PHYSIOLOGICAL, PRODUCTION AND ECONOMIC IMPACTS OF INADEQUATE PRE-PARTUM NUTRITION OF BEEF COWS

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A compromised nutritional state in beef cows during the last trimester of gestation adversely effects calf health at the time of calving and during the period from birth to weaning. These main effects can be summarized into the following areas: 1) vigor, 2) thermoregulation, 3) passive immunity, and 4) susceptibility to disease. Cows that calve in a thin bodily condition (≤ 4 body condition score) are more prone to lower rebreeding performance than their contemporaries that maintained body weight before parturition.

Physiological and Productivity Consequences of Pre-Partum Nutritional Compromise

Calf Vigor. Heavily pregnant heifers and cows fed suboptimal amounts of energy and protein deliver more calves exhibiting decreased vigor (ability of calf to stand and nurse in a timely manner) at birth. These calves also typically have a lighter birth weight compared to similar calves born to females receiving adequate energy.

Corah and co-workers[1] demonstrated in the early 1970's that, compared to 2-year-old heifers that received adequate energy during the last 100 days of gestation, heifers that received only 65% of recommended NRC energy levels delivered calves with a significantly lighter birth weight (30.6 kg vs. 28.6 kg, respectively). The 2 kg (4.4 lb) lighter birth weight did not result in less dystocia as both groups experienced similar amounts of calving difficulty. However, the heifers on the starvation diet lost 7% more calves at birth (combination of dystocia and weakness of calf). At weaning, calves born to the heifers that were starved also weighed significantly less than herdmates born to adequately fed heifers (160.6 kg vs. 147.6 kg, respectively). Other studies[2-4] report similar findings.

Admittedly, the aforementioned studies do support rancher contentions that feeding heifers "too good" results in relatively heavier calves at birth whereas decreasing feed availability to heifers before calving results in lighter calf birth weights. Their rationale for this practice is to reduce calving difficulty. However, evidence to date demonstrates that dystocia is not reduced by starving heifers. Furthermore, it should be pointed out to these ranchers that calves that survive dystocia are at greater risk (in one study,[5] 2.4 times more susceptible) to become sick during the first 45 days of life.

One of the best ways to evaluate the adequacy of dietary energy levels is to monitor the female's body condition via body condition scoring (1 to 9; 1= emaciated and 9= obese).[6] Strive to achieve a body condition score 5 for cows and 5.5 to 6 for heifers at calving.

Inadequate quantities of protein during late gestation can also adversely impact calf vigor and survival. For example, Bull[7] has shown that when protein in the diet was increased during the last 60 days pre-partum from 0.68 kg (1.5 lb) to greater than 0.91 kg (2.0 lb), the percentage of weak calves subsequently born to cows decreased from 9.8% to 0.6%.

A few trace minerals have been shown to decrease calf vigor and increase susceptibility to disease. Selenium deficiency is associated with an increase in weak calves.[8] Susceptibility to diarrhea is heightened with pre-existing copper deficiency.[9] Iron toxicity and iodine deficiency can cause weak calves.[10] In addition, for the immune system of the calf to function properly, adequate levels of copper, selenium, zinc, and manganese must be present.[10] Calves with these deficiencies are more susceptible to diarrhea, pneumonia, and other calfhood diseases.

Vitamin A and/or beta carotene deficiency has been associated with an increase in the number of stillborn and weak calves at birth.[10]

These studies point out that ranchers that fail to adequately feed heavily pregnant heifers and cows suffer both short and long term shortcomings in production.

Calf Thermoregulation. Carstens[11] has reviewed the thermoregulatory responses of the newborn calf subjected to cold environmental temperatures. When faced with exposure to cold environmental temperatures and a drop in body temperature, the newborn calf can utilize shivering and non-shivering mechanisms to raise body temperature. Approximately 40% of the thermogenic response comes from nonshivering (brown adipose tissue) with the balance attributed to shivering (skeletal muscle) activity.

Prior to the establishment of colostrum feeding the neonate depends entirely on mobilization of fetal tissue glycogen and lipid stores to provide energy substrates for basal metabolism and heat production. Compared to other breeds of cattle, Brahman neonates have greatly reduced quantities of BAT and, thus, are highly susceptible to developing hypothermia.

Prepartum protein and energy restriction of dams during the last trimester reduce heat producing capabilities of newborn calves. Protein restriction has a more pronounced effect. As mentioned previously, energy restriction in the dam results in calves with a lighter body weight at birth. Light weight neonates have a lower metabolic rate per unit of surface area. Consequently, light weight calves will be less cold tolerant than heavy weight calves.

Dystocia creates an inability of the neonate to maintain thermal balance during the early postnatal period. Body temperature typically drops in dystocia calves immediately post-partum and takes several hours to correct. A persistent metabolic acidosis accompanies body temperature changes. It is thought that metabolic acidosis caused by hypoxic conditions during a difficult birth may be involved in suppressing nonshivering (BAT) thermogenesis.

Calf Passive Immunity. In females older than 2-years-of-age, body condition at calving does not appear to influence colostral or calf serum immunoglobulin concentrations.[12] However, nutritional deprivation of first-calf heifers during late gestation does subsequently compromise immune status of their calves. In one study,[12] beef heifers in adequate body condition (BCS $\geq$ 5) at calving tended to produce a greater volume of colostrum than herdmates in poor body condition (BCS $\leq$ 4). Immunoglobulin concentration of colostrum from both groups of heifers was similar. However, calves from the heifers with BCS 3 and 4 subsequently had lower immunoglobulin concentrations than calves from heifers in better body condition. There were more long-term health problems in the hypogammaglobulinemic calves.

Selenium supplementation appears to increase colostral IgG concentration in beef cows that graze selenium-deficient pastures. Swecker, et al.[13] showed that ad libitum oral supplementation of selenium continuously in cows beginning at mid-gestation produced a higher colostral IgG concentration than did Se-deficient cows. Calves from Se-supplemented cows also had higher post-suckle serum concentrations of IgG than did calves from cows without Se-supplementation.

The incidence of hypogammaglobulinemia also appears to increase if calves are born as a sequela to dystocia.[12] This observation may be related to a longer period of time that elapses before the calf ingests colostrum since "dystocia" calves typically have less vigor and take longer to stand compared to calves born unassisted.

Ingestion of colostrum is also critical for supplying the nutrients needed to maintain normal thermogenic responses.[11]

Calf Disease. Calves that have inadequate serum concentrations of immunoglobulin (< 800 mg/dL IgG_1) are highly susceptible to contracting septicemia, particularly colisepticemia.[14] Mortality is quite high. Most calves die during the first 10 days of life. Hypogammaglobulinemic calves are also at greater risk to die from enteritis and pneumonia before weaning age.[15]

As mentioned previously, trace mineral deficiencies also compromise the calf's immune function. Consequently, calves are probably more susceptible to acquiring common calf hood diseases.

Post-Partum Anestrus in Cows. Cows, especially two-year-old heifers, that calve in thin body condition (≤ 4 BCS) as a result of energy restriction during late gestation are typically slow to return to estrus and have sub-optimum rebreeding percentages. An early study by Whitman, et al[16] showed clearly that cows in good body condition at calving (≥ 5 BCS) have the best chance for returning to estrus and subsequently becoming pregnant early in the breeding season. Another study showed that there was a negative (R= -0.50) relationship between the post-partum interval and change in weight during the pre-partum period.[17] A later study by Spitzer et al[18] demonstrated that greater BCS at calving resulted in more cows in estrus and more cows pregnant by 40 and 60 days of a breeding season.

Economic Consequences of Pre-Partum Nutritional Compromise

The magnitude of economic losses from pre-partum nutritional compromise in a beef cow herd will vary depending upon the number of cows in thin body condition and their expected post-partum interval as well as the variable and fixed cost structure for the beef enterprise. A model will be presented at the seminar that inputs productivity changes and costs to determine economic losses.

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