Nutritional influences on Reproduction

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Introduction

Producers spend a lot of time pouring through sire catalogs and analyzing EPD's for bulls that are going to be used. There is no question this is a good practice and the increased attention to detail and increased accuracies of predictor traits has no doubt led to the increased performance witnessed in the beef industry. However, it has been well documented that reproduction is the single most important factor affecting the profitability of the cow/calf producer. It has also been well documented that reproduction is 5x more economically important that product quality or growth. Simply because more calves on the ground is more pounds of beef sold at weaning. I don't mean to insinuate that we should not be cognoscente of increasing product quality or having growthier calves because I believe that we should. However, producers would be wise to pay as much attention to maternal traits, such as longevity, age at puberty, etc. as we do for feedlot type traits.

There has been a tremendous amount of research studying the impact of nutrition on reproduction. It has been estimated that only 75-85% of all cows calve annually (USDA-APHIS, 1994). One of the principle factors in a cow failing to establish a pregnancy is simply a result of cows not cycling during the controlled breeding season. The period of time between a cow calving and when she begins to cycle again is the post-partum interval. The number one factor that affects the length of the post-partum interval is the body condition score (BCS) that she has at the time of calving. Therefore, nutrition is the key to achieving successful reproduction rates.

It has been estimated that it a cow must reach the age of 6 and have reared 4 calves before she has paid for her developmental costs. The optimal economic return for cows has been reported to be within the range of 8 to 11 years for commercial cow-calf operations. However, research has reported (Nunez-Dominguez et al., 1991) that less than 30% of cows within a herd reach 10 years of age. A lot of time and money are put towards developing heifers. Generally speaking, it is not that difficult to get heifers in good enough condition to breed as yearlings. However, to get her to rebreed as a first calf heifer is the much bigger challenge. The first calf heifer is usually considered the most difficult to manage and rebreed due to her lactation requirements in addition to her growth requirements. Why then do cows fall out of the herd in their productive primes after they have overcome the hurdles of getting re-bred as still growing 2 and 3 year-old

cows? Certainly heifer developmental programs and environmental factors play a role. However, we want to focus on another potential factor.

The answer, in part, may possibly be explained by graph 1. Although the data is from the 1950's, it is more pertinent now than ever. This graph illustrates that cows that calve later in the calving season are more likely to fall out of the herd. Although this seems simplistic, it is directly related to how early in the breeding season cows are being bred. Cows that fall out of the breeding season in their prime years, 4-6, likely were pushed back a little every year. If detailed records were kept, it could be noted that each year a cow may move back a little more, and after a few years she is calving late and simply does not have enough time to resume cycling before the bulls are pulled. Physiologically there is likely nothing wrong with that cow; she simply did not have enough time to re-breed. Therefore, proper nutritional management to ensure that she has the best opportunity to rebreed in a timely manner is critical.

The livestock industry and animal scientists around the world have long recognized the importance of proper nutrition for beef cows to achieve reproductive success. In fact, the first publication in what is now the Journal of Animal Science was a review article on the nutritional and endocrine controls of reproduction (Guilbert, 1942). One of the many challenges of nutritional research, is that "nutrition" is a global term that is all encompassing and includes energy, protein, vitamins and minerals. In a research study, most results are confounded with other nutrients, making clear-cut conclusions difficult. Therefore, the purpose of this paper is not to do an extensive literature review on each nutrient class, but to skim the surface and bring to light some take home messages about the impacts of global nutrition, energy, and protein on reproductive performance.

Global Nutrition and Energy Reserves

Body condition scores (BCS) are an estimate of energy reserves and encompass the global nutritional condition of a cow. Cows that calve in a BCS of 5 or better had a shorter postpartum interval and increased pregnancy rates compared with thinner cows (Houghton et al., 1990). Data from Purdue University (Houghton et al., 1990) reported an increase in postpartum interval from 59 days in cows managed to a BCS of 5 to 70 days for cows managed to be a BCS 4. To keep cows from falling out of the herd (culled for being open), it is important for cows to calve every 365 days and not just every calendar year to maintain a yearling calving interval and optimize profitability. To maintain a yearly calving interval, cows have roughly 82 days from the time she calves to rebreed. That means cows really need to be cycling by day 60 to have a couple chances at being bred by 80 days. However, if she is in poor condition, she likely has not even started cycling prior to when she needs to be bred. Similar to the postpartum interval data, cows in a BCS 4 had a 21% decrease in pregnancy rates compared to cows in a BCS 6. Likewise, data from the University of Wyoming (Lake et al., 2006) demonstrated that range cows that were managed in a BCS of 4 or 6 prior to calving had roughly a 30% decrease in overall pregnancy rates (BCS 4 = 60%; BCS 6 = 91%). The unique aspect of the Wyoming study is that these cows were managed to achieve a BCS of 4 or 6 in the 2nd trimester, as opposed to steadily decreasing as calving approached. These cows were

being fed to meet their nutritional requirements from the 3rd trimester on through early lactation. Therefore, it can be concluded that the lack of energy reserves at breeding, and not a plane of nutrition, resulted in differences in performance. Research from Oklahoma State University (Selk et al., 1988) reported that the changes from a BCS 4 to a 6 had greater impact on pregnancy rates than changes above 6 or below 4. Therefore, very little benefit was realized by increasing BCS above a 6.

Collectively, research has demonstrated that if cows are managed to calve in a BCS of 5-6, she will have a shorter postpartum interval, increased rebreeding rate, which will likely lead to an increased stayability in the herd.

Energy

The age-old question is which is more important: energy or protein? Truth be told, it is difficult to give a direct answer, but for the sake of argument and the fact that energy makes up well over half of the caloric intake, we will say energy. Energy is the primary nutrient regulating reproduction in beef cattle. Cows and heifers that are undernourished have a delayed response to the resumption of estrous cycles (cows) or attainment of puberty in heifers. The mechanism by which energy controls reproduction appears to be through the regulation of GnRH from the hypothalamus and LH and FSH from the pituitary. It also appears that energy or energy substrates act upon the ovary and influence follicular growth, estrogen production, and circulating progesterone levels.

Timing of dietary energy increase or decrease appears to also be important in determining pregnancy rates. For example, restricting energy intake during late gestation increases the length of postpartum interval and reduces subsequent pregnancy rates (Bellows et al., 1982). The impact of energy deficiency could not be overcome by increasing energy intake during the postpartum period, which is likely due to the added nutritional strain of lactation. These studies have demonstrated the importance of energy, resulting in overall poor condition of the animal, during the third trimester. However, cows that have received adequate energy during the last trimester received a boost in performance when their energy intake was increased (flushing) between calving and breeding. Therefore, it appears that the benefits of flushing are likely only realized in cows that are already in a good BCS. This type of approach (flushing) is a good method to improve conception rates, however, it is not as successful in overcoming poor nutritional management.

Heifers represent the best genetics of the herd, and therefore, proper management is essential. Heifers raised on low energy diets are delayed in their attainment of puberty and have lower pregnancy rates during their first breeding season than heifers raised on a high-energy diet (Short and Bellows, 1971). The benchmark for raising heifers has traditionally been 62-65% of their mature body weight. In this scenario, heifers will have received sufficient nutrients for attainment of puberty by 12 months of age. However, recent research out of the University of Nebraska has suggested that heifers can be grown to 55% of their mature body weight without affecting reproductive performance in a 45 d natural service or 60 d AI plus natural service breeding season compared with heifers

developed to 60-65% of mature body weight (Funston and Deutscher, 2004; Martin et al., 2008; Larsen et al., 2009).

Protein

The effects of dietary protein intake on reproduction are more difficult to quantify and are often times confounded with dietary energy. There are numerous classes of microorganisms in the rumen of a cow. The fundamental job of the microbes is to break down cellulosic feedstuffs and produce protein. The protein in return is a highly digestible and a quality protein that the animal can use as a portion of its total protein requirement. The microorganisms in the rumen need dietary protein to do their fundamental job, which is to break down cellulosic feedstuffs. They also need energy to build their protein, so energy and protein work hand-in-hand. But if a cow is deficient in protein, its utilization of cellulosic feedstuffs, i.e. energy, goes down also. Cows consuming low to medium quality forages will benefit from digestible intake protein (DIP). The added degradable protein will increase the ability of the rumen microbes to digest more of the fiber, creating more available energy for the cow. Therein lies the confounding effect of protein supplementation: is the increase in performance due to protein supplementation or increase in available energy? For example, degradable protein supplementation to pregnant or early lactating cows grazing dormant protein deficient western forages, resulted in a reduced postpartum interval and greater overall pregnancy rates (Vanzant and Cochran, 1994).

Undegradable intake protein (UIP) is the fraction of protein that is not degraded in the rumen and is available for absorption post-rumen (either in their abomasum, their simple stomach, or in their small intestine). Because the majority of plant proteins are degradable, there has been interest in supplementing UIP sources. However the results have been mixed.

Wiley et al. (1991) reported reduced postpartum interval and increased number of first calf heifers that were rebred during the first cycle when supplemented with a protein source that was 30% UIP. However, increasing UIP content in the diet of postpartum first calf heifers had no effect on any reproductive measures (Aldterton et al., 2000; Anderson et al., 2001).

Although Dhuyvetter et al. (1993) reported a decrease in postpartum interval in mature cows, they reported no differences in pregnancy rates due to increasing the proportion of UIP in the diet. Several other studies have reported no effect of UIP supplementation to mature cows and appear to be independent of forage quality (Encinias et al., 2005).

Obviously, there is much to be learned about type of protein supplementation. The most beneficial effects appear to be in younger animals, which is true with most supplementation strategies. Because younger animals are still growing, they have greater requirements and are often times more sensitive (positively and negatively) to changes in diet and supplementation strategies.

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Graph 1. Effect of calving date on the number of cows calving the following year (adapted from Burris and Priode, 1958).