunk body weight (BW) of 69 yearling heifers vs. image-predicted BW. Results generated a R^2=.8905 and a small standard error of the means (SEM =1.54 lb).

Summary with Implications

This study was conducted to determine the accuracy of using 3D imaging technology as a method to predict shrunk body weight (BW) of growing yearling beef heifers. Red Angus × Simmental heifers (n = 69, BW = 726 ± 62 lb; 12 months of age) were utilized for data collection. A time-of-flight depth camera (Azure Kinect, Microsoft) was used to collect depth videos as heifers walked out of the chute. Ideal image frames were identified from videos and used to determine the body volume of each heifer. Prediction of BW using images produced an R^2 (estimate of model fit) = 0.89 and SEM (standard error of the mean, estimate of variation) = 7.28 lb. These results indicate it is possible to accurately predict heifer BW using dorsal depth images. This presents producers with the potential to improve management of grazing livestock without the need for moving cattle across a scale, which can reduce cattle stress and labor costs.

Introduction

Body weight (BW) and changes in BW are important measurements for nutritional and management decisions in cow-calf and rangeland cattle operations. Accurate BW measurements can be used for replacement heifer selection, determining nutrient supplementation strategies, and monitoring average daily gain. However, many cow-calf producers cannot measure BW accurately or often. Using a depth camera and 3D imaging technology is gaining popularity as another method that can be used to predict BW of livestock without the need to walk cattle over a scale. If the depth camera is able to predict BW accurately, it provides an alternative method for producers to measure BW and BW changes on grazing livestock and make better informed management decisions.

There has been substantial research conducted regarding estimation of BW with 3D imagery in the swine and dairy production systems, but limited research is present utilizing grazing livestock, specifically in the United States. Therefore, the objective of this study was to determine the efficacy of 3D imaging technology as a method to predict BW in yearling beef heifers. It was hypothesized that 3D imaging technology would be able to accurately predict BW, and thus, serve as an alternative sensing tool to obtain BW of grazing livestock.

Procedure

This study was conducted at the Gudmundsen Sandhills Laboratory (GSL) near Whitman, Nebraska from May to August 2022. A total of 69 Red Angus × Simmental crossbred yearling beef heifers were used for video collection. Heifers were approximately 12 months of age and weighed between 620 to 970 lb. Heifers were restricted from feed and water for approximately 24 hours before data collection to estimate shrunk BW of the heifers. Prior to feed restriction, heifers were grazing upland native range. Dorsal 3D depth videos were taken of these heifers using an Azure Kinect depth camera that was positioned approximately 10 feet above floor level. These videos were taken as cattle exited the working chute.

These videos were analyzed to select individual frames that met specific criteria to be used for further data analysis. Criteria included the heifer having all four feet on the ground at the same time and no obstruction from other objects or animals in the image. Corresponding scale-measured BW were recorded for each animal during video collection. The depth images were analyzed using a customized program written in MATLAB (R2022a). From this program, height pixel values that form the heifers' dorsal area were produced. The summation of these height pixel values was then used to determine the heifer dorsal volume. The head region of all animals was excluded from the image analysis to reduce the variation associated with different head positions (e.g., bending, swinging, shaking, etc.).

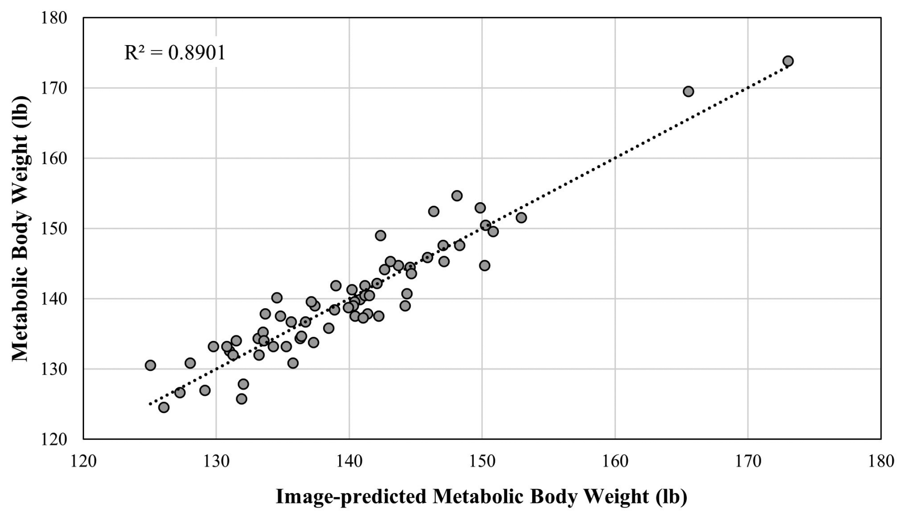


Fig. 2. Regression of calculated metabolic BW (MBW) vs predicted MBW generated from 3D image analyses. MBW was calculated by taking the shrunk BW to the ¾ power. Results of an $R^2 = 0.89$ and a 0.49 lb standard error of the mean (SEM) were obtained.

After obtaining the image-extracted dorsal body volumes, scale-measured BW were regressed against heifers' dorsal volumes to develop an equation for calculating the BW of the heifers when a scale is not accessible (Predicted BW=b×dorsal volumes+a; where b and a are linear regression coefficients). The heifer dorsal body volumes were then inserted into to the equation to calculate a predicted shrunk BW. To assess the accuracy of this approach estimating heifer shrunk BW using imaging analysis, the predicted BW was then regressed against scale measured BW (Figure 1).

Scale-measured shrunk BW was also converted to metabolic body weight (MBW) to look at the accuracy of the prediction model when using metabolic BW (Figure 2). Heifer MBW was calculated by taking BW to the ¾ power.

Data were analyzed using the PROC REG and PROC CORR procedures in SAS (v 9.4), summary statistics and common regression and correlation evaluation parameters are provided (i.e., standard error of the means (SEM), coefficient of the determination (R^2) and the Pearson coefficient, r). In this case, a small SEM means more accurate predication, a higher R^2 value indicates the better goodness-of-fit of the model, and a high r value indicates the scale-measured heifer shrunk BW is highly correlated with the image predicted dorsal volume, meaning one can estimate one input from the other.

Results

The regression of scale-measured shrunk BW versus predicted body volume produced an $R^2 = 0.8905$ (Figure 1). Prediction of BW using the regression equation produced an $R^2 = 0.8905$ and a SEM = 1.54 lb when compared to scale-measured shrunk BWs. The average difference between the scale-measured shrunk BW and the predicted BW was 16.30 lb. Pearson correlation coefficient comparing scale-measured shrunk BW and predicted BW produced an r = 0.9437 ($P < 0.0001$). When comparing predicted and actual MBW, there was an average difference of 5.11 lb. Coefficient of determination $R^2 = 0.8901$ was obtained when comparing predicted and actual MBW and the SEM of the difference between predicted and actual MBW was equal to 0.49 lb (Figure 2). The high correlation that was seen in these two models demonstrates the ability to accurately predict BW or MBW from yearling beef heifer body volume. However, more data is needed to validate these results, preferably with animals of different ages and breeds.

Conclusion

The results of this study show that there is great potential to accurately predict body weights of yearling beef heifers using 3D imaging technology. The regression model was able to predict BW of Red Angus × Simmental crossbred beef heifers using the linear equation developed from the image-extracted body volumes. A larger sample size is needed to validate the model for prediction of BW of growing beef heifers. Further research is advised to apply this model to different ages and breeds of beef cattle to determine the accuracy of prediction.

Dalton Anderson, Graduate student, Animal Science, Lincoln.

Yijie Xiong, Assistant Professor, Animal Science and Biological System Engineering, Lincoln.

Andrea K. Watson, Associate Professor, Animal Science, Lincoln.

J. Travis Mulliniks, Professor, Animal Science, North Platte.

Statistics Used in the Nebraska Beef Report and Their Purpose

The purpose of beef cattle and beef product research at UNL is to provide reference information that represents the various populations (cows, calves, heifers, feeders, carcasses, retail products, etc) of beef production. Obviously, the researcher cannot apply treatments to every member of a population; therefore he/she must sample the population. The use of statistics allows the researcher and readers of the Nebraska Beef report the opportunity to evaluate separation of random (chance) occurrences and real biological effects of a treatment. Following is a brief description of the major statistics used in the beef report. For a more detailed description of the expectations of authors and parameters used in animal science see Journal of Animal Science Style and Form at: http://jas.fass.org/misc/ifora.shtml.

—**Mean** Data for individual experimental units (cows, steers, steaks) exposed to the same treatment are generally averaged and reported in the text, tables and figures. The statistical term representing the average of a group of data points is mean.

—**Variability** The inconsistency among the individual experimental units used to calculate a mean for the item measured is the variance. For example, if the ADG for all the steers used to calculate the mean for a treatment is 3.5 lb then the variance is zero. But, this situation never happens! However, if ADG for individual steers used to calculate the mean for a treatment range from 1.0 lb to 5.0 lb, then the variance is large. The variance may be reported as standard deviation (square root of the variance) or as standard error of the mean. The standard error is the standard deviation of the mean as if we had done repeated samplings of data to calculate multiple means for a given treatment. In most cases treatment means and their measure of variability will be expressed as follows: 3.5 0.15. This would be a mean of 3.5 followed by the standard error of the mean of 0.15. A helpful step combining both the mean and the variability from an experiment to conclude whether the treatment results in a real biological effect is to calculate a 95% confidence interval. This interval would be twice the standard error added to and subtracted from the mean. In the example above, this interval is 3.2–3.8 lb. If in an experiment, these intervals calculated for treatments of interest overlap, the experiment does not provide satisfactory evidence to conclude that treatments effects are different.

—***P* Value** Probability (P Value) refers to the likelihood the observed differences among treatment means are due to chance. For example, if the author reports P 0.05 as the significance level for a test of the differences between treatments as they affect ADG, the reader may conclude there is less than a 5% chance the differences observed between the means are a random occurrence and the treatments do not affect ADG. Hence we conclude that, because this probability of chance occurrence is small, there must be difference between the treatments in their effect on ADG. It is generally accepted among researchers when P values are less than or equal to 0.05, observed differences are deemed due to important treatment effects. Authors occasionally conclude that an effect is significant, hence real, if P values are between 0.05 and 0.10. Further, some authors may include a statement indicating there was a tendency or trend in the data. Authors often use these statements when P values are between 0.10 and 0.15, because they are not confident the differences among treatment means are real treatment effects. With P values of 0.10 and 0.15 the chance random sampling caused the observed differences is 1 in 10 and 1 in 6.7, respectively.

—**Linear & Quadratic Contrasts** Some articles contain linear (L) and quadratic (Q) responses to treatments. These parameters are used when the research involves increasing amounts of a factor as treatments. Examples are increasing amounts of a ration ingredient (corn, by-product, or feed additive) or increasing amounts of a nutrient (protein, calcium, or vitamin E). The L and Q contrasts provide information regarding the shape of the response. Linear indicates a straight line response and quadratic indicates a curved response. P-values for these contrasts have the same interpretation as described above.

—**Correlation (r)** Correlation indicates amount of linear relationship of two measurements. The correlation coefficient can range from 1 to 1. Values near zero indicate a weak relationship, values near 1 indicate a strong positive relationship, and a value of 1 indicates a strong negative relationship.

Acknowledgements

Appreciation is expressed to the following research technicians, unit managers, and valuable employees involved in the research programs at our various locations.

Eastern Nebraska Research and Extension Center, Ithaca

Mitch Norman
Paul Kumke
Dale Foster
TJ Sabatka
Sam Caires
Ken Cejka
Austin Holliday
Aaron Lauer
Brett Mehom
Allison Miller
Justin Moore
Ben Schneider
Mark Schroeder
Matt Sillivan
Keith Street
Samantha Wagner

Department of Animal Science, Lincoln

Jeff Bergman
Kevin Bahr
Braden Troyer
Bethany Blackburn
Clay Boyles
Holly Heil
Brent Johnson
Tommi Jones
Scott Kurz
Eileen Marks-Nelson
Erin Marotz
Samantha Powell
Calvin Schrock
Rebecca McDermott
Erin Stevens
Darren Strizek

Gumundsen Sandhills Laboratory, Whitman

Andy Applegarth
Jacki Musgrave
John Nollette
Roger Carpenter

Panhandle Research & Extension Center, Scottsbluff

Alejandro Casella
Nabor Guzman

West Central Research & Extension Center, North Platte

Mike Kirby
Jess Milby
Jim Teichert

High Plains Ag Laboratory

Jacob Hansen
David Blanke

Animal Science
http://animalscience.unl.edu

Curriculum: The curriculum of the Animal Science Department at the University of Nebraska–Lincoln is designed so that each student can select from a variety of options oriented to specific career goals in professions ranging from animal production to veterinary medicine. With unique opportunities to double major in ***Grazing Livestock Systems*** (http://gls.unl.edu) or complete the ***Feedlot Management Internship Program*** (http://feedlot.unl.edu/intern)

Careers:

Animal Health
Banking and Finance
Animal Management
Consultant
Education
Marketing
Technical Service
Meat Processing
Meat Safety
Quality Assurance
Research and Development
Veterinary Medicine

Scholarships: The Animal Science Department also offers scholarships to incoming freshmen and upperclassmen. The department awards over $30,000 each year to Animal Science students.

ABS Global Scholarship
Baltzell-Agri-Products, Inc. Scholarship
Maurice E. Boeckenhauer Memorial Scholarship
Mike Cull Judging and Activities Scholarship
Don Geweke Memorial Award
Parr Young Senior Merit Award
Nebraska Pork Producers Association Scholarship
Waldo Family Farms Scholarship
Frank and Mary Bruning Scholarship
Art and Ruth Raun Scholarship
Animal Science Department Freshman Scholarship
Feedlot Management Scholarship
Robert Boeckenhauer Memorial Scholarship
Burnell Scholarship Fund
Doane Scholarship
Lincoln Coca-Cola Bottling Company Scholarship.
William J. and Hazel J. Loeffel Scholarship
Nutrition Service Associates Scholarship
Parr Family Student Support Fund
Chris and Sarah Raun Memorial Scholarship
Walter A. and Alice V. Rockwell Scholarship
Standard Manufacturing Co. Scholarship
Max and Ora Mae Stark Scholarship
D. V. and Ernestine Stephens Memorial Scholarship
Dwight F. Stephens Scholarship
Arthur W. and Viola Thompson Scholarship
Thomas H. Wake, III Scholarship
Frank E. Card Scholarship
Derrick Family Scholarship
G. H. Francke Livestock Judging Scholarship
Eric Peterson Memorial Award
Winkler Memorial Livestock Judging Scholarship

Electronic copies of Nebraska Beef Reports
and Summaries available at:
http://beef.unl.edu, click on reports.