Effects of maintenance energy requirements of beef cows on cow and calf performance

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STORY IN BRIEF

Spring calving Angus cows (4 to 7 yr of age) with a BCS of 4.9 ± 0.1 and BW of 572 ± 8 kg were evaluated for variation in maintenance energy requirements (MR). At 160 ± 5 d of gestation cows were individually fed a complete diet for 7 wk in the amount to meet their MR (fed to maintain constant BW and BCS). After 2 wk, daily feed intake was adjusted weekly until constant BW was achieved for at least a 17 d period. Daily energy required for maintenance averaged 90.5 ± 5.3 Kcal·kg BW $^{-0.75}$·d^{-1}. Cows were classified based on MR as low (n = 13; **LMR**, > 0.5 SD less than mean), moderate (n = 11; **MMR**, ± 0.5 SD of mean), or high (n = 8; **HMR**, > 0.5 SD greater than mean). The actual amount of daily energy required to maintain constant BW and BCS differed ($P < 0.001$) by MR. There was a 29% difference in energy required for maintenance between the most and least efficient cows. Calf BW ($P = 0.89$), weaning weight ($P = 0.52$), and ADG from birth to weaning ($P = 0.58$) were not influenced by MR. Identification of cows that require less energy to maintain BW, while maintaining performance, could improve efficiency of beef cattle production.

Key Words: maintenance energy requirements, beef cows, calf growth

INTRODUCTION

Maintenance energy requirement (MR) of cows is the greatest variable cost in beef production. Approximately 70% of the total energy required by cows is attributed to MR, and this value is independent of cow type (Ferrell and Jenkins, 1984). In addition, feed costs have increased $5 per beef cow per year since 2000 (American Angus Assoc.). Efficiency in the cow calf industry could be improved by decreasing the energy required for maintenance of cows. Differences in MR within and between breeds have been identified (Derno et al., 2005; DiCostanzo et al., 1990; Ferrell and Jenkins, 1984). Maintenance energy requirements are moderately heritable in cattle (Hotovy et al., 1991), however, methods to estimate MR of cows are expensive, time consuming, and require specialize equipment and/or expertise. Identification of more efficient and reliable methods to identify and select beef cows that require less energy for maintenance should increase efficiency of beef cattle production. However, it is important that selection for improved efficiency will not decrease production output in terms of cow and calf production. Therefore, objectives of this study were to determine variation in MR of mature, nonlactating beef cows during mid gestation, and to evaluate the influence of MR on cow performance and postnatal calf growth.

MATERIALS AND METHODS

Spring-calving Angus cows were used to determine the influence of MR on physiological functions. Estrus was synchronized and cows were AI to a single Angus sire during 20 d in May. Calves were born in February and March and weaned in October at 210 ± 6 d of age. Maintenance energy requirements were estimated in nonlactating pregnant cows (4 to 7 yr of age, n = 42) with a BCS of 4.9 ± 0.1, and BW of 572 ± 8 kg during 5 to 7 mo of gestation (November and December). Cow and calf performance were evaluated. Maintenance energy requirement was defined as the amount of dietary energy intake that resulted in no net loss or gain of energy from animal tissues (NRC, 1996), resulting in constant BW and BCS of cows. To estimate actual MR, cows were individually fed once daily at 0730 h a complete diet consisting of (as fed) dry rolled corn (36%), alfalfa pellets (35%), cottonseed hulls (22%), soybean meal (4%) cane molasses (3%), salt (0.2%) and vitamin A (0.01%). Cows were fed amounts to meet their MR based on the NRC Table Generator Software of the Level 1 Model. Initial BW for each cow was used to calculate individual MR.

Shrunk body weights after deprivation from feed (23 h) and water (17 h) were recorded at the initiation of the trial, weekly during the first 4 wk of the trial and twice weekly during the final 3 wk of the trial. Body condition scores (1 = emaciate, 9 = obese; Wagner et al., 1988) were determined at the beginning and end of the trial. After cows consumed diets to meet NRC predicted MR for 14 d, daily feed offerings were adjusted every 7 d, if necessary, to maintain constant BW. When BW of a cow increased or decreased 14 kg over three consecutive weights, the diet was decreased or increased by 0.45 kg feed/d compared with the previous diet. Diet refusal (≥ 2 kg) occurred for one cow on 2 d before the period when intake was used to calculate MR. Actual MR of cows were determined during the same 17 d when all cows had achieved constant BW. Constant BW was determined with regression analyses using PROC REG (SAS Institute Inc., Cary, NC). Cows with a significant ($P < 0.10$) linear regression of BW over days were eliminated from further analyses.

Cows were classified based on MR as low (n = 13; **LMR**, > 0.5 SD less than mean), moderate (n = 11; **MMR**, ± 0.5 SD of mean), or high (n = 8; **HMR**, > 0.5 SD greater than mean). Shrunk body weights and BCS of cows were recorded at 244 ± 5 d of gestation, 41 ± 6 d postpartum, and at weaning. Calf BW were recorded at birth (mean calving date = March 5), early lactation (62 ± 6 d), mid lactation (146 ± 6 d), and at weaning (210 ± 6 d). Body weight and BCS of cows and BW of calves were analyzed as a completely randomized design using the GLM procedure of SAS (SAS Institute Inc.). Maintenance requirement of cows, calf sex and the interaction were included in the statistical model for calf data. Maintenance energy requirements of cows were analyzed with the GLM procedure of SAS. The statistical model included MR group (LMR, MMR, HMR) and actual MR ($\text{Kcal}\cdot\text{kg BW}^{-0.75}\cdot\text{d}^{-1}$).

RESULTS AND DISCUSSION

The complete diet was fed for 7 wk and cows maintained constant BW and BCS for 46 d (n = 12), 25 d (n = 11) or 17 d (n = 9), respectively. Mean daily ambient temperature during the constant BW period (Dec 7 to 24) was 2°C. Average minimum and maximum daily ambient temperatures during the period when MR of cows was determined were -4°C and 7°C, respectively. Ambient temperature ranged (actual coldest to warmest) from -9°C to 20°C during the constant BW period (Oklahoma Mesonet, Marina Station). Maintenance energy requirements averaged 90.9 ± 5.3 Kcal·kg BW $^{-0.75}$·d^{-1}. Previous trials in our lab with a similar model yielded mean MR of 89.2, 93.0, and 90.4 Kcal·kg BW $^{-0.75}$·d^{-1} (Prado, 2009). The actual amount of daily energy required to maintain constant BW and BCS was influenced ($P < 0.001$) by MR. The difference between the cow with the greatest and least MR was 29% (Figure 1). Previous trials in our lab with a similar model found differences of 29% and 24% (Prado, 2009). Similarly, ME_m varied by 27% in Angus cows (DiCostanzo et al., 1990) and 23% in Hereford steers (Derno et al., 2005). The coefficient of variation (CV) for MR in this study was 5.9%. Previous trials in our lab with a similar model found CV of 7% and 5% (Prado, 2009), and the CV for MR of Angus cows was 11% (DiCostanzo et al., 1990). These studies support the premise that variation in MR exists within a herd of similar cows. Additionally, MR is moderately heritable and selection of more efficient cows may be possible if MR of cows can be accurately identified without extreme expense.

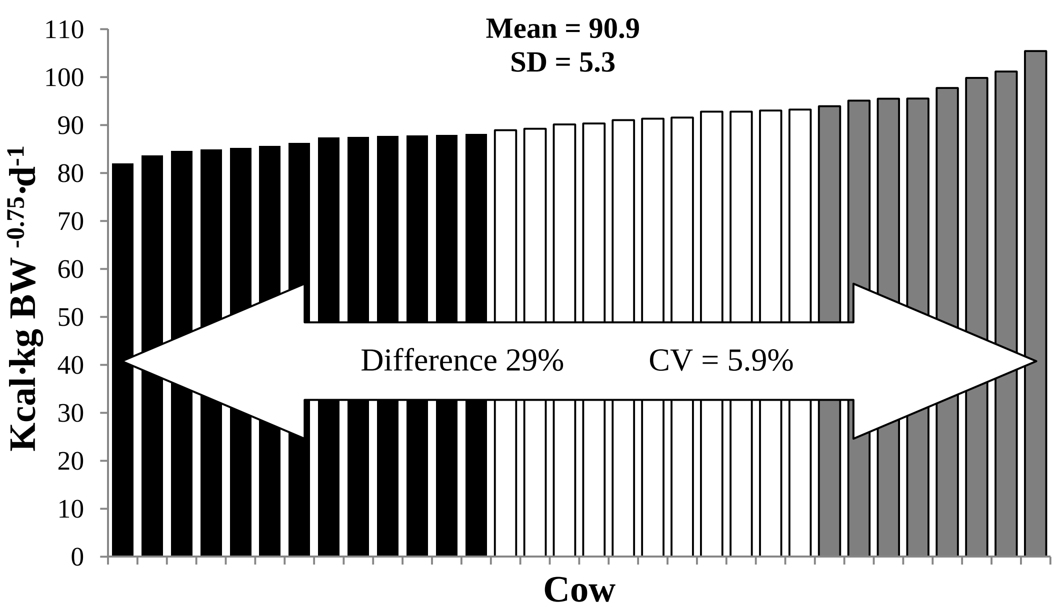

Figure 1. Maintenance energy requirements (MR, Kcal·kg BW $^{-0.75}$·d^{-1}) of beef cows during mid gestation. Bars represent actual MR of each cow (Black bars = Low MR, white bars = Moderate MR, and grey bars = High MR cows). Difference is percentage difference in MR for the cow with the greatest MR and the cow with the least MR.

Mean cow BW was 572 ± 8 kg at the initiation of feeding the MR diet and 569 ± 8 kg at the conclusion of feeding the MR diet. Cows weighed 624 ± 8 kg at 244 ± 5 d of gestation, 537 ± 13 kg at 62 ± 6 d after calving and 603 ± 11 kg at weaning (Figure 2). Body weights of cows were not influenced ($P \geq 0.16$) by MR. Initial (4.9 ± 0.1) and final (5.0 ± 0.1) BCS of cows were not influenced ($P \geq 0.16$) by MR (Table 1). At 244 ± 5 d of gestation cows with HMR had less BCS ($P = 0.04$) compared with MMR cows and tended ($P = 0.06$) to have less BCS compared with LMR cows; BCS of cows with MMR and LMR were similar ($P = 0.78$). At 41 ± 6 d after calving, cows with HMR had less BCS ($P = 0.02$) compared with MMR cows; BCS were similar between cows with HMR and LMR ($P = 0.24$) and LMR and MMR ($P = 0.19$). Body condition of cows was not influenced by MR at 62 ± 6 d ($P = 0.17$) or 146 ± 4 d ($P = 0.35$) after calving or at weaning ($P = 0.74$).

Cows with greater MR may have been in a greater negative energy balance during early lactation and consequently mobilized more fat stores and had greater weight loss compared with moderate and low MR cows. Body condition score at parturition influences onset of luteal activity and the duration of the postpartum anestrous period. Cows in moderate condition at parturition had a shorter postpartum anestrous period compared with cows with less BCS (Richards et al., 1986). Days to resumption of luteal activity postpartum were not influenced by MR of cows in previous years with a similar experimental model (Prado, 2009). Although differences in BCS were detected, BCS did not drastically differ between MR groups. Differences in BCS < 0.5 units are likely irrelevant if cows are in moderate condition. Selection for cows with low MR will likely not negatively impact postpartum resumption of luteal activity and subsequent reproduction. Additionally, HMR cows may be at risk for reduced postpartum reproductive performance because of reduced BCS, especially when energy is limited by reduced forage availability during early lactation.

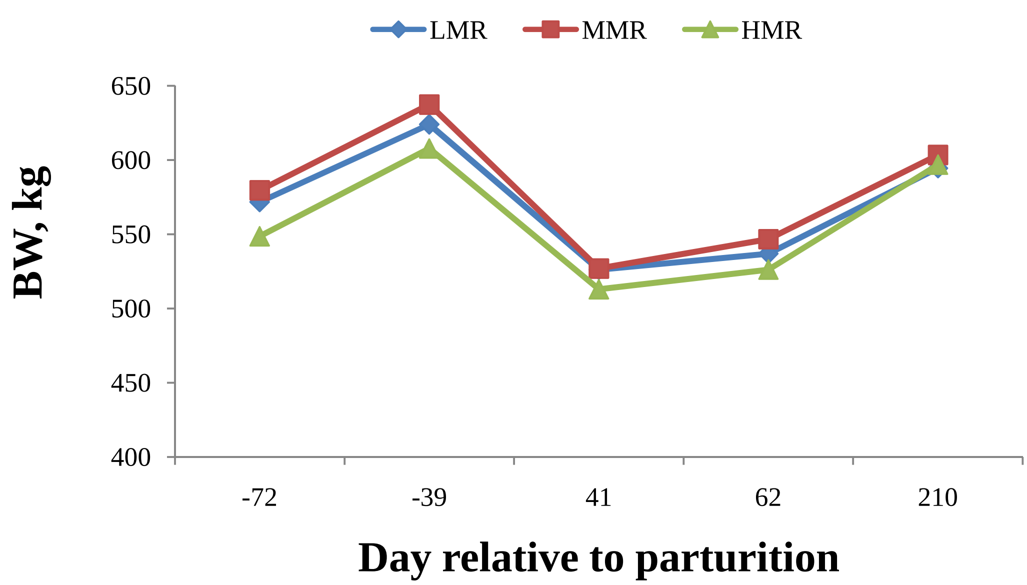

Figure 2. Body weight (BW) of beef cows (kg) with low (LMR; > 0.5 SD less than mean), moderate (MMR; ± 0.5 SD of mean) or high (HMR; > 0.5 SD greater than mean) maintenance energy requirements (MR). Average SE across days was 15 kg.

Table 1. Body condition score of beef cows with low (LMR), moderate (MMR) or high (HMR) maintenance energy requirements (MR)

	MR[1]				
Item	LMR	MMR	HMR	SE	*P* value
Cows, n	13	11	8		
BCS Initial[2]	4.8	5.0	4.8	0.1	0.21
BCS Final[3]	5.0	5.1	4.9	0.1	0.16
BCS, 244 d of gestation	4.9[a]	5.0[a]	4.7[b]	0.1	0.09
Cows, n[4]	12	10	8		
BCS 41 d postpartum	4.3[a]	4.5[a]	4.1[b]	0.1	0.08
BCS 62 d postpartum	4.5	4.7	4.3	0.1	0.17
BCS 146 d postpartum	4.3	4.5	4.3	0.1	0.35
BCS at Weaning[5]	4.6	4.7	4.6	0.1	0.74

[1] Cows were classified based on MR as low (LMR; > 0.5 SD less than mean), moderate (MMR; ± 0.5 SD of mean) or high (HMR; > 0.5 SD greater than mean).
[2] BCS on the first day (Nov 6) of feeding NE_m (NRC).
[3] BCS on the last day (Dec 24) when cows were at constant BW.
[4] Two cows were removed from the experiment after calving.
[5] 210 ± 6 d after calving.
[ab] means without a common superscript differ (P< 0.06)

Birth weight and 205 d adjusted weaning weight of calves were not influenced by MR in this study (Table 2). Maternal milk production is associated with weaning weights of calves (Neville, 1962; Rutledge et al., 1971). Milk production was not associated with variation in MR in the present study, indicated by similar weaning weights of calves from dams with low, moderate, or high MR. This study indicates that selecting for low MR cows will likely not change calf performance at weaning.

Table 2. Performance of calves (kg) born to dams with low (LMR), moderate (MMR) or high (HMR) maintenance energy requirements (MR)

	MR[1]				
Item	LMR	MMR	HMR	SE	*P* value
Calves, n	13	11	8		
Birth Weight	39	38	39	2	0.89
Calves, n[2]	12	10	8		
BW 62 d of age	96	103	102	4	0.33
BW 146 d of age	183	192	194	7	0.45
Adjusted 205 d weaning weight	196	202	206	8	0.58
ADG[3]	0.96	0.99	1.00	0.04	0.58
Age at weaning	209	211	210	2	0.75

[1] Calves are classified based on MR of their dam, as low (LMR; > 0.5 SD less than mean), moderate (MMR; ± 0.5 SD of mean) or high (HMR; > 0.5 SD greater than mean).
[2] Two calves were removed from the experiment after birth.
[3] ADG from birth to weaning.

IMPLICATIONS

Maintenance energy requirements varied 29% between the most and least efficient cow, indicating that the opportunity to select cows with lower MR is possible within a herd of similar cows. In addition, MR did not influence cow or calf performance, indicating that selection for more efficient cows will likely not negatively impact calf performance. Improved feed efficiency has the potential to increase profitability while decreasing the environmental impact of beef cattle production (Moore et al., 2009). Development of accurate, inexpensive methods to identify MR in cows will allow selection for more efficient animals. Identification of cows that require less energy for maintenance, while maintaining performance, will improve efficiency of beef cattle production.

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