Maintenance Energy Requirements of Gestating Beef Cows and Relationship with Cow and Calf Performance

M.J. Prado-Cooper, N.M. Long, , M. Anderson, R. Jones, R.P. Wettemann, G.W. Horn, L.J. Spicer, C.R. Krehbiel

Story in Brief

Angus x Hereford, nonlactating, pregnant, spring-calving cows (BCS = 5.0 ± 0.2, BW = 1283 ± 82 lb) were used to determine variation in maintenance energy requirements (MR), and performance of cows and calves, during two years (27 and 32, cows respectively). After an adaptation period (7 d) to a complete diet, cows were fed predicted MR (NRC level 1 Model; 1996) for 14 d, and then feed intake was adjusted to maintain BW. Body weights were recorded weekly. Cows were stratified, within year, into low (> 0.5 SD less than mean, L), medium (± 0.5 SD of mean, M) or high (> 0.5 SD more than mean, H) MR. Mean MR were 89.2 Kcal/BW$^{0.75}$/d (yr 1) and 93.0 Kcal/BW$^{0.75}$/d (yr 2), and the greatest differences in MR were 29 and 24% within yr 1 and 2, respectively. Weaning weights (205 d) of calves in yr 1 and BW of calves at 60 d in yr 2 were not influenced by MR of their dams. Plasma concentrations of IGF-I (yr 2), after consuming the predicted MR (NRC, 1996) were greater (P<.06) for M cows (66.5 ± 4.8 ng/mL) compared with L (38.9 ± 5.7 ng/mL), and H cows (52.8 ± 4.8 ng/mL). After 3 wk of constant BW, concentrations of IGF-I were not different (P=.14) among L, M and H cows. Variation in MR of gestating cows was as great as 29% and was not associated with performance of calves. Variation in MR of beef cows offers an opportunity to identify cows that require less feed for maintenance and to increase the profitability of beef production

Key words: Maintenance, Energy, Beef Cattle, IGF-I, Calves.

Introduction

The efficiency of beef production could be improved by decreasing the energy required for maintenance of cows. Maintenance energy requirement (MR) of cows is considered one of the greatest variable costs in beef production; it represents approximately 70% of the cost to feed a cow herd (NRC, 1996). Differences in MR among different breeds and types have been recognized (Ferrell and Jenkins, 1984), but individual variations in MR and its impact on cow and calf performance are not established. The coefficient of variation (CV) of MR in beef cattle ranges from 5 to 35%, indicating important differences within breeds (Johnson et al., 2003). The greatest difference observed in metabolizable energy for maintenance (MEm) in Hereford steers was 23% (Derno et al., 2005). Therefore variation in MR could be used to increase the profitability of beef production considering the heritability of MR is moderate (Hotovy et al., 1991). Different methods can be used to estimate MR. Common approaches are feeding trials, comparative slaughter and calorimetric methods (NRC, 1996). All methods are expensive and/or time consuming, hence biomarkers to identify beef cows with low MR are essential to make progress in selecting for this trait. Objectives of this study were to determine variation in maintenance energy requirements of mature, nonlactating, beef cows during mid to late gestation, and to evaluate the relationship among maintenance energy requirements and plasma concentrations of IGF-I, performance, and postnatal calf growth.

Materials and Methods

Spring calving, nonlactating, pregnant, Angus x Hereford cows (BW =1283 ± 82 lb; BCS = 5.0 ± 0.2, age = 4 to 7 yr) were evaluated in two trials. In yr 1, cows (n = 27) were 6 to 8 mo of gestation during the trial (November to January). In yr 2 cows (n = 32) were 5 to 7 mo of gestation during the trial (November to December). To determine MR it was assumed that the maintenance energy requirement is the amount of dietary energy intake that results in no net loss or gain of energy from animal body tissues (NRC, 1996), and consequently BW remains constant. Cows were individually fed at 0730 h once a day, weighed weekly, and BCS was determined at the beginning and end of the trial. The diet (as fed) was composed of rolled corn (38%), alfalfa pellets (35%), cottonseed hulls (21%), soybean meal (4%), cane molasses (3%), salt (0.2%) and vitamin A, containing an NEm = 0.65 Mcal/lb. Cows were adapted to a drylot and the complete diet for 7 d. After adaptation, cows consumed the predicted MR diet based on NRC Level 1 Model (NRC, 1996) for 14 d, then the amount of feed consumed by individual cows was adjusted weekly to maintain constant BW for at least 21 d. Constant body weight of cows was determined with regression (SAS Inst., Inc., Cary, NC); cows with significant ($P<.1$) linear regression coefficients of BW over days, indicating BW gain or loss, were eliminated from analyses. Maintenance energy requirement of individual cows was the dietary energy required to maintain constant BW (yr 1 = 21 d, yr 2 = 28 d), and is expressed as Kcal/ $BW^{0.75}$/d. Determination of MR allowed stratification of the cows into: low (> 0.5 SD less than mean, L), medium (± 0.5 SD of mean, M) or high (> 0.5 SD more than mean, H) MR groups. After determination of MR, cows were maintained as a group, grazed native pasture, and received protein supplementation. Cows and calves were weighed and cow BCS was determined during lactation. In yr 2, blood was collected from caudal veins, and plasma was recovered and stored at -20°C. Plasma concentrations of IGF-I were quantified in samples on d 14, after cows consumed predicted MR diets (NRC level 1 model) for 2 wk, and on d 49, at the end of the constant BW period. Body weight change of cows and calf BW, within year, were analyzed as a completely randomized design using the GLM procedure of SAS; the statistical model included MR, calf sex and the interaction. Concentrations of IGF-I in plasma were analyzed as a completely randomized design using the Mixed Model procedure of SAS; the statistical model included MR, hour and the interaction. Cow was considered to be random and all others effects in the model were considered fixed.

Results and Discussion

Body weight and BCS of cows averaged 1332 ± 55 lb and 5.0 ± 0.2 in yr 1, and 1228 ± 99 lb and 5.2 ± 0.2 in yr 2. Daily MR (NEm, Kcal/$BW^{0.75}$/d) averaged 89.2 (yr 1) and 93.0 (yr 2). The greatest differences in MR for all cows were 29% (yr 1) and 24% (yr 2) (Figures 1, and 2). Similarly MEm varied by 23% in Hereford steers (Derno et al., 2005).

Maintenance energy requirements were not associated with age or BW of the cows.

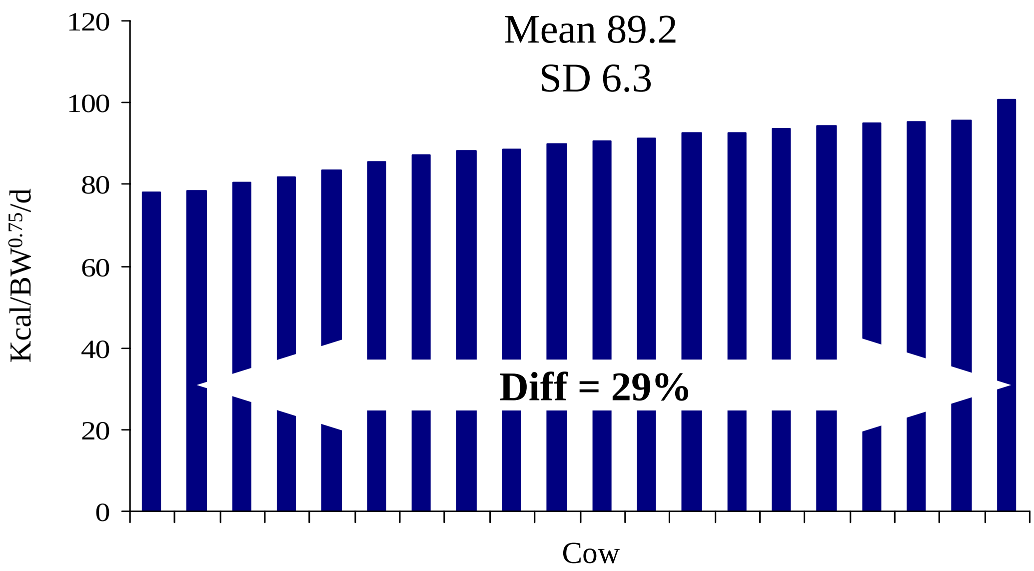

Figure 1. Maintenance energy requirement of individual beef cows (yr 1).

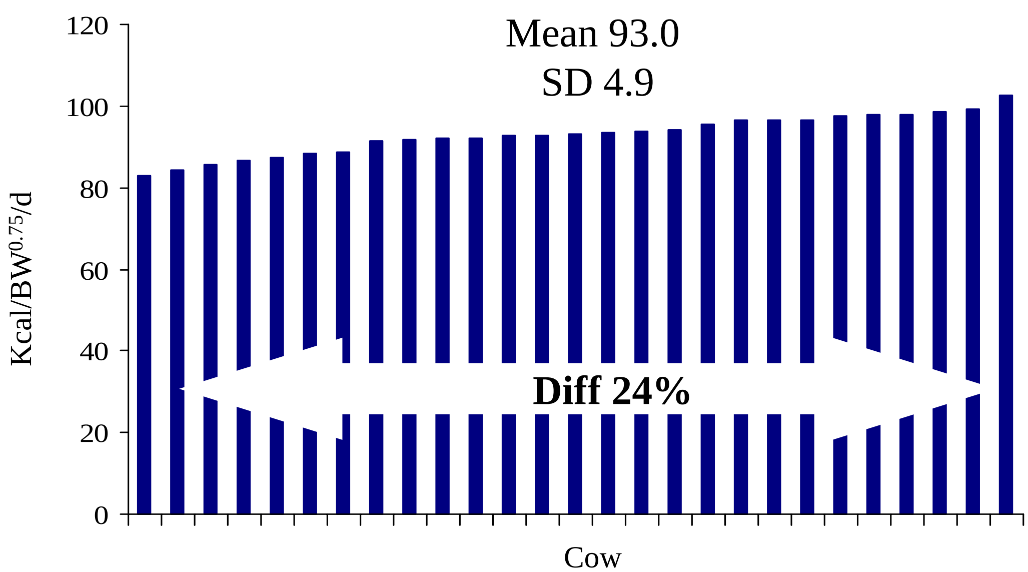

Figure 2. Maintenance energy requirement of individual beef cows (yr 2).

Body weights of calves at weaning in yr 1 (205 d, 441 ± 19 lb) and calves at 60 d (245 ± 6 lb) in yr 2 were not influenced (P>.1) by MR of dams (Figures 3 and 4). Postpartum BW changes or BW at weaning of cows in yr 1 were not influenced (P>.1) by MR. Body condition score of cows in yr 1 at weaning tended (P=.08) to differ (5.1, 4.9, and 4.6 for L, M, and H, respectively).

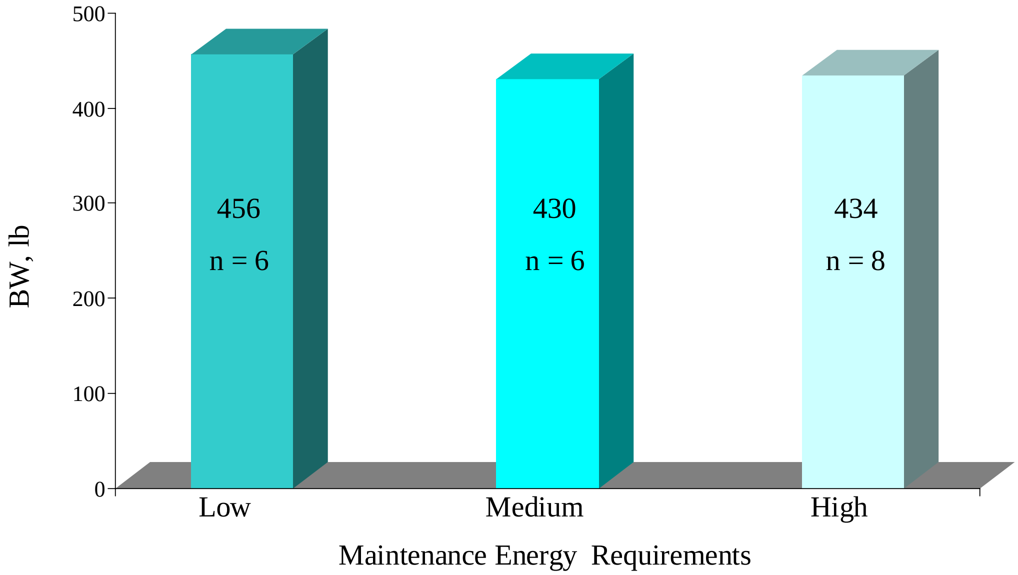

Figure 3. Weaning weights (205 d) of calves from beef cows with low, medium and high maintenance energy requirement (yr 1). SE = 19 lb.

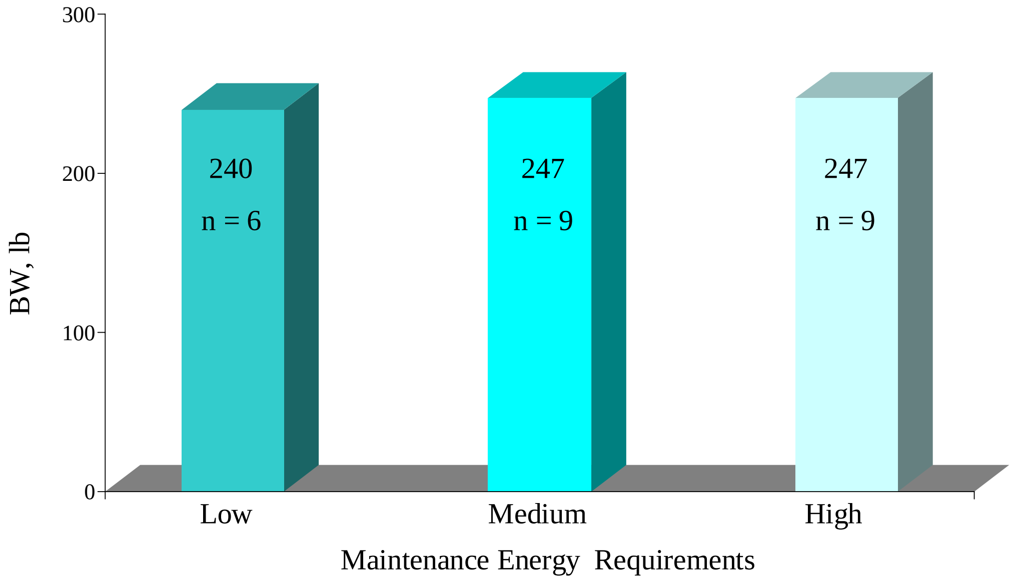

Figure 4. Body weights at 60 d of calves from beef cows with low, medium and high maintenance energy requirement (yr 2). SE = 6 lb.

Plasma concentrations of IGF-I in yr 2 (Figure 5), when cows consumed predicted MR diets on d 14, were greater ($P<.06$) for M cows (66.5 ± 4.8 ng/mL) compared with L cows (38.9 ± 5.7 ng/mL) and H cows (52.8 ± 4.8 ng/mL). On d 49, after 28 d of constant BW and consumption of the maintenance diet, concentrations of IGF-I were not different ($P=.14$) among L, M and H cows (40.2, 52.1 and 51.2 ± 4.4 ng/mL, respectively). Concentrations of IGF-I in plasma were not correlated ($P=.18$, $r=0.26$) with MR (Kcal/$BW^{0.75}$/d), nor ($P>.3$) with daily dietary energy intake (Kcal/d) or BW of the cows.

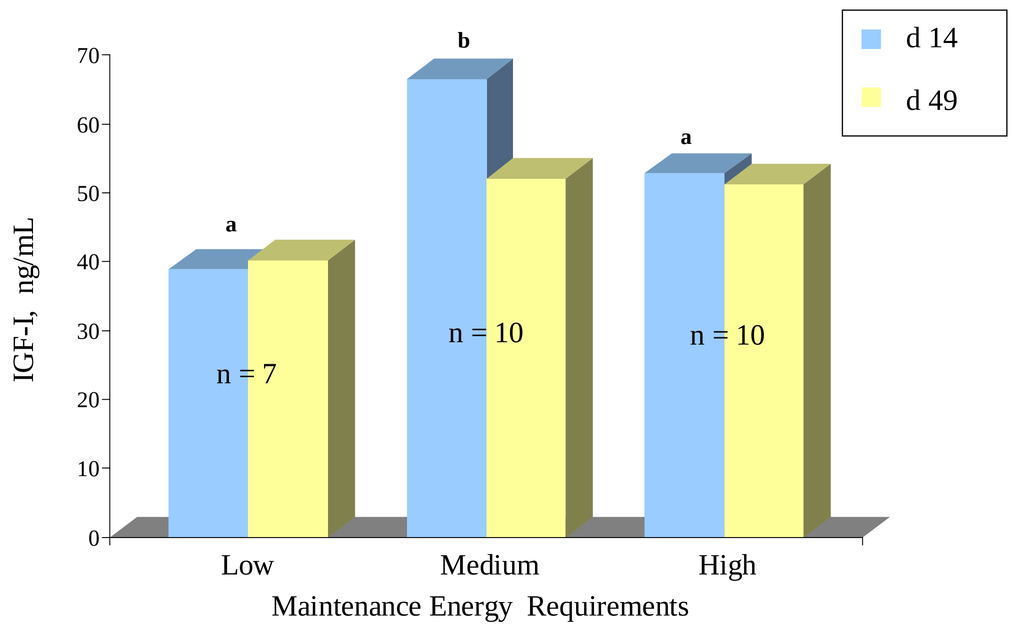

Figure 5. Concentrations of IGF-I in plasma of low, medium and high maintenance energy requirement beef cows on d 14 (NRC) and 49 (maintenance) (yr 2). [a,b]LSMeans with out common superscript differ ($P<0.06$). SE = 4.6 ng/mL

Conclusions

Variation in maintenance requirements of nonlactating, pregnant, Angus x Hereford cows ranged from 24% to 29%. This offers the opportunity to improve efficiency of beef production since this trait is moderately heritable. Variation in maintenance energy requirements was not associated with performance of calves. Variation in maintenance energy requirements of nonlactating, pregnant beef cows may be associated with plasma concentrations of IGF-I. Identification of biomarkers for maintenance energy requirements will allow selection for efficient cows that require less energy for maintenance and therefore improve efficiency of production.

Literature Cited

Derno M. et al. 2005. J. Anim. Sci. 83: 2590.

Ferrell C. L., and T. G. Jenkins. 1984. J. Anim. Sci. 58: 222.

Hotovy, S. K. et al. 1991. J. Anim. Sci. 69: 940.

Johnson, D. E. et al. 2003. J. Anim. Sci. 81: E27.

National Research Council. 1996. National Academy Press. Washington.

Acknowledgements

Special thanks to Mark Anderson and Randy Jones for the excellent care of the animals.

Authors

Wettemann, R.P. - Regents Professor

Spicer, L.J. – Professor

Horn, G.W. – Professor

Krehbiel, C.R. - Associate Professor

Prado, M.J. – Graduate Student

Long, N.M. - Graduate Student

Anderson M. - Herd Manager, Range Cattle Research Center

Jones R. - Herd Manager Assistant, Range Cattle Research Center