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# The influence of maternal energy status during mid-gestation on growth, cattle performance, and the immune response in the resultant beef progeny[1]

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## ABSTRACT

*The objective of this experiment was to determine the effects of cow energy status during mid-gestation on progeny growth performance and health. To alter maternal energy status, cows (n = 151) were either fed to achieve or maintain BCS 5.0 to 5.5 (positive energy status) or fed at 80% of the energy requirements for BW maintenance (negative energy status) over the ensuing 91-d period of mid-gestation. Cows were managed as a common group beginning with the third trimester of gestation through subsequent weaning. Weaned calves (n = 71 steers and 61 heifers) were allotted to pens according to cow energy status during gestation and sex and stratified by BW to allow for live cattle performance evaluation. A subsample (n = 30) of calves was subjected to an ovalbumin challenge 19 d after entering the feedlot to compare antibody titer response. Mid-gestation dam energy status did not affect (P > 0.05) birth weight, weaning weight, or adjusted 205-d weaning weight of progeny. No differences (P > 0.05) were observed between treatments during the feeding period on ADG, DMI, and G:F. Ovalbumin results showed no interactions (P > 0.05) between treatments, days, or sexes, as well as no sex main effects. However, progeny of negative energy status cows had lower (P < 0.05) antibody titers in response to the ovalbumin challenge during the receiving period. These results suggest that differences in cow energy status applied during mid-gestation in this experiment will not affect BW or growth performance differences throughout the postnatal period in beef cattle progeny but may have an effect on the adaptive immune response during their receiving period in calves.*

**Key words:** beef cattle, fetal programming, health, maternal energy status

## INTRODUCTION

Growth performance in cattle is affected by many different variables including genetics, health, and maternal influences. Not only are postnatal influences such as milk production important for growth, but prenatal influences can also affect growth throughout life. These prenatal influences on the developing fetus and the responses that manifest in progeny after birth are collectively called fetal or developmental programming (Barker and Clark, 1997; Godfrey and Barker, 2000, 2001). In cattle, the most commonly reported prenatal influence is nutrient restriction, because many grazing cows experience climatic conditions affecting forage availability and quality (Vavra and Raleigh, 1976), which can result in a period of inadequate nutrition for gestating cows. In livestock, maternal undernutrition during gestation has been reported to alter muscle growth and

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**Table 1. Least squares means for cow BCS, BW, LM area, and fat thickness at the beginning and end of the mid-gestation treatment period[1]**

| | Cow energy status | | | *P*-value |
|---|---|---|---|---|
| Item | Positive[2] | Negative[3] | SEM | Treatment |
| Days of gestation[4] | 84 | 84 | 1.3 | 0.963 |
| Initial BCS | 4.80 | 4.92 | 0.052 | 0.210 |
| Final BCS | 4.98 | 4.29 | 0.043 | <0.001 |
| Change in BCS | 0.17 | −0.63 | 0.050 | <0.001 |
| Initial BW, kg | 463 | 461 | 2.3 | 0.625 |
| Final BW, kg | 516 | 437 | 2.4 | <0.001 |
| Change in BW, kg | 53 | −24 | 2.2 | <0.001 |
| Initial LM area, cm$^2$ | 57.42 | 59.36 | 0.903 | 0.234 |
| Final LM area, cm$^2$ | 60.71 | 53.03 | 1.032 | <0.001 |
| Change in LM area, cm$^2$ | 2.99 | −6.31 | 0.710 | <0.001 |
| Initial 12th rib fat thickness, cm | 0.39 | 0.39 | 0.014 | 0.911 |
| Final 12th rib fat thickness, cm | 0.42 | 0.35 | 0.010 | 0.010 |
| Change in 12th rib fat thickness, cm | 0.02 | −0.04 | 0.010 | 0.007 |

[1]Measurements were taken at the beginning and end of the mid-gestation treatment period normalized for fill.

[2]Cows managed to maintain BCS during mid-gestation.

[3]Cows managed to lose one BCS during mid-gestation.

[4]Days of gestation at the beginning of mid-gestation treatment as estimated by pregnancy ultrasound.

adipose deposition, potentially affecting live cattle performance (Larson et al., 2009; Underwood et al., 2010; Long et al., 2012). Additionally, cows experiencing poor prepartum nutrition can result in detrimental effects on calf health (Hough et al., 1990; Quigley and Drewry, 1998). Late gestation maternal nutrient restriction has been reported to negatively affect calf health postnatally (Corah et al., 1975; Hough et al., 1990). Although postpartum calf health is important, health during the receiving period in the feedlot is critical because this is a period of time when cattle can be immunocompromised and bovine respiratory disease is prevalent (Loerch and Fluharty, 1999; Duff and Galyean, 2007). To date, most research has focused on fetal programming outcomes in response to management techniques and progeny development, with less research focusing on live cattle performance and health. Therefore, the objective of this experiment was to determine the influence of maternal energy status during mid-gestation on live cattle performance and the adaptive immune response of progeny.

## MATERIALS AND METHODS

### *Cow Management*

The South Dakota State University Animal Care and Use Committee approved the following animal experiment. Cows were managed and treatments applied similarly as reported by Mohrhauser et al. (2015a). Briefly, crossbred, 3- and 4-yr-old cows (second and third parity, respectively; n = 151) from 2 South Dakota State University research stations in western South Dakota were naturally bred to Angus/SimAngus bulls over a 60-d breeding period. Cows were allotted into mid-gestation management groups considering day of gestation, source, BW, age, and BCS to 1 of 2 management strategies: (1) fed to achieve or maintain a BCS of 5.0 to 5.5 (positive energy status, **PES**; n = 76) or (2) fed to lose one BCS over a 91-d period of mid-gestation (negative energy status, **NES**; n = 75). At the time of allotment, mean day of gestation via transrectal ultrasonography determination was 84 ± 11 d, cow BW was 495 ± 58 kg, cow age was 4 ± 1 yr, and BCS was 4.9 ± 0.5. Feed and water was withheld from cows for 12 h before weighing to obtain shrunk BW, which were measured every 28 d throughout mid-gestation. Ultrasound measurements (Aloka 500V real-time ultrasound machine, Aloka, Wallingford, CT) were collected for 12th rib s.c. fat thickness, LM area, and BCS for evaluation at the beginning and the end of mid-gestation (Table 1).

Diets were formulated to meet recommendations based on Nutrient Requirements of Beef Cattle (NRC, 2000) software for cows during mid-gestation. During treatment, cows managed for PES remained on dormant native pasture composed of mostly western wheatgrass (*Pascopyrum smithii*), as well as green needlegrass (*Stipa viridula*), little bluestem (*Schizachyrium scoparium*), buffalo grass (*Buchloe dactyloides*), and blue grama (*Bouteloua gracilis*). In formulating a diet for the PES treatment, the composition of the grazed forage was assumed to be similar to the tabular values for Range Winter listed by the NRC (2000). Intake was assumed to equal predicted DMI generated from NRC Model Level 1 (NRC, 2000) for the Range Winter forage. With supplementation (Table 2) the model predicted days to change one BCS was 178 d. The supplement was pelleted and fed on alternate days to the entire group of cows at a fixed rate of 12.71 g/kg BW$^{0.75}$ per day based on initial cow BW. The mid-gestation feeding period was October 10, 2010, through January 18, 2011. Pastures remained free of snowpack until mid-January. In January PES cows were supplemented with mature brome hay at 9.77 kg/cow per day (5.76% CP, 53% TDN) while continuing ad libitum access to native range and protein supplementation.

During the treatment period, NES cows were managed in 10 dry-lot pens and blocked by BW. They were fed