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What We Know About Fetal Programming

Maternal stress, cow management have significant effects on calf profitability.

by *Troy Smith*

When managers of cow herds ponder nutrition programs, a primary concern is the fueling of optimum reproduction. Cow-savvy managers know that quantity and quality of feed sources influence the cow's ability to breed in a timely fashion and deliver a healthy, vigorous calf. Producing that annual coupon is really tough when cow nutrition isn't up to snuff.

And producers are often reminded of how important it is to provide adequate nutrition to cows during the third trimester of pregnancy. Most of an unborn calf's growth occurs during that latter part of gestation, with about 75% of growth occurring during the last two months. The cow's nutritional status during those later

months of pregnancy also influences how quickly a cow's reproductive system recovers postpartum and resumes normal estrous activity. It's hard to get a cow ready to breed if she was in sorry shape at the time of calving.

Consequently, much research and plenty of producers' efforts have concentrated on the cow's dietary needs during late gestation. The first half of gestation may have seemed less important — at least when you consider her fetus' limited nutrient requirements for growth and development. However, evidence suggests there is a lot going on at the beginning, as well as later in the pregnancy — things that can affect producer profitability — as a result of fetal or developmental programming.

What is fetal programming?

The Center for the Study of Fetal Programming was established at the University of Wyoming in 2002 to investigate the special effects maternal stresses may have on offspring later in life. Scientists from multiple institutions and disciplines are associated with the center, including medical doctors looking at how fetal programming affects the health and well-being of humans.

In fact, the concept grew out of human health studies. David Barker, at Southampton University in England, related maternal stresses to infant weight and physical characteristics at birth and to eventual health status. It was Barker who coined the term "fetal programming."

► **Above:** Nutrition during gestation may have far-reaching effects in progeny performance and profitability. Says Rick Funston, there's enough evidence to make producers rethink nutrition management strategies that focus only on the cow.

Prompting the human studies were the eventual health problems occurring among offspring born to undernourished women in Nazi-occupied Holland during World War II. The women delivered apparently normal, healthy babies that later developed hypertension, diabetes and other diseases at much higher rates than the remainder of the population.

“The center’s primary focus is to discover how maternal insults during gestation impact offspring later in life. These impacts can be due to hormonal and environmental stresses, as well as nutrition,” says University of Wyoming ruminant nutritionist Bret Hess.

Involved with studies of fetal programming in sheep and cattle, Hess says the potential effects on offspring due to nutritional insults to the dam can include enlargement of the heart, hypertension (as early as 8 months of age), insulin resistance and hampered ability to produce insulin. Evidence suggests kidney development may be affected, as well as basic protein synthesis essential to normal skeletal and muscular development.

What’s happening during early gestation?

North Dakota State University reproductive physiologist Kimberly Vonnahme says a key to fetal programming is development of the placenta.

Development of the placenta and a vascular system between it and the fetus begins early in gestation. In cows, she says, vascularity of the caruncles (sites of attachment between placenta and uterine wall) begins around Day 90 of gestation, with a marked increase in both blood flow and vascular density by Day 120.

“The establishment of the vascular architecture is essential if the maternal side is to support the exponentially growing fetus during the last trimester of gestation,” Vonnahme explains. “Any detrimental effects of maternal nutrition during this critical establishment of the maternal-fetal vascular systems would impact the ability of the fetus to acquire the proper amount of nutrients and oxygen.”

Plus, organs of the fetus are developing simultaneously with the placenta, including the heart, pancreas, liver, lungs, adrenals, thyroid, spleen, brain, thymus and kidneys. By Day 45 of the pregnancy, testicles of male calves are being developed, and ovaries of female calves begin development at 50 to 60 days. The rates at which different organs develop vary, but Vonnahme says each is susceptible to stresses, including inadequate nutrition of the dam, during early gestation.

Vonnahme says maternal nutritional status is a factor in the programming of

nutrient partitioning in the fetus. In other words, some fetal tissues have priority when receiving nutrients. Skeletal muscle has a lower priority compared to the brain and heart, so it is particularly vulnerable to nutrient deficiency.

What does it mean for performance?

Hess says a collaborative study between the University of Wyoming and the U.S. Department of Agriculture (USDA) Fort Keogh Livestock and Range Laboratory (Montana) provided evidence of the real-world effects of fetal programming. The study involved spring-born steer calves whose mothers had grazed native range during mid-gestation, compared with steers out of cows that grazed improved pastures. Neither group of cows received supplemental protein.

“This would be comparable to a common ranch scenario, with cows grazing late-summer or fall range consisting of forage that has gone through reproductive stages and is of lower quality,” Hess says, noting that cows on improved pasture would consume forage of higher quality.

All calves were backgrounded and entered the finishing yard at comparable weights. After 120 days on feed, the steers whose mothers grazed on native range exhibited lower gains, produced lighter carcasses, lower backfat and lower marbling scores.

Studies also suggest that cow nutrition during late gestation affects fetal programming. During three years, University of Nebraska researchers tracked calves during the last trimester whose dams received protein supplement while grazing dormant Sandhills range. Results were compared to that of calves whose dams received no supplement. First, it should be mentioned that the supplemented cows

weaned 5% to 9% more calves than cows receiving no supplement. And calves born to the supplemented cows outperformed their counterparts, producing carcasses that were, on average, 60 pounds (lb.) heavier.

Of particular interest to University of Nebraska reproductive physiologist Rick Funston, however, is the apparent long-term effect on heifers born to late-supplemented cows. Three years of study focused on how dam nutrition influences growth and reproduction of heifer calves showed higher overall pregnancy rates for daughters of cows that received protein supplement during late gestation. In addition, a higher percentage of those heifers delivered their first calves early in the calving season.

The overall pregnancy rate was 93% for daughters of supplemented dams, compared to 80% for heifers whose mothers received no supplement. The percentage of heifers that calved during the first 21 days of the calving season was 77% for heifers whose mothers received supplement. Of heifers whose mothers received no supplement, only 49% calved during the first 21 days of the season.

These results, Funston says, are independent of the heifers’ ages at puberty or estrus activity immediately before breeding season. The evidence suggests dam nutrition during late gestation has a fetal programming effect on daughter fertility. Certainly, more study is needed to better understand how far-reaching the effects of fetal programming might be. But Funston believes there is already enough evidence to make producers rethink nutrition management strategies that focus only on the cow.

“The research shows,” he says, “that our management may also influence the profitability of the calf she’s carrying.”

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