Fetal Programming: Does Maternal Nutrition During Mid-Gestation Cause Changes to Genes that Might Alter Body Composition on the Calf?

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Fourteen million feeder cattle are finished annually in the U.S. and the most recent National Beef Quality Audit listed among the greatest concerns with regard to beef carcass quality, inadequate marbling and excess external fat relative to lean tissue. This unfavorable distribution of fat relative to lean tissue is estimated to result in $169 million of lost revenue annually within the beef industry and this does not account for losses incurred as a result of poor feed efficiency that occurs with excessively fat cattle. Despite efforts to improve fat distribution in the beef carcass, carcasses with a Yield Grade 4 or 5 have increased 6% since 1995 and the percentage of carcasses grading USDA Choice or Prime has decreased from 84% to 60% since 1975.

Most research aimed at improving carcass quality in beef cattle has focused on nutrition and management of the calf from birth through harvest, and less research has focused on the impact that maternal nutrition during gestation may have on offspring performance. The majority of beef cow-calf operations in the U.S. rely heavily on grazing forages to supply nutrients to the gestating cow. In a normal grazing season, nutrient availability from pasture fluctuates as temperature and rainfall fluctuate. It is not uncommon for beef cows to encounter periods of inadequate nutrition during gestation as a result of nutritional quality and availability of the forage. This problem can be exacerbated by drought, which has been occurring in the Northern Great Plains and Southeastern U.S. in recent years. Both of these regions of the U.S. are predominated by beef cow-calf operations.

Supplemental nutrients can be provided to the cow by feeding harvested grains or forages during times of limited pasture resources. However, harvested feeds are expensive compared with pasture, and their delivery, compared with grazing cattle, is labor-intensive. Because of the added expense, supplementing harvested grains or forages to grazing beef cows must be well-justified. Most research to justify supplementing harvested feeds to cows has focused on its impact on reproductive efficiency in the cow and not on the impact that nutrition, during gestation, has on the calf and its potential for growth postpartum. Severe undernutrition of the dam can result in abnormal growth of the fetus. However, the fetus maintains high priority for nutrients, and fetal nutrient requirements not met by feed intake are met at the expense of the dam's body stores. Beef cows have been reported to lose 10-15% of their body weight during gestation. However, depending on the severity and duration of the imposed restriction, significant differences in calf birth weight do not always result. Although a reduction in calf birth weight may not result with moderate nutrient restriction to the dam, the hormonal and metabolic environment in which the fetus develops may influence postpartum growth and carcass composition. This gives rise to the concept of fetal programming.

A recent SDSU project, evaluated the effects of providing the dam greater or less energy than needed for body weight maintenance during the middle of gestation on fetal weight and the expression of genes involved in the development of fat tissue in intramuscular (loin muscle) and subcutaneous fat depots. Energy restriction was sufficient to result in differences in dam weight, however, fetal body weight was not influenced. Expression of some genes involved in the development of fat tissue in fetal intramuscular (marbling), but not subcutaneous depots were influenced by maternal nutrition during mid-gestation. Subsequent trials are being conducted to determine whether or not maternal nutrition influences genes involved in lean tissue development and whether differences in gene expression in the fetus carry through to result in differences in postpartum growth or composition of the carcass.