The influence of beef cow weaning weight ratio and cow size on winter grazing and supplement intake behavior[1]

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INTRODUCTION

An ongoing discussion in the beef cattle industry explores if small or large cows, based on BW and BCS, are more suited for arid, western environments, and production systems (Dickerson, 1978; Stewart and Martin, 1983; Scasta et al., 2015). The foundation to this discussion is what cow type is more efficient in western rangeland systems, converts forage consumed to more kilograms calf weaned, and optimizes use of extensive rangeland environments (Scasta et al., 2015; Beck et al., 2016). Previous research and applied practice have suggested the ratio of calf weight weaned to cow weight, or weaning weight ratio (**WWR**), is a potential metric to estimate cow efficiency (Dinkel and Brown, 1978; Kress et al., 2001; Scasta et al., 2015). However, few studies have examined the relationship between cow size, cow efficiency, and grazing behavior. Since extensive grazing systems are embedded in western rangeland beef cattle systems, attaining increased distribution across landscapes is vitally important for the success of these production systems. There has been considerable research on biotic and abiotic features that alter grazing distribution in beef cattle on rangeland environments (Ganskopp, 2001; Bailey, 2005; Stephenson et al., 2016). However, very little research has evaluated how cow type or cow characteristics influence grazing distribution on native landscapes (Bailey et al., 2006; VanWagoner et al., 2006; Walburger et al., 2009). Therefore, the purpose of this study was to assess whether cow efficiency as classified by cow WWR and cow size has an effect on grazing behavior and supplement consumption in a winter grazing environment.

MATERIALS AND METHODS

Protocols for this research were approved by the Montana State University Agricultural Animal Care and Use Committee (#2015-AA04). Lifetime production records from cows with a minimum of three calf crops and bred for the forth calf from the Montana State University Northern Agriculture Research Center Angus-based cow herd were used to identify high and low WWR groups. All calf data were corrected for age of dam, sex of calf and equalized to a 205-d adjusted weaning weight. Likewise, cow weights were adjusted to a

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standardized body condition (5 on a scale of 1–9) before calculating WWR. Forty multiparous (minimum of three weaned calves) Angus cows (cow initial BW = 598 ± 55.7 kg) were located in a 329-ha pasture at the Thackeray Ranch, 21-km south of Havre, MT (48.377236, −109.632802), for 45 d from December 1, 2016 to January 15, 2017 and 60 d from November 1 to December 31, 2017. Dominant vegetation in the pasture was Kentucky bluegrass (*Poa pratensis*), rough fescue (*Festuca campestris*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and western wheatgrass (*Pascopyrum smithii*). Average forage production at study initiation was 2,456 and 3,156 kg/ha for 2016 and 2017, respectively. Prior to each grazing period, cows were stratified into a split-plot design by randomly allotting cows to high and low WWR groups (whole-plot; ±0.75 SD from herd mean) and, within WWR classification groups, allotted to light and heavy weight groups (subplots) using cow lifetime mean WWR and BW (Table 2), resulting in the following four classification groups: 1) high WWR-light BW (**HL**; 56% ± 2.4% WWR; 502 ± 21.4-kg BW), 2) high WWR-heavy BW (**HH**; 53% ± 1.6% WWR; 548 ± 21.2-kg BW), 3) low WWR-light BW (**LL**; 42% ± 2.9% WWR; 597 ± 18.7-kg BW), and 4) low WWR-heavy BW (**LH**; 42% ± 1.9% WWR; 642 ± 15-kg BW). Additionally, 20 cows, five from each group, were randomly assigned to wear a Lotek 3300LR GPS collar (Lotek Engineering, Newmarket, ON, Canada). Collars were programed to collect location iterations every 15 min, head position iterations every 5 min, and were placed on cows and removed at the time of cow weight and BCS data collection pre and post grazing period. A commercially available, fully fortified, 30% CP, salt-limited, pelleted supplement (CHS Nutrition, Sioux Falls, SD) was provided to the cowherd (Table 1). The supplement was provided in eight SmartFeedPro feeders that were fully contained within two portable trailers (C-Lock Inc., Rapid City, SD), which were centrally located in the pasture. Cows had continuous access to water throughout the study period. Supplement, supplement storage, water, and pasture fence locations were collected using a Garmin GPSMAP 64st handheld GPS unit (Garmin International Inc., Olathe, KS). Vegetation data were collected prior to and post grazing each year. Seventy-five, 30-m transects were randomly located within the pasture and six, 10th-m^2 plots were placed every 5 m along each transect. Vegetation composition, production, canopy cover, and visual obstruction readings (**VOR**) were collected at each 10th-m^2 plot following the methods of Dowhower et al. (2001), Daubenmire (1959), and Robel et al. (1970) with modifications. Each 10th-m^2 plot was also clipped, and these samples were transported to Montana State University where they were dried at 60 °C for 48 h and ground in a Wiley Mill (Thomas Scientific, Swedesboro, NJ) to pass a 2-mm screen. Samples were then dried at 100 °C for 12 h and analyzed for DM (modified Goering and Van Soest, 1970), TDN (Goering and Van Soest, 1970), NDF (Van Soest et al., 1991), ADF (modified AOAC, 2000), and CP (AOAC, 2000). Individual cow average daily supplement consumption (**DSC**), average daily feeding bout duration (**FBD**), number of visits per day (**NOV**), and time of day (**TOD**) feeding bouts occurred were collected for all cows. Total supplement consumption (**TSC**) and total time spent eating per day (**TSE**) over the data collection periods were calculated post grazing. Additionally, total distance traveled (**TDT**), time spent grazing (**TSG**), and time spend resting (**TSR**) were collected on individual cows with GPS collars.

Table 1. Ingredient and nutrient composition (DM basis) of the fully fortified, 30% CP, salt-limited, pelleted supplement

Item	%
Ingredients	
Canola meal	35.0
Salt	25.0
Malt sprouts	15.0
Cane molasses	5.0
Dried distillers grain	5.0
Bentonite powder	4.0
Urea 281	3.5
Calcium carbonate	3.0
Wheat middlings	2.3
Trace mineral mix*	0.2
Nutrient composition	
DM	92.8
CP	30.2
NDF	17.9
ADF	9.6

*Trace mineral mix: 2.1% to 2.4% Ca, 1% P, 10% Na, 15.4% CL, 0.9% K, 0.3% Mg, 131.8-ppm Mn, 158.7-ppm Fe, 65.9-ppm Cu, 231.1-ppm Zn, 5.7-ppm I, 2.1-ppm Se, 9.1-IU/kg vitamin A, 0.9-IU/kg vitamin D, 9.1-IU/kg vitamin E.

Statistical Analysis

Cow location data were analyzed as a randomized split-plot design using the PROC MIXED procedure in SAS (v. 9.4; SAS Inst. Inc., Cary, NC). Dependent variables were TDT, TSG, and TSR. Supplement intake data were analyzed as a randomized split-plot design using the PROC MIXED procedure in SAS. Dependent variables were DSC, FBD, NOV, TSC, and TSE. The PROC FREQ

Table 2. Cow lifetime average BW, average calf weaning weight, and lifetime average WWR and cow BW, cow BCS, cow age, and calf weaning weight per year

	High*		Low†			WP‡	SP‖	WP * SP$
Item	Light	Heavy	Light	Heavy	SE	*P* value	*P* value	*P* value
Lifetime averages								
Cow BW, kg	502.2[a]	548[b]	596.7[c]	642.1[d]	4.4	<0.01	<0.01	0.96
Calf wt, kg	280.6[a]	290.4[ab]	247.8[c]	267.5[d]	3.5	<0.01	<0.01	0.16
WWR¶, %	55.9[a]	53.1[b]	41.5[c]	41.7[cd]	0.5	<0.01	0.014	<0.01
Year 1								
Cow BW, kg	605.1[a]	635.8[ab]	689.2[bc]	713.2[cd]	16.2	<0.01	0.10	0.84
Cow BCS	5.4[a]	5.8	6[b]	5.7	0.2	0.12	0.74	<0.03
Cow age, yr	5.6[a]	6.2	6.7	8.2[b]	0.7	<0.01	0.12	0.50
Weaning wt, kg	303.7	300.5	270.9	294.8	8.5	0.052	0.23	0.12
Year 2								
Cow BW, kg	572.7[a]	612.9[ab]	682.6[c]	730.3[cd]	12.7	<0.01	<0.01	0.77
Cow BCS	5.3	5.2	5.5	5.6	0.2	0.07	0.87	0.42
Cow age, yr	5.6	6.7	7.7	7.5	0.7	0.047	0.53	0.37
Weaning wt, kg	262.1	291.0[a]	248.3[b]	265.6	7.9	0.029	<0.01	0.47

December to January 2016–2017 and November to December 2017.

*High = high WWR cows.

†Low = low WWR cows.

‡Whole-plot = cow WWR.

‖Split-plot = cow BW.

$Whole-split-plot interaction was the interaction between WWR and cow BW.

¶WWR = calf weaning weight/cow weight.

P values were considered significant at ≤0.05 and were considered as a trend toward significance at ≤0.1

[a–d]Means within a row with different superscripts differ ($P \leq 0.05$).

Table 3. Cow supplement intake and feeding behavior while winter grazing northern Montana rangeland, December to January 2016–2017 and November to December 2017

	High*		Low†			WP‡	SP‖	WP * SP$
Item	Light	Heavy	Light	Heavy	SE	*P* value	*P* value	*P* value
Year 1								
Intake								
Daily, kg	0.74	1.0	0.95	1.0	0.28	0.73	0.51	0.66
g/kg cow BW	1.1	1.8	1.4	1.4	0.44	0.79	0.42	0.50
Feeding bouts								
Number/day	1.9	2.5	2.3	2.3	0.63	0.87	0.64	0.64
Duration, min	1.1	1.4	1.5	1.7	0.18	<0.05	0.18	0.80
Per day, min	2.75	3.74	3.44	3.63	0.96	0.76	0.54	0.68
Year 2								
Intake								
Daily, kg	1.49	1.90	1.61	1.34	0.20	0.29	0.73	0.12
g/kg cow BW	2.59	3.15	2.37	1.87	0.34	<0.04	0.93	0.13
Feeding bouts								
Number/day	4.8	6.3	5.2	3.8	0.63	0.13	0.91	<0.03
Duration, min	1.24	1.25	1.24	1.29	0.12	0.84	0.92	0.80
Per day, min	5.31	7.69	6.33	5.10	0.77	0.34	0.50	0.02

*High = high WWR group.

†Low = low WWR group.

‡Whole-plot = cow WWR.

‖Split-plot = cow BW.

$Whole-split-plot interaction was the interaction between WWR and cow BW.

P-values were considered significant at ≤0.05 and were considered as a trend toward significance at ≤0.1.

procedure in SAS was used to determine TOD of feeding bouts. Means were separated using the LSMEANS procedure of SAS and a Tukey–Kramer test was included in both MIXED procedures. *P* values ≤0.05 were considered significant, and *P* values ≤0.10 were considered a trend toward significance.

RESULTS AND DISCUSSION

As expected, cow BW at the beginning of year 1 (HL 605.1 ± 6.6 kg; HH 635.8 ± 30.4 kg; LL 689.2 ± 18.9 kg; LH 713.2 ± 14.1 kg) was significantly affected by WWR classification group ($P < 0.01$), and BW classification group tended to have an affect ($P = 0.10$; Table 2). Cow BW at the beginning of year 2 (HL 572.7 ± 12.1 kg; HH 612.9 ± 22.1 kg; LL 682.6 ± 14.9 kg; LH 730.3 ± 18.5 kg) was affected by WWR ($P < 0.01$) and BW ($P < 0.01$) classification groups (Table 2). Cow age was also significantly affected by WWR classification group for both years ($P < 0.05$), with low WWR cows being an average of 2 y older than high WWR cows both years (Table 2). This suggests that cow weight is confounded by age, despite our efforts to equalize 205-d adjusted weaning weights and standardize cow weight to a common BCS of 5 (on a 1–9 BCS scale). For year 1, WWR classification group tended to affect ($P < 0.06$) calf 205-d weaning weight (Table 2). For year 2, both WWR ($P < 0.01$) and cow BW ($P < 0.04$) classification affected calf 205-d weaning weight. High WWR cows tended to wean an average of 19.25 ± 8.5 kg and 19.6 ± 7.9 kg more than low WWR cows for years 1 and 2, respectively. Heavy BW cows weaned an average of 23.1 ± 7.9 kg more than light BW cows, the second year ($P < 0.05$) of the study but did not differ in year 1.

Cow classification did not significantly affect daily supplement intake when expressed as kg/d ($P > 0.10$; Table 3). However, when expressed as g/kg BW, high WWR cows ate 2.87 g/kg BW and low WWR cows ate 2.12 g/kg BW ($P < 0.04$) in year 2 of the study. However, this significance was not observed the first year of the study ($P > 0.10$; Table 3). Number of visits made to supplement each day did not differ between classification groups year 1 ($P > 0.10$; Table 3). During year 2, WWR and BW interacted to affect the NOV made to supplement per day, with the low WWR–heavy BW group making an average of 2.5 less visits per day (Table 3). Time per day spent eating supplement was also not signif-

Table 4. Total number of feeding visits and TOD feeding events occurred at, categorized by six, 4-h periods: early morning (0100–0400 h), morning (0500–0800 h), late morning (0900–1200 h), afternoon (1300–1600 h), evening (1700–2000 h), and night (2100–0000 h), while winter grazing northern Montana rangeland, December to January 2016–2017 and November to December 2017

	High*		Low†			WP‡	SP‖	WP* SP$
Item	Light	Heavy	Light	Heavy	SE	*P* value	*P* value	*P* value
Year 1								
TOD								
Early morning	3	11	3	8	1.3	0.78	0.25	0.78
Morning	95	132	110	91	24.8	0.89	0.93	0.78
Late morning	409	745	670	484	23.8	1.00	0.45	<0.02
Afternoon	172	287	250	344	22.5	0.46	0.27	0.91
Evening	21	40	23	49	4.6	0.77	0.25	0.85
Night	6[a]	26[b]	19	8	1.2	0.69	0.36	<0.01
Year 2								
TOD								
Early morning	32	25	25	12	3.3	0.44	0.47	0.83
Morning	1,009	707	1,054	750	160.2	0.94	0.65	1.00
Late morning	2,213	1,737	1,510	1,254	134.8	0.26	0.51	0.84
Afternoon	397	390	398	212	28	0.43	0.41	0.44
Evening	49	44	64	27	6.9	0.97	0.46	0.57
Night	74	49	60	4.7	3.1	0.64	0.31	0.79

*High = high WWR group.

†Low = low WWR group.

‡Whole-plot = cow WWR.

‖Split-plot = cow BW.

$Whole-split-plot interaction was the interaction between WWR and cow BW.

P-values were considered significant at ≤0.05 and were considered as a trend toward significance at ≤0.1.

[a–d]Means within a row with different superscripts differ ($P \leq 0.05$).

icantly affected by classification group during year 2 ($P > 0.10$). However, the interaction between WWR and BW affected time per day spent consuming supplement ($P < 0.02$) in year 2, with low WWR–heavy cows spending 1 min and 27 s less time eating supplement. Average duration of each feeding visit was significantly affected by WWR classification in year 1 ($P < 0.05$), with high WWR cows spending an average of 21 s less per feed visit than low WWR cows (Table 3). However, this did not significantly differ between groups for year 2 ($P > 0.10$). Total number of feeding visits to supplement late morning (0900 to 1200 h) and at night (2100 to 0000 h) was effected by WWR and BW interaction ($P < 0.02$ and $P < 0.01$, respectively) during year 1 (Table 4). However, there was no difference ($P > 0.10$) in total NOV made to supplement between groups when examined by TOD in the second year (Table 4). The most visits occurred at both years were between 0900 and 1200 h (Table 4). Although there was no significant difference in supplement feeding variation, data collected indicated that some cows consumed supplement daily, whereas some cows consumed supplement only every 2 to 3 d.

IMPLICATIONS

Results from this research provide additional information on how cow size and cow–calf WWR affect resource use, grazing distribution, and supplement intake while winter grazing native rangeland. Although not present both years, high WWR cows consumed more supplement when expressed as g/kg than low WWR cows in the second year of the study. Also, not observed both years but observed the first year, high WWR cows spent less time per visit consuming supplement although number of feeding bouts between cow groups did not differ. These results further the understanding of what resource attributes influence grazing distribution and resource use and thus adds to the discussion of what type of cow is more suited to western range environments.

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