



**EXTENSION**  
**BEEF CATTLE RESEARCH UPDATE**  
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**Effects of Limit Feeding and Shade Allocation on Growing Calf Performance, Water Usage, and Animal Comfort**

Research has shown that limit-feeding high energy diets can improve feed efficiency in growing calves compared with traditional high-roughage diets fed ad libitum.<sup>1, 2, 3</sup> Due to the incidence of heat stress across the Central Plains region, the use of shade has been evaluated as a mitigation strategy to improve animal comfort and growth performance of finishing beef cattle.<sup>4</sup> Recent Kansas State University research evaluated the impacts of limit feeding and shade access as possible strategies to improve cattle efficiency, reduce water usage, and improve animal comfort in growing cattle.<sup>5</sup>

In this study, during the summers of 2021 and 2022, 852 heifers (553 lb) were assigned to one of four treatments: high-roughage diet fed for ad libitum intake or limit-fed high-energy diet in shaded or non-shaded pens. The high-energy diet was formulated to provide 60 Mcal of net energy for gain (Neg) per 100 lb of DM fed at 2.2% of body weight (BW) daily and the high-roughage diet was formulated to provide 45 Mcal of NEg per 100 lb of dry matter (DM) fed for ad libitum intake (Table 1). The heifers were fed once daily beginning at 7:00 a.m. and bunks were observed prior to feeding to estimate ad libitum intake. Pen weights were measured weekly from day 14 to 84 and individual BW were measured on days 0, 90, and 97. Pen weights were used to adjust weekly intakes of limit-fed diets. All calves were fed a single diet at 2.5% of BW daily (DM basis) between days 90 and 97 to equilibrate gut-fill among treatments. Growth performance and water usage were measured during a 90-day growing period.

Table 1. Composition of experimental diets.

Ingredient, % DM	Diet <sup>1</sup>		
	45	60	53
Dry-rolled corn	8.6	38.8	23.8
Supplement	6.4	8.2	6.9
Sweet Bran <sup>2</sup>	40.0	40.0	40.7
Alfalfa Hay	22.5	6.5	14.2
Prairie Hay	22.5	6.5	14.4

<sup>1</sup>45 = diet containing 45 Mcal of Neg per 100 lb of DM offered for ad libitum intake; 60 = diet containing 60 Mcal of Neg per 100 lb of DM limit-fed at 2.2% of BW daily (DM basis); 53 = diet containing 53 Mcal of Neg per 100 lb of DM limit-fed at 2.5% of BW daily (DM basis).

<sup>2</sup>Cargill Corn Milling (Blair, NE).

To determine the effects of shade on animal comfort, animals were evaluated at 9:30 a.m., 1:30 p.m., and 5:30 p.m. on days when the temperature humidity index (THI) was estimated to be greater than 74 (US MARC Animal Comfort Index). Individual panting score was determined using respiration rate and breathing conditions. Three animals per pen were selected randomly at each time point to represent each pen. The three values were averaged to obtain a mean panting score for each pen.

The effects of shade and diet type on growth performance, feed efficiency, and water usage are shown in Table 2. Day 90 BW were greater ( $P < 0.01$ ) for calves fed ad libitum compared with limit-fed calves. After the gut-fill equilibration period, limit-fed calves had greater ( $P < 0.01$ ) BW compared with calves previously fed for ad libitum intake. The authors noted that this demonstrates how the diet affects gut fill and subsequently BW. Thus, it is important to equalize gut fill to obtain the best possible estimates of true BW gain.

Table 2. Effects of shade and diet type on growth performance, feed efficiency, and water usage.

Item	Treatment <sup>1</sup>				P-value		
	No Shade		Shade		Diet	Shade	D X S
	45	60	45	60			
Number of pens	20	20	20	20			
Number of animals	214	213	215	210			
Body Weight, lb							
Day 0	551	551	548	549	0.90	0.22	0.76
Day 90	784	772	801	787	<0.01	<0.01	0.80
Day 97	785	799	802	811	<0.01	<0.01	0.58
ADG (0 - 97), lb/day	2.25	2.39	2.44	2.53	<0.01	<0.01	0.47
DMI, lb/day							
Days 0 to 90	20.14	14.84	21.45	14.92	<0.01	<0.01	<0.01
Days 0 to 97	20.78	20.75	21.00	20.94	0.69	0.07	0.90
Feed:Gain (days 0-97), lb/lb	9.04	6.37	8.82	6.09	<0.01	0.03	0.76
Water Usage <sup>2</sup> , gal/day	11.9	10.8	10.6	9.8	<0.01	<0.01	0.13

<sup>1</sup>45 = diet containing 45 Mcal of NEg per 100 lb of DM offered for ad libitum intake; 60 = diet containing 60 Mcal of NEg per 100 lb of DM limit-fed at 2.2% of body weight (DM basis) daily.

<sup>2</sup>Analysis of year one data only: non-shaded 45 = 105 animals; shaded 45 = 106 animals; non-shaded 60 = 100 animals; shaded 60 = 102 animals. Treatments in year one comprised 10 pens each.

Adapted from DeBord et al., 2023.

Average daily gains (ADG) from day 0 to 97 were greater ( $P < 0.01$ ) for limit-fed heifers compared with heifers fed for ad libitum intake. In addition, ADG was greater ( $P < 0.01$ ) for shaded calves compared with non-shaded calves. Dry matter intake (DMI) was greater ( $P < 0.01$ ) for calves fed ad libitum compared with limit-fed calves for days 0 to 90. Intakes from day 0 to 97 did not differ between treatments. The authors noted that this was expected because during the gut-fill equilibration period all cattle were limit fed. Limit fed heifers were more efficient ( $P < 0.01$ ) than ad libitum heifers over the entire 97-day study. In addition, shaded calves were more efficient than ( $P = 0.03$ ) than non-shaded calves.

Limit-fed calves used ~9% less water when compared with calves fed for ad libitum intake (10.3 vs. 11.25 gallons/day,  $P < 0.01$ ). This difference in water usage between diets may be attributed to differences in DMI. Water usage was ~11% less ( $P < 0.01$ ) for calves provided shade compared with calves not provided shade (10.2 vs. 11.35 gallons/day) which can be attributed to a decrease in heat load of calves in shaded pens compared with calves in non-shaded pens.

Calves in non-shaded pens had greater ( $P < 0.01$ ; Figure 1) mean panting scores than calves in shaded pens. We attribute this difference to an increase in animal comfort due to reduced solar radiation exposure in shaded pens leading to lower heat load during the summer.

These researchers concluded that limit feeding a high-energy ration during the receiving period can improve feed efficiency and reduce water usage when compared to a higher forage diet fed for ad libitum intake. During periods of heat stress, shade can improve animal performance, reduce water usage, and improve animal comfort.

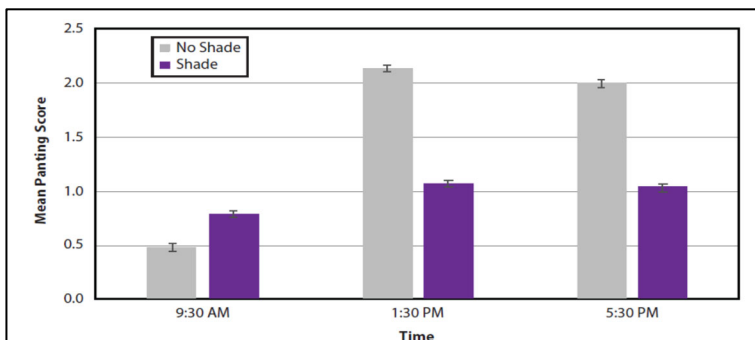


Figure 1. Effect of shade allotment on mean panting scores. Shade effect:  $P < 0.01$ .

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