Managing mature beef bulls on divergent planes of nutrition prior to the breeding season alters activity and eating behavior

Roberta B. A. Dahlen[1], Sarah R. Underdahl[1], Matthew S. Crouse[2], Kacie L. McCarthy[3], Joel S. Caton[1], Kevin K. Sedivec[1] and Carl R. Dahlen[1]

Bulls play a critical role in determining the genetic progress of beef herds; thus, this study assessed the impact of divergent pre-breeding nutritional planes on feeding and activity behaviors in mature beef bulls. Bulls on a weight gain trajectory exhibited higher dry matter intake and greater overall and high-intensity activity levels. Conversely, bulls losing weight spent more time in behaviors classified as eating, likely reflecting increased foraging activity post-feed delivery. These findings reinforce the importance of proper nutritional management prior breeding to optimize bull performance and reproductive success.

Summary

To evaluate eating and activity behaviors, 15 mature Angus-based beef bulls (initial body weight [BW] = 1,764.2 ± 36.39 lbs.) were stratified by BW and randomly assigned to a positive (POS, n = 7) or negative (NEG, n = 8) plane of nutrition for 112 d. Bulls received a common total mixed ration delivered into Insentec feeders, which was adjusted every two weeks to achieve a targeted BW change of approximately ±12.5%. Behavior was continuously monitored using CowManager ear tags and classified as eating, ruminating, not active, active, or highly active. Data were averaged into four 28-d periods and analyzed using repeated measures in time within the MIXED procedure of SAS, with bull as the experimental unit. Due to the intended divergence in gain, POS bulls had greater ($P < 0.001$) dry matter intake (28.0 vs. 11.7 ± 2.36 lbs./d) and weight gain (2.67 vs. -2.65 ± 0.11 lbs./d) compared with NEG bulls. A treatment × period interaction ($P = 0.04$) was observed for eating behavior, with NEG bulls spending more time ($P \leq 0.001$) eating in periods 1 and 3 and tending ($P = 0.06$) to do so in period 2; no difference was observed in period 4 ($P = 0.99$). Although eating behavior increased, NEG bulls spent more time ($P \leq 0.03$) not active during periods 2 through 4; no difference was observed in period 1 ($P = 0.44$). Ruminating did not differ ($P = 0.36$) by treatment, nor treatment × period interactions ($P \geq 0.14$) were detected for ruminating, active, and highly active behaviors. However, POS bulls spent significantly more time ($P < 0.001$) in active (283.8 vs. 176.8 ± 9.03 min/d) and highly active (117.6 vs. 84.3 ± 3.29 min/d) states than NEG bulls. Thus, despite the lower feed intake, NEG bulls exhibited increased eating behavior, likely reflecting foraging from pen floors and bedding after initial allotment was consumed. Additionally, NEG bulls exhibited more not active behavior, whereas the higher energy intake of POS bulls supported elevated active and highly active behaviors.

Introduction

Effective management of breeding bulls is as important, if not more important, than the management of cows and heifers, given the significant impact a single bull can have on the genetic and reproductive success of a cattle herd. Bulls often experience substantial weight fluctuations, even over short periods of time, due to varying nutritional strategies and workload demands. Such changes in adequate energy balance and body condition leading up to the breeding season can expose developing sperm cells to altered hormonal environments and metabolic substrates during spermatogenesis and can instigate a behavior shift from attending to females to prioritizing feed searching in pens and pastures.

Weight loss in mature bulls can often occur as outlined by a survey of producers reporting a wide range in stocking rates, from four to 80 cows per bull (Dahlen and Stoltenow, 2015). As described

[1]Department of Animal Sciences, North Dakota State University, Fargo, ND 58102, USA
[2]Agricultural Research Service, US Department of Agriculture, Clay Center, NE 68933, USA
[3]Department of Animal Sciences, University of Nebraska, Lincoln, NE 68583, USA

by Walker et al. (2009) and Hersom and Thrift (2008), bulls can lose between 100 to 400 lbs. during the breeding season. As a result, bulls that lose weight must be managed appropriately post-breeding to regain condition (Barth and Waldner, 2002). In addition to workload, undesired feeding management decisions dictate when bulls begin to lose or gain weight relative to the breeding season. In some systems, bulls begin to lose weight when the breeding season starts and are then allowed to gain weight in preparation for the following season, thus having abundant energy. In other systems, bulls may begin losing weight before the breeding season due to environmental and dietary changes after purchase or because they are offered less feed to get them into "breeding shape" after being managed to gain weight during the winter season, thus having scarce energy.

With energy levels above metabolic requirements, bulls can maintain necessary physiological processes for survival, growth, and reproduction (Schneider, 2004). However, when energy is scarce, physiological processes prioritize survival at the expense of growth, longevity, and reproductive functions, resulting in increased food-seeking behaviors while suppressing locomotion and sexual activity (Schneider, 2004). In addition, cattle are highly social animals that form strong bonds and maintain structured herd dynamics. Hence, as more individual animals shift attention to foraging, the herd as a whole may be led away from reproductive focus (Ramseyer et al., 2009). It is also important to avoid excessive energy intake, which may result in increased fat deposition and obesity which can have negative effects on reproduction, such as infertility (Schneider, 2004). Thus, this experiment was conducted to evaluate how divergent pre-breeding planes of nutrition affect eating and activity behaviors in mature beef bulls, which may consequently influence reproductive outcomes in the herd.

Procedures

All procedures were approved by the North Dakota State University Institution for Animal Care and Use Committee. Fifteen mature Angus-based beef bulls (1,764.2 ± 36.39 lbs. initial BW) were used in a 112-day study to evaluate the effects of divergent planes of nutrition on eating and activity behaviors. For details related to impacts of treatments on scrotal circumference and concentrations of hormones and metabolites, see Dahlen et al. (2021). Bulls were housed in two partially covered pens at the NDSU Beef Cattle Research Complex (BCRC; Fargo, ND). Once adapted to the Insentec feeding system (Hokofarm Group B.V., Marknesse, Netherlands), bulls were stratified by BW and randomly assigned to one of two dietary treatments: 1) in one pen, bulls were managed on a positive plane of nutrition (POS, n = 7), and 2) in another pen, bulls were managed on a negative plane of nutrition (NEG, n = 8). Bulls were fed a common total mixed ration (TMR) containing approximately 45% corn silage, 27% triticale hay, 8% cracked corn, 16% dried distillers grains plus solubles (DDGS), and 4% vitamin/mineral premix on a dry matter (DM) basis (Table 1). Water was always available. Bulls were weighed every 14 days, and the amount of feed delivered to each pen was adjusted as needed to achieve the targeted weight gain or loss of approximately 12.5% of initial BW over the feeding period. Activity data were captured using an ear tag accelerometer system (CowManager, Harmelen, Netherlands) with eating, ruminating, not active, active, or highly active behaviors monitored. To monitor behavioral changes over the course of the study, data were arranged into four 28-days periods with period 1 including days 0 to 27, period 2 including days 28 to 55, period 3 including days 56 to 83, and period 4 including days 84 to 112. Data were analyzed using the MIXED procedure of SAS (V. 9.4, Inst. Inc., Cary, NC) for effects of treatment, period, and their interaction. Day was used as a repeated measure over time and bull the experimental unit. Differences were considered significant when $P \leq 0.05$ and tendencies were noted when $0.5 < P \leq 0.10$.

Results and Discussion

Consistent with the study design, POS bulls (28.0 ± 2.43 lbs./d) consumed significantly more dry matter ($P < 0.001$) than NEG bulls (11.7 ± 2.27 lbs./d) and had greater ($P < 0.001$) BW gain (2.67 ± 0.11 lbs./d) compared with NEG bulls (-2.65 ± 0.11 lbs./d). There was a treatment × period interaction ($P = 0.04$) for eating behavior, with NEG bulls spending more ($P \leq 0.001$) time eating during periods 1 and 3 and tending ($P = 0.06$) to spend more doing so in period 2 than POS bulls; no difference ($P = 0.99$) was observed in period 4 (Figure 1). This difference in eating behavior

Table 1. Dietary ingredients and nutrient profile of diet fed to mature bulls on divergent planes of nutritio[1]

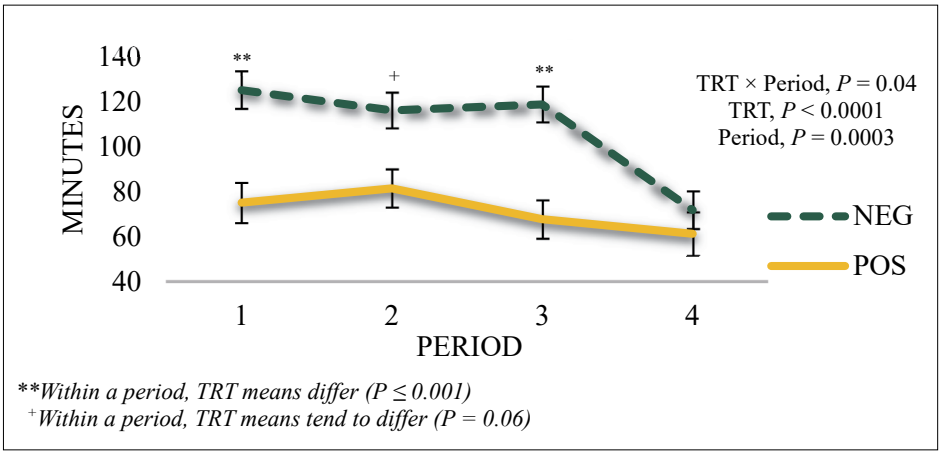
Item	Inclusion
Ingredient, % DM	
Corn silage	44.6
Triticale hay	27.4
Cracked corn	8.0
DDGS	15.6
Vitamin-mineral premix	4.4
Nutrient Composition, %	
Ash	9.16
Crude Protein	12.30
ADF	27.30
NDF	50.00
Fat	2.91
Ca	0.56
P	0.39

[1]Diets were offered and re-adjusted as needed to a target rate of 12.5% gain (POS) or loss (NEG) of original BW.

occurred even with NEG bulls having access to less feed compared with POS bulls. Under conditions of energy scarcity, physiological systems prioritize instinctive survival behaviors; thus, more time may have been spent seeking food from pen floors and bedding after initial feed allotment to bunk was consumed (Schneider, 2004). The treatment × period interaction and the main effect of treatment did not influence ($P \geq 0.14$) ruminating behavior.

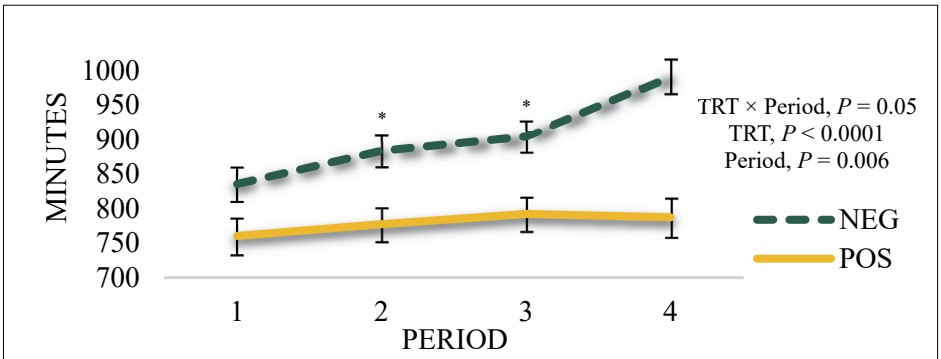
Behavior categorized as not active was also influenced ($P = 0.05$) by a treatment × period interaction. Although NEG bulls spent more time exhibiting eating behavior, they spent more ($P \leq 0.03$) time not active during periods 2 through 4 compared with POS bulls; no difference ($P = 0.44$) was observed in period 1 (Figure 2). An interaction between treatment and period was not present for active ($P \geq 0.14$) and highly active ($P > 0.14$) behaviors. However, active and highly active behaviors were strongly impacted ($P < 0.001$) by treatment, with POS bulls spending almost 2 h/d more exhibiting active behavior and ½ h/d more exhibiting highly active behavior than NEG bulls, Figure 3. Under conditions of abundant food availability and low energetic demand, sufficient energy can be allocated not only to immediate survival but also to long-term physiological investments, including somatic growth, immune competence, and reproductive function (Schneider, 2004).

Our findings emphasize the importance of implementing appropriate nutritional strategies for bulls entering the breeding season. The observed increase in not active behavior, excluding foraging, relative to active and highly active behaviors, suggests suboptimal energy allocation during a period when optimal physiological readiness is critical. Reduced activity prior to breeding may carry over into the breeding season, potentially



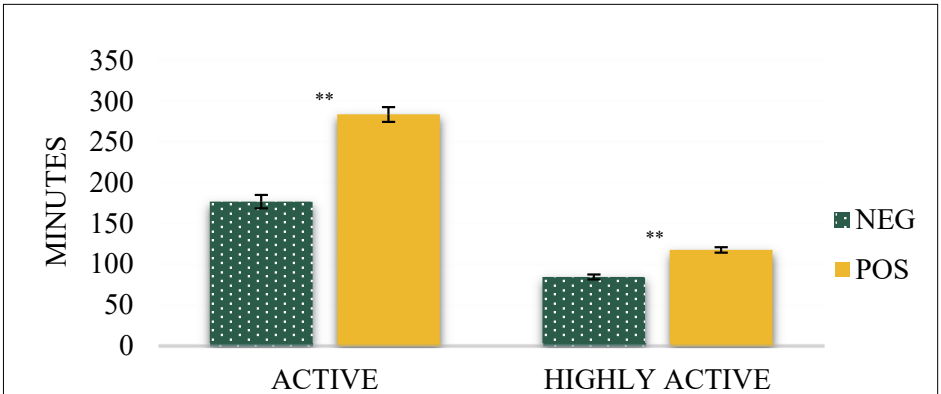
***Within a period, TRT means differ ($P \leq 0.001$)*
+Within a period, TRT means tend to differ ($P = 0.06$)

Figure 1. Effect of divergent planes of nutrition on mature bulls eating behavior.



***Within a period, TRT means differ ($P < 0.0001$)*
**Within a period, TRT means differ ($P \leq 0.03$)*

Figure 2. Effects of divergent planes of nutrition on mature bulls not active behavior.



***Within a behavior, TRT means differ ($P < 0.0001$)*

Figure 3. Effects of divergent planes of nutrition on mature bulls active and highly active behavior.

diminishing mating activity and lowering the proportion of females successfully bred. However, further research is warranted to confirm these associations. In contrast, adequate energy intake in POS bulls may enhance reproductive success. Nonetheless, overfeeding should be avoided, as excessive energy intake can exceptionally lead to obesity, which may negatively impact fertility.

Acknowledgments

We would like to thank the State Board of Agricultural Research and Education for partial funding of this project and the NDSU Central Grasslands Research Extension Center for providing bulls for this experiment. We would also like to express our gratitude to the personnel at the NDSU Beef Cattle Research Complex.

The mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA. The USDA is an equal opportunity provider and employer.

Literature Cited

Barth A. D. and C. L. Waldner. 2002. Factors affecting breeding soundness classification of beef bulls examined at the Western College of Veterinary Medicine. Can. Vet. J. 43: 274-284.

Dahlen, C. R. and C. L. Stoltenow. 2015. The PregCard study; assessing the impact of routine management strategies on reproductive performance of beef herds in the upper Great Plains. Bov. Pract. 49: 152-155.

Dahlen C. R., S. R. Underdahl, M. S. Crouse, K. L. McCarthy, C. J. Kassetas, F. Baumgaertner, J. D. Kirsch, S. T. Dorsam, K. K. Sedivec, A. K. Ward, and J. S. Caton. 2021. Managing mature beef bulls on divergent planes of nutrition alters scrotal circumference and concentrations of hormones and metabolites. North Dakota Livestock Research report. pp 50-53.

Hersom, M. and T. Thrift. 2008. Nutritional Management of Bulls. University of Florida Extension Bulletin, AN211.

Ramseyer, A., A. Boissy, B. Dumont, and B. Thierry. 2009. Decision-making in group departures of sheep is a continuous process. Anim. Behav. 78: 71-78.

Schneider, J. E. 2004. Energy balance and reproduction. Phys. Behav. 81: 289-317.

Walker, J., G. Perry, R. Daly, and K. Olson. 2009. Bull management and nutrition. Proc. Range Beef Cow Symposium XXI.