Managing for the Cow Herd in the Four Stages of Production for Optimum Reproductive Performance and Profitability

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For cow-calf producers, there are critical time periods that determine an operation's profitability, and failure to manage the nutrition of the cow herd during these times can hurt productivity in many ways that producers often do not think about. In a commercial beef herd, profitability is determined by several factors, including the total weight of calves sold, the cost of maintaining the cow herd, the percentage of cows bred that wean a calf, and the price received for calves. The most critical periods of time to influence these factors are the two months prior to calving, through breeding. The two months prior to calving are important to the cow, and her fetus, as the nutrition during this stage of production has a tremendous impact on the eventual calf's health and survivability, and the ability of the cow to rebreed in a timely manner. The cow has 3 basic functions to perform during this time. First, she must provide nourishment to the fetus, which is growing at just under 1 pound per day. The cow must also have proper nutrition for developing high-quality colostrum, calving, and having sufficient milk to nourish the calf. Restricting nutrient intake to the cow during this stage of production can cause: a reduced calf birth weight and survival percentage; dystocia, or calving difficulty, reduced conception rate during the following breeding season, reduced milk production, and reduced calf weaning weight.

We place several demands on the beef cow, and we should expect her to do the following, without fail, or be culled from the herd: maintain her body weight and body condition, come into heat promptly after calving (estrous cycle is 21 days in cattle), conceive early in the breeding season, deliver a live calf without difficulty, provide a high-quality colostrum to the calf to ensure proper health and survivability, and nurse the calf adequately for approximately 7 months. In beef cattle, receiving a high-quality colostrum is essential for calf health, as the structure of the placenta prevents the fetus from receiving immunoglobulins in utero. Therefore, calves are born without immunoglobulins, and acquire passive immunity by consuming colostrum in the first 24 hours of life. Timing is critical, as a calf's ability to absorb colostral immunoglobulins from its small intestine starts to decline after the first 6 hours, and is essentially stopped after 24 hours (Rogers and Capucille, 2000). Additionally, the amount and timing of colostrum is critical, and calves should get 200 grams in the first 12 hours, and up to 400 grams before the first 24 hours (McGuirk, 1998). An adequately nourished beef cow should produce sufficient antibodies to provide an appropriate level of passive immunity in about 3 liters of colostrum, and calves should consume one pint of colostrum for every 20 pounds of calf weight (Rogers and Capucille, 2000).

The nutritional management of the cow, or heifer, in late gestation is critical, as colostrum production begins about 5 weeks prior to calving (Field et al., 1989). In recent research trials, the rate of twinning, calving difficulty, calves born to heifers, calves from thin cows, calves from fat cows all have been related to inadequate immunoglobulin G (IgG) production or consumption in beef calves. In one Canadian study from the University of Saskatchewan, (Waldner and Rosengren, 2009) found that 6% of calves between 2 and 8 days of age had inadequate passive transfer, and 10% of the calves had a marginal passive transfer, with the adequate serum IgG level being 24g/L, and one-third of the calves being below this. The effects of poor immune status are real. Calves with inadequate serum immunoglobulin at 24 hours of age were found to be up to nine times more likely to become sick, and they were five times more likely to die before weaning, compared with calves that received adequate passive immunity (Wittum and Perino, 1995). Additionally, those calves that were sick within the first 28 days, after calving, had a weaning weight that was 35 pounds lighter than calves that were healthy (Wittum and Perino, 1995). If the cow, or heifer, is nutritionally deficient during late gestation, it can have long-term impacts on the calf's performance, as the number of skeletal muscle fibers is set at birth, and nutrient restriction during gestation can reduce the body weight of offspring, even at 30 months of age (Greenwood et al., 2004). Furthermore, work done by the University of Nebraska with heifer offspring, from cows grazing dormant Sandhills range, showed that in areas where protein is deficient in the forage, protein supplementation to the pregnant cow in late gestation resulted in heifer offspring that were heavier at weaning, prebreeding, first pregnancy diagnosis, and before their second breeding season, as well as having greater pregnancy rates and calving 21 days earlier than heifers from non-protein supplemented dams (Martin et al., 2007). These recent studies clearly show that there are areas where many beef producers lose productivity in ways that are never measured in normal production settings.

The major nutritional requirements are: water, energy, protein, minerals, and vitamins. In many cases, beef producers do a good job of providing adequate water, energy, and protein. In beef cattle, macro minerals are described as those required at concentrations greater than 100 ppm of the diet and are often expressed as a percentage of the diet. Trace minerals are considered to be those required at concentrations less than 100 ppm (McDowell, 1992; NRC, 1996). Macro minerals include calcium, phosphorus, potassium, magnesium, sulfur, and sodium and chloride (salt), whereas the trace minerals include cobalt, copper, iodine, manganese, selenium, iron and zinc (NRC, 1996). The most commonly deficient vitamin is vitamin A during the winter when hay is fed, as vitamin D is synthesized by cattle exposed to sunlight or fed sun-cured forages, and vitamin E concentrations are high in fresh forages. Rumen microflora synthesize B- vitamins in sufficient quantities, and B-vitamin supplementation is not normally needed. It is important to remember, however, that the most important nutrient is the one that is missing or deficient, and in the case of nutrient imbalances, there can be more than one! Magnesium and the trace minerals copper and manganese are all cofactors in the cow's energy producing metablolic pathways, and deficiencies can limit energy production and utilization at the tissue level.

In breeding cattle, lactational anestrous (the period of time that it takes an animal to start estrous cycles and re-breed following calving) occurs when an animal that is nutrient deficient, but milking heavily, can't rebreed. The result of this increased nutrient demand on the cow is that she will maintain herself, and lactate, but she will not re-breed until her nutrient intake and utilization meets her nutritional requirements. One way to increase an animal's performance with forages is grinding the forage to increase its' digestibility by making more surface area available to ruminal bacteria and increasing the rate of passage of the forage through the digestive tract, decrease the bulk fill inherent with the forage, and decrease the animal's maintenance requirement by decreasing the digestive tract weight. However, not many beef producers are going to purchase hay grinders, so options such as feeding Amaferm® (Biozyme Inc., St. Joseph, MO) to increase the rate of digestion by breaking lignin bonds and increasing the available surface area of cellulose and hemicellulose in a forage diet is a possibility. However, because mineral nutrition must be appropriate for forage digestion, lactation, and reproduction to occur, it is also very important to have a well-balanced, highly available mineral. Beef producers often overlook mineral nutrition, because forages are seen as being relatively inexpensive on a price per pound basis compared with minerals. We need to learn to think in terms of cost per day, not cost per ton, when determining what feeds to use. For instance, a ton of mineral that has a four ounce per head per day feeding rate supplements cattle for 8,000 animal days. When we look as supplemental feeds on a cost per ton basis, rather than a daily cost basis, this often results in mineral deficiencies. Both selenium and vitamin E have been shown to affect the quality, and quantity, of colostrum, and in one study by Swecker et al., (1995), higher concentrations of IgG were seen in the colostrum of cows grazing selenium-deficient pastures, and supplemented with a trace mineral salt containing selenium compared with those receiving a selenium injection prepartum, or control cows not receiving selenium.

For instance, if a mineral is $1200 per ton, it seems like a lot of money so producers tend to purchase the cheapest mineral possible. However, at a 4 ounce per day intake, the mineral only costs $.15 per day ($1200 ÷ 2000 pounds = $.60 per pound × .25 [4 ounces = ¼ pound] = $.15 per day. The cost of really good mineral nutrition is only $54.75 per animal per year (365 days × $.15 per day)! Well, does that pay? Let's assume that the price of feeder calf is $1.40 per pound. If the cow's nutritional status is insufficient, and she does not breed on her first estrus, it will be 21 days before she can breed. Normally, calves should gain approximately 2.5 pounds per day from birth to weaning at 205 days. Remember that most operations wean their calves on one day. Therefore, losing 21 days on a calf's age costs around 52.5 pounds (21 days × 2.5 pounds per day). At $1.40 per pound, that's $73.50, or $18.75 **more** than the cow's entire mineral nutrition cost for the entire year! Furthermore, many producers supplement their cows with distillers grains, or corn. If dry distillers grains (DDG) are $250 per ton, that's $.125 per pound ($250/ton ÷ 2000 lb/ton), and if corn is $7.50 per bushel, it costs $.134 per pound ($7.50/bu ÷ 56 lb/bu). If a producer supplements their cows with 5 pounds of distillers grains, or corn, for 60 days in late gestation and early lactation in order to keep body condition in the 5.0 to 5.5 range, it would cost $.625 per day for DDG, and $.67 per day for corn. That's $37.50 for DDG, and $40.20 for corn, and that doesn't include the cost, and time, involved with transportation and feeding.

So, if you're a low-cost producer paying $7.50 for a trace mineral salt block that weighs 50 pounds, you're paying $.15 per pound ($7.50 ÷ 50 pounds). That's $300 per ton, and your yearly cost of mineral supplement is $13.69, assuming that your cows consume 4 ounces per head per day. However, most cows don't consume the required amount from a block, and even if they did, the oxide form of minerals in the salt block is about 5 to 10% absorbable. Why not feed a mineral mix that improves the digestibility of the forage that the cow consumes herself throughout the year, take advantage of improvements in body condition throughout the summer and fall, and improves her nutritional status through improved mineral nutrition. Producers could reduce energy and protein supplementation costs, reduce the average number of days from calving to rebreeding, and increase the total pounds of calves weaned and whole-herd profitability potential, and focus more time on management.

Feed costs are high, and corn prices are maintaining around the $7.50 per bushel. This equals $.134 per pound, or $268 per ton. Dried distillers grains are currently in this same price range, and the prices of other alternative feeds are keeping pace on an energy and protein basis, so there are no cheap supplemental feeds for cow-calf producers or stocker cattle operations. Therefore, forage-based operations must utilize cost effective management tools that maximize forage digestibility. However, the conversion of fibrous forages to meat and milk is not efficient, with only 10 to 35% of the energy intake being captured as net energy to the animal, because 20 to 70% of the cellulose may not be digested (Varga and Kolver, 1997). I can't imagine anyone buying grain and then throwing more than half of it away. However, we do the same thing with hay when we make it, store it, and feed it in a way that results in only a 10 to 35% digestibility (and we're not even talking about the wastage that occurs with round bales that are stored and fed improperly, resulting in spoilage!).

All nutrients (energy, protein, vitamins, minerals, and water) are used in a hierarchy that goes from maintenance → development → growth → lactation → reproduction → fattening. This means that an animal's maintenance needs must be met before any other functions can occur. For example, a cow that has calved and is in lactation will take longer to re-breed if her nutrient requirements are not being met. If she is three years old, or younger, and still growing, her nutrient requirements will be even higher than if she were mature, and not growing. The impacts of improper forage management include cows in poor body condition, delayed rebreeding times, lower conception rates, and lighter weaning weights due to cows not breeding on the first service, and then having lower milk production than they would have had if they were in better condition.

In ruminants, feed is digested in the rumen by ruminal bacteria that attach to the surface of a feed particle to digest it. In ruminants, maintaining the visceral organs (rumen, reticulum, omasum, abomasum, small intestine, and large intestine) plus the liver and kidneys can take as much as 40-50% of the energy and 30-40% of the protein consumed in a day. Forage diets that are very bulky and only 40-60% digestible. More mature, less digestible forages increase the weight of the digestive tract, because more undigested feed remains in each segment of the digestive tract, causing the visceral organs to grow. Additionally, in contrast to cattle being fed grain-based diets, the size of the rumen limits the amount of energy that can be consumed with forage-based diets, and digestible energy intake decreases with increasing forage maturity. Combined, these factors increase an animal's maintenance energy requirements, leaving fewer nutrients for production purposes. In order to reduce an animal's maintenance requirements with forage, it is necessary to use technologies that reduce the particle size of the forage, and/or increase the rate of forage digestion.

The rate, and extent, of fiber digestion in the rumen is controlled by the amount of surface area that is available for the fiber digesting bacteria to attach. From a practical standpoint with unprocessed forages, the large size of mature forage reduces the energy available to the animal, because for digestion to occur, the microorganisms in the rumen must first be associated with the forage, and then attach to the forage. Furthermore, *digestion of the forage by the bacteria normally occurs from the inside of the forage to the outer layers*. Limitations to the speed at which this occurs include the physical and chemical properties of the forage, the moisture level of the forage, time for penetration of the waxes and cuticle layer, and the extent of lignification (Varga and Kolver, 1997). Anything that decreases the particle size of forages also increases the surface area for the bacteria to attach, and this speeds up the rate of digestion, allowing the animal to get more nutrients in a quicker time. The digestible carbohydrate portions of fiber, cellulose and hemicellulose, must be freed from the indigestible structural strengthening component, lignin, in a timely manner to allow for an adequate amount of digestible energy to be achieved. Lignin is an indigestible compound that gives the plant strength. It limits the areas of attachment of the bacteria to the digestible portions of the fiber. This is why cattle ruminate (regurgitate and re-chew their food), to create smaller particle sizes that allow more area for bacterial attachment.

The undigested forage forms a mat layer in the rumen, on the top of the rumen fluid, and this mat layer is regurgitated and re-chewed until it is either digested or reduced in particle size to a point where it can pass through the reticulum to the omasum. In many cases, the space that the mat layer takes up actually reduces an animal's feed (and energy) intake, because it takes up space that a more digestible feed could occupy. Think of 'hay belly' as a buildup of indigestible feed that must be chewed until the particle size is reduced enough for the forage to either be digested or small enough to pass on down the digestive tract. Most particles leaving the rumen are smaller than 1mm (.04 inches), although particles as large as 5 cm (2inches) may leave the rumen (Welch, 1986). It is, therefore, not hard to understand how reducing the large particle size of many mature forages to 2 to 6 inches can reduce maintenance energy expenditures due to a decrease in visceral organ mass and the reductions in energy expenditure of rumination and re-chewing. What's the particle size of first-cutting Orchardgrass or Timothy hay in a round bale....3 to 4 feet? Have you ever thought of how much energy a cow needs to expend to reduce that to ½ to 1 inch?

Dr. Steven Loerch, at The Ohio State University, investigated the potential of using processing technologies to improve the utilization of prairie hay. Dr. Loerch reported that "One effective option producers rarely consider is hay chopping. Chopping hay allows the cows to eat 25-30% more energy. Costs of chopping hay (equipment, labor, etc.) should be compared to costs of purchasing supplemental energy. For some producers, this may be a cost effective option. I came to realize the potential of hay chopping from an observation at the OARDC Beef Center in Wooster. Steers fed a chopped hay based diet gained 2.5 lbs/day while those fed round baled hay (same hay source) in a rack gained less than 1.5 lbs/day." (Source: http://beef.osu.edu/library/AltFeedSuplong.pdf). This can be explained on the basis of more surface area being available for degradation, allowing for a more rapid rate of digestion; a faster rate of passage of indigestible components from the rumen allowing for an increase in feed intake, and the possibility that these factors allowed for an increase in propionate production due to a faster rate of digestion, and an increased rate of passage of indigestible components (Hintz et al., 1999). Finally, harvesting techniques have been found to result in improvements in forage digestibility. Hintz et al. (1999) reported that maceration, an intensive forage conditioning process that shreds forage thus reducing rigidity and increases field drying rates by as much as 300% by disrupting the waxy cuticle layer of the plant and breaking open the stem, resulted in an increase in surface area available for microbial attachment in the rumen, a decreased lag time associated with NDF digestion, an increase in NDF digestion.

If forage is evaluated on a price per pound, rather than a price per ton, the necessity to maximize digestibility becomes apparent. If corn is $7.50 per bushel, it is $.134 per pound. If hay is $180 per ton, it is $.09 per pound. Normally, the digestibility of corn is around 95%, but the digestibility of hay may only be 40%, so from a digestibility standpoint, the price for a pound of corn would be $.14 per pound ($.134/.95), but the price of hay from a digestibility standpoint would be $.225 per pound ($.09/.40). Therefore, in order for forages to be economically competitive, they must be managed, harvested, and potentially processed to their optimum digestibility. High prices for all feeds will necessitate that beef producers adopt grazing practices and forage harvesting and processing technologies that reduce the animal's energy and protein requirements through reducing visceral organ mass; increase the digestibility of forages through providing more sites for bacterial attachment; and use technologies and products that increase the microbial protein yield. If a producer could increase the digestibility of the hay from 40% to 55%, they would take the price of their hay from a digestibility standpoint from $.225 to $.164 per pound, a 27.2% decrease in price! In conclusion, we need to look at the cost of feed from a digestibility and a production potential standpoint, not the input cost.

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