Fundamental Nutritional Challenges Faced by Beef Cattle Nutritionists – Understanding, Preventing and Solving Them

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Introduction

In the years since mankind domesticated wild animals and became their primary caregivers, challenges and problems have arisen along their historical journey. From Biblical times to the first English colonies in the new world to the American West on to the modern times in agriculture that we now enjoy, difficulties in animal nutrition have been omnipresent. There are many factors that may contribute to losses and inefficiencies in livestock production such as predation, disease, injury, parasites, genetic defects, inadequate nutrition and reproductive challenges. Likewise, these challenges may affect all domesticated species. This manuscript will identify, describe, and outline preventions and solutions for ten fundamental challenges faced by beef cattle nutritionists.

Determining Forage Intake of Cattle on Pasture

Forage-based beef cattle production relies on pasture or stored forage for the base of all nutritional decisions. However, it is rather difficult to determine the daily dry matter intake of an animal as grass or hay. Subsequently, bridging the nutritional "gap" between intake and requirements becomes somewhat inexact. To simply this challenge and give nutritionists a starting point, it is suggested to use 2% of an animal's live weight as voluntary daily dry matter intake (Holechak et al., 1989). Furthermore, the nutritional requirements of beef cattle are determined by weight, growth rate, and milking ability. These requirements are only published (NRC, 1996) for beef brood cows weighing up to 1400 lbs, but many cows are much heavier than that, creating a ration-balancing challenge and adding to the inexactness of nutritional science.

Determination of milking ability is also often an educated guess, and many times nutritionists find themselves using a "shotgun approach" or in other words formulating to an average cow weight and milking ability (20 lb/day peak milk). Body condition scoring (BCS) is an available tool that may be used to overcome much of this. Though BCS is a 1 to 9 system, it can be simplified into three categories. Body condition scores of 1 to 4 represent under-conditioned BCS 5 to7 are "just right" or carrying adequate condition, and BCS of 8 or 9 are over-conditioned. With all else being equal, lactating cows that appear under-conditioned may be heavy milkers and should be treated accordingly when determining requirements and balancing diets. Likewise, cows that are adequately conditioned can be considered of average milking ability, and over-conditioned cows are likely to be below average in milk production. By using, 2% of body weight as dry

matter intake and BCS as a visual indicator of milk production, nutritionists have a more accurate starting point for ration balancing and nutritional recommendations.

Feeding According to Stage of Production and the Effect of Year Around Calving

It is safe to say that many cow-calf operations in the Southeast have two calving seasons, January to June and July to December, in other words, year around. Year around calving lends itself to another fundamental challenge for beef nutritionists: the ability to feed according to stage of production or to "manage like kinds together." Not all the cows in a herd have the same nutritional requirements. One way to provide extra nutrition to the cattle that need it, while assuring that no cows are over-fed is to separate the herd based on nutritional needs and then feed accordingly. Separation into groups housing replacement heifers, first-calf-cows and thin or heavy milking cows, mature cows in adequate condition, and if needed, over-conditioned cows allows for more targeted and accurate feeding. However, with no defined calving season, this is difficult if not impossible as few animals will be in the same stage of production at the same time.

First and second-calf-cows may suffer the most if not provided with adequate nutrition. Cattle prioritize nutrients for maintenance, lactation, growth in young females and reproduction. Consequently, while reproduction is extremely important financially, it is the first to suffer in times of poor nutrition. Failure to provide proper nutrition to first and second-calf-cows can be devastating to a herd's fertility and conception rate. Market timing is an additional challenge related to year around calving. It is difficult, if not impossible, for the average Tennessee beef producer to market calves in groups and/or receive premium calf prices in regard optimum market weight, gender, and season of the year. Where possible, having a defined breeding/calving season, sorting cattle into feeding groups and providing more targeted nutrition will improve overall efficiencies in a beef cow-calf enterprise.

Predisposition to Overemphasize and Overfeed Protein While Underfeeding Energy

On many farms, the emphasis of supplementation programs revolves around crude protein (CP) rather than energy, often defined as total digestible nutrients (TDN). In many situations, hay of average quality (8% CP; 50% TDN) contains enough protein and energy to sustain dry, pregnant beef cows (NRC, 1996). For cows in the second or third month of lactation, protein and energy requirements increase substantially. After calving, protein supplementation is commonplace, whereas the feeding of additional energy is often overlooked. Convenience supplements, such as molasses-based tubs, liquid feeds, and distillers dried grain-based tubs containing up to 35% CP with a relatively large portion as non-protein nitrogen (NPN), are often misused. Their misuse or overuse in related to the fact that they are offered without forage testing and may represent more of a "feel-good pill" than true nutritional supplementation. Such a program can be referred to as the "blanket" approach to supplementation. There is a great risk that if we guess wrong in regard to forage quality, the wrong supplementation program will be provided and production and reproduction may suffer.

Performing a forage test at least once a year and then the provision of supplements that provide the proper balance of protein, vitamins, minerals, and energy to complement on-the-farm forages is the most efficient and effective way to feed beef brood cows. In designing supplementation programs, it is importance to keep in mind the efficacy of using a blend of proteins rather than a single source.

Variations in Quality and Quantity of Hay From Year to Year and the Importance of Forage Testing

While forages represent the cornerstone of cow-calf production systems, hay and pasture quality and quantity will vary greatly from year to year and even from field to field. Forage species, fertilization program, date of harvest, and storage method have a great influence on forage quality (NRC, 2001). This concept was well illustrated in by a forage quality data set complied by the University of Tennessee Extension Service and Tennessee Farmers Cooperative in mid 2006. Crude protein percentages among 72 forage samples from across Tennessee ranged from 6.69 to more than 19%. With this great degree of variation, forage testing becomes more and more important. It would be a literal "shot in the dark" to try and balance a ration or design a supplementation program for forages without a defined starting point.

The equipment, labor and time required to produce hay represents a considerable expense in beef production. While it may be difficult to justify $50,000 to $125,000 in equipment to produce, harvest, store, and feed hay, as well as the high price of farm land needed to grow hay, for 25 or less beef cows, most beef producers are somewhat independent and will likely continue to harvest their own hay. Therefore, to overcome the challenge of variation in forage quality, nutritionists, consultants, and extension personnel should continue to encourage testing for forage quality and work to improve fertilization programs, harvest dates, and hay storage.

Small Herd Numbers and the Inefficiencies Associated With Them

The average beef cow herd in Tennessee stands at about 25 head according to the 2006 Tennessee Agriculture Handbook. It is then likely to be difficult to purchase feed in large quantities to utilize commodities and blend diets on the farm. However, many producers attempt to do so anyway, which creates several challenges. First of all when finished feeds or commodities are improperly stored or stored for long periods of time, significant wastage may occur. Improper storage may also lend itself to molding and spoilage of feedstuffs. In such a case, feeds may be refused due to decreased palatability or toxicities may occur from certain molds.

Furthermore, without some relatively modern equipment, it is challenging to properly blend commodities into complete feeds. Settling and separation are side effects of on-farm blends. It is then possible, for a few animals to receive most of the nutrition while shy or more timid animals receive lesser nutrient dense material. Cattlemen with relatively small herds often forego the issue of blending and use a single commodity as his/her main feed source.

As is mentioned earlier in this manuscript, cattle need a balance of energy, vitamins, minerals, and proteins from multiple sources. Corn gluten feed is an often over-used commodity feed ingredient. Poore and Mueller (1995) at North Carolina State University showed that the inclusion of corn gluten feed in a corn-soybean meal (SBM) based supplement and the replacement of corn-SBM in the diet of 500 lb steer calves decreased average daily gain, feed efficiency, gross return, and return over feed cost. This demonstrates that a single commodity may be inferior to proper blend of quality ingredients. Small herd numbers may not justify the initial expenses to properly outfit a beef operation. Feeders, working facilities, weaning/feeding pens, hospital or isolation areas, loading chutes for tractor-trailers, and other items associated with an economy of size have a sizeable start-up cost. One solution would be to specialize in preconditioning steers or raising only replacement heifers. This would give producers an opportunity to manage larger groups of animals together and work with nutritionists and feed dealers to take advantage of purchasing blended feeds in larger quantities.

Lack of Homogeneity in Beef Operations Within a Given Region

Many different environments exist among beef cattle operations. It is a real challenge for nutritionists to make general recommendations that will work from farm to farm. Neighbors may not use the same the soil fertilization program or may not use any fertilization at all. Many times the differences in calving percentage, weight gains, and feed efficiencies may be related more to disease and mismanagement than nutrition. Forage quality and quantity will vary greatly among operations. Forage species, varieties, rotational grazing management and use of summer and winter annuals contribute to these variations. Animal health protocols often vary from farm to farm. Ineffective anthelmintics, incomplete vaccination programs, and/or improper dosages of either may contribute to the inconsistency of responses to nutrition. Any depression in health and performance will again likely be blamed on nutrition rather than animal health.

While the lack of homogeneity in beef operations is not solely related to nutrition, it does create difficulties for beef cattle nutritionists. To overcome this challenge, nutritionists and other that disseminate information regarding nutrition, management, and animal health should work to bolster the effectiveness of all inputs and when possible encourage producers in community, county, or region to get on similar programs. This approach could help in terms of marketing calves together and buying or leasing herd bulls in partnership. Another way to take advantage of an existing economy of size is to source inputs through a farmers' cooperative and benefit from volume buying power.

Mineral Nutrition, Mineral Intake Variation, and Grass Tetany

In regard to the mineral nutrition of beef cattle, several fundamental challenges still exist. To successfully supplement cattle on pasture, mineral requirements of the animal, biological availability, mineral mixture intake, total diet dry matter, and concentration of each mineral in the mixture must be known. Mineral requirements for beef cattle according to stage of production are readily available from the National

Research Council (NRC, 1996) and from many technical bulletins and trade publications. Bioavailability is not a real concern, as the ingredients used in mineral mixtures are somewhat limited and bioavailability does not vary greatly among commonly used inorganic mineral sources. Likewise, concentration of each mineral is published on the product tag of commercial mineral-vitamin mixtures. However, as was earlier discussed, total diet dry matter is much more difficult to define and varies due to many factors. This can be overcome by consistently calculating from a standard estimate of intake.

The greatest challenge is to overcome the variation in mineral intake. Many factors influence the intake of mineral-vitamin mixtures that are offered free-choice. Forage species, soil fertility, availability of other feedstuffs, stage of production, adaptation to minerals, palatability of mixture, physical form of minerals, and previous experiences all have an influence on mineral consumption of grazing cattle (McDowell and Arthington, 2005). When animals are fed in confinement, nutritionists and managers can determine mineral needs and add them at the desired levels into the rations. This eliminates many of the challenges faced with grazing livestock.

Though many factors have a bearing on mineral consumption, nutritionists, feed manufacturers, and cattlemen can make great strides toward moderating variation and increasing consistency of mineral intake. Palatability of mineral mixtures can be improved through the addition of ingredients such as distillers dried grains and cottonseed meal. More recently, high intensity sweeteners have become available and have shown improvement in take of receiving rations for beef calves. These may have application in increasing the acceptance of free-choice mineral mixtures. Concentration of salt can be increased or decreased in order to change consumption rates as salt content drives consumption.

Consumption of minerals may not remain at desired levels due to changes in season, stage of production, soil fertility program, or feed/forage availability, and changes in palatability alone may not remedy the situation. Fortunately, there are management changes that may help. Mineral feeder locations can be changed with respect to proximity to feeding stations, hay, water, and loafing areas. In general, moving away from these areas will decrease mineral consumption and conversely, moving closer to will generally cause increased consumption. Switching from a loose mineral to a mineral block or vice versa is a method of changing consumption through physical form.

Consumption obviously plays a large part in mineral nutrition of grazing cattle. But, having the right minerals in the proper concentrations and ratios is paramount. The use of trace mineralized salt and the underfeeding of phosphorus and trace minerals, particularly copper, zinc, and selenium continue to be prevalent in many beef herds across Tennessee. A complete mixture of minerals and vitamins should include calcium, phosphorus, potassium, magnesium, cobalt, copper, iron, selenium, iodine, zinc, and manganese. Phosphorus content should be 4 to 9%, depending on phosphorus content of forage sand the ratio of calcium to phosphorus should not exceed 2:1. Copper, manganese, and zinc should be in approximate 1:2:3 ratio except in the presence of increased levels of antagonists to copper such as sulfur. In such a case, copper

concentration the mineral mixture should be increased to compensate for the antagonism. Sodium selenite should be included at a concentration, generally 20-50 parts per million (ppm), to allow for a 3-mg selenium intake. While selenium from selenium yeast has been shown to be much more biologically available, it is not cleared for use in free-choice mineral mixtures at this time.

Trace minerals that have undergone the process of chelation are more bioavailable that their inorganic counterparts. Chelation, a process in which metal trace minerals are chemically bound to organic carriers such as amino acids, helps prevent the interference in absorption experienced by inorganic sources. This improvement in bioavailability can be advantageous in certain cases. Newly-arrived feeder calves, cattle that have been sick, shown, transported, or otherwise stressed may benefit, as chelated trace minerals act to replete mineral concentrations in the blood and body organs faster than inorganic minerals. Likewise, providing chelated minerals to cows and heifers just prior to breeding and those involved in artificial insemination and/or embryo transfer programs may prove to be beneficial to reproductive performance.

Consistent consumption of high magnesium minerals fed to help prevent grass tetany is especially important. Grass tetany is still often diagnosed in Tennessee beef cow herds. Cows are at greatest risk when grazing small grain or lush, growing permanent pastures. A rise in temperature followed by a cool wet period increases the chances of the occurrence of grass tetany. Conversely, when average temperatures are in excess of 57° for six consecutive days, risk of grass tetany generally decreases. In general, the consumption of 2 oz. of magnesium oxide that contains about 1 oz. of magnesium will prevent grass tetany. Most commercial "high mag" mixtures will contain 12-14% magnesium and require an intake of 4 to 7 oz per head per day. Consumption problems, palatability issues, and feeding too little or no salt all may reduce the amount of actual protection being provided. Incidences of grass tetany can be greatly reduced through diligent nutrition and management.

Long Term Effects of Ethanol Production on Feeding Programs and Feed Prices

Ethanol production across the United States will reach an estimated 10 billion gallons by the end of 2008 (Fatka, 2007). Corn that goes to produce ethanol becomes unavailable as feed for livestock and may create a shortage. The law of supply and demand dictates that corn prices will increase in such a situation. Recent history shows that the feed ingredient market closely follows the corn market, thus it is likely that most feed ingredients may be more costly in future years. This creates a challenge for nutritionists to not only use more alternative feedstuffs, but also to better utilize the by-products from ethanol production. One underlying challenge in using corn co-products or by-products is the difficulty in balancing minerals in such diets. The use of high percentages (above 20%) of corn gluten feed and/or distillers dried grains will often require a substantial addition of limestone to arrive at the proper calcium to phosphorus ratio.

Underestimation of Feed Requirements When Budgeting for Preconditioning or Joining Alliance Marketing Programs

There are many costs associated with preconditioning programs regardless of whether calves are purchased or home-raised. One underestimation is the amount of feed that will be consumed by growing calves when offered free-choice and the amount of feed necessary to produce the body weight gains that today's cattle are often capable of. Once acclimated to feed, calves weighing from 600 to 850 lbs can often consume 3 to 3.5% of their body weight as dry matter. These underestimations are in addition to increased costs associated with animal health programs, labor, facilities, death loss, and poor performance in the first days of the program. These are often exacerbated by the fact that some marketing alternatives may not be able to glean the premium prices that are necessary to make preconditioning a worthwhile activity.

Toxicities that Often Plague Beef Cattle

Excess copper, urea, toxic plants, and nitrates may be present in feed, hay, pasture and stored forages. While any or all of these substances can be toxic when ingested in high enough quantities, with proper management they do have to present a problem. As was earlier described in the minerals section, certain conditions warrant the addition of copper in beef cattle diets in higher than normal levels. The total diet dry matter requirement for copper is 10 ppm and the maximum tolerable level is 100 ppm. However, even in instances of high copper antagonism, total diet copper concentration should not exceed 30 ppm in order to avoid possible toxicities.

Urea toxicity may occur if urea is fed at high levels. Most cases of urea poisoning are due to poor mixing of feed or errors in calculating the amount of urea to add to the ration. Accidental over-consumption of urea-containing supplements also has resulted in some cases of urea toxicity. If the proper level of urea is added to the ration and it is mixed uniformly, no problem should arise. Keeping daily intake of urea to 0.1 lb per head or less and assuring that diets are sufficient in energy from carbohydrates will also help assure that toxicities do not occur.

Toxic plants and weeds most often cause problems when cattle are in essence forced to consume them due to pasture or hay shortages. To help prevent this, pasture management practices such as clipping and spraying can eliminate the availability of undesirable plants. Using your pasture at our below their animal carrying capacity will also help alleviate the potential, as cattle will have options other than to consume weeds and other non-forage plants. Another word of caution deals with wilted wild cherry leaves. In times after storms, when trees in or near pastures may blow over or in instances that they are cut down for other reasons, the potential for toxicity to cattle exists. Cherry leaves contain cyanogenic compounds and, when wilted, are known to be toxic to cattle and sheep. Be mindful of this and do not allow livestock access to wilted cherry leaves.

Nitrate accumulation occurs in forages when the uptake of soil nitrates continues even as plant photosynthesis, and carbohydrate and protein synthesis cease. Factors that contribute to the accumulation of nitrates in plants include drought (more so in mild drought conditions), frost, low light intensities, low temperatures, soil nutrient deficiencies, excess nitrogen fertilization, and some plant diseases. Nitrates will accumulate to varying levels within the plant with the lower portions generally containing the highest concentrations. When conditions exist that may lead to accumulations of nitrates in forages, they should be tested for nitrate concentrations. Testing should be performed before the first use of the forage to avoid potential problems. Some concentrations of nitrates are acceptable to be fed to certain livestock (Table 1). Forages should be tested annually and whenever there is a change in harvesting dates. Conditions that add to nitrate accumulation could have occurred between harvesting dates, resulting in different nitrate levels.

Table 1. Forage Nitrate Levels and Recommended Feeding Rates of High Nitrate Forages

Forage nitrate levels (ppm)	Recommendations
Less than 4400	Safe to feed under all conditions. Safe to feed to non-pregnant animals under all conditions. Limit to 50% of dry matter intake of pregnant animals.
6601 to 8800	Safe to feed if limited to 50% of total dry matter intake. Limit to less than 35% of total dry matter of pregnant animals.
8801 to 10,000	Limit to 35-40% of total dry matter intake. Do not feed to pregnant animals.
Greater than 10,001	Do not feed under any circumstance

While an ounce of prevention is often worth a pound of cure, consultation with your veterinarian should still play a large role in the prevention and/or treatment of toxicities in livestock and for an overall animal health program.

Concluding Remarks

Given the numerous fundamental challenges described in this manuscript and the derivations thereof, a tremendous opportunity exists for improving the nutrition and performance of beef cattle in Tennessee. Producers should be closely aligned with their local extension agent and/or co-op manager for assistance with Beef Quality Assurance certification, their veterinarian for herd health issues, and their farmers cooperative or input supplier to source products and services at sustainable prices. Livestock market managers and marketing alliance directors can aid producers in assembling truck-load lots of cattle of like size, age, and quality in order to realize the true value of these cattle.

Also, it is paramount that producers take advantage of the cost-share programs for genetics, equipment, and hay storage currently being offered by the Tennessee Department of Agriculture. Finally, in an ever-competitive market place, beef producers should stay abreast of industry trends such as age and source verification in order to increase marketing opportunities and glean the highest return possible for the quality cattle that we produce.

Bibliography

Fatka, J. 2007. Ethanol production to outpace itself. Feedstuffs. Jan. 1, 2007

Holechek, J.L., R.D. Pieper, and C.H. Herbel. 1989. Range management principles and practices. Prentice Hall, NJ

McDowell, L. R. and J. D. Arthington. 2005. Minerals for grazing ruminants in tropical regions. University of Florida Press. Gainesville, FL

National Research Council. 1996. Nutrient requirements of beef cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

National Research Council. 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

Poore, M. H. and J. P. Mueller. 1995. Corn gluten feed as an alternative concentrate source for growing steer calves fed orchardgrass hay-based diets. Department of Animal Science Annual Report. Raleigh, NC.