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New National Research Council (NRC) Beef Cattle Requirements - Range Application

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Beef producers have used experience and guidelines for many years to determine proper level of nutrition for their cow herd. In the early 1900s, research started to compare various feeding programs to determine which feeds or supplements worked best, and then comparisons were made on various levels of supplements to determine how much supplement was needed. In the 1920s, considerable research was conducted at the Valentine, Nebraska Experiment Station (no longer in existence) to see if calves wintered on sandhills range would benefit from cottonseed cake (cottonseed meal was large chunks or "cake" in the 1920s), and a series of other studies determined the "best" level of supplementation. Since that time tremendous quantities of research have been conducted to determine the exact requirement of cattle for all known nutrients.

In order to gain some consensus of opinion on exact cattle requirements, the National Research Council appointed a subcommittee on beef cattle nutrition to evaluate all published data and publish exact requirements for major and minor nutrients for all classes of beef cattle. New requirements are published about every 10 years. The committee has historically met for at least a two year period and has in-depth review and discussion of new nutritional concepts, as well as new research that deals with animal requirements. The subcommittee is made up of highly recognized and respected nutritionists from across the U.S., each having specialities in the various areas of cattle nutrition. They also seek the expertise of others in forming final requirements. Finally, after days and months of review and discussion by the leading experts in the field, the new requirements are published. This is often referred to as the nutritionists' bible. In the past 10 years, nutritionists have used the 1984 Nutrient Requirements of Beef Cattle. In May of 1996, the 1996 Nutrient Requirements of Beef Cattle was released. As with any new publication the 1996 requirements suggested several changes, however not without controversy.

How accurate are the 1996 Nutrient Requirements of Beef Cattle? It is not uncommon to hear comments such as "those published requirements don't apply to your situation because your cattle and conditions are different and as a consequence, my recommendations are different and better." The producers' question should be "what research do you base your recommendation on and then question is it thorough and unbiased?" In 99.9% of the cases the answer to your second question will be no. The 1996 published requirements are the "state of the art" from the top nutritionist in the U.S. The challenge is to apply the requirements in a practical way.

The objective of this paper is to discuss new nutritional concepts and recommendations as outlined in the new publication, and to utilize these concepts in practical feeding recommendations.

ENERGY REQUIREMENTS

In the past, the beef cow industry has used Total Digestible Nutrients (TDN) in balancing the cow's energy requirements. When most of the commonly used feeds are utilized, TDN still serves very well in determining how to meet the cow's energy requirements. The new publication justifiably uses the net energy system - net energy for maintenance (NEm) and net energy for gain (NEg). The net energy system has been used in balancing energy needs in the feedlot industry for the past 20 years. Most cow diets can still adequately use the TDN when considering a dry pregnant cow for maintaining weight, and the average lactating cow when no weight gain (or loss) is desired. The major advantage of the net energy system is it allows for precise estimates of the amount of weight gain (or loss) that is desired or that could be expected. For example, if a group of cows is in condition score 4 in November and it is desired to raise their condition to a condition score of 5 by March, the net energy system provides the tools to very accurately estimate the amount of feed needed to raise the weight (or condition score) to the desired level.

The 1996 net energy system breaks out the energy requirements for maintenance of the cow, development of the fetus, lactation and body weight gain (or energy available if weight loss occurs). Maintenance is simply the feed energy required that will result in no weight gain or loss of the cow. This includes the energy for body functions such as the digestion process, temperature regulation, physical activity and other metabolic activity. The maintenance requirements are adjusted for several breeds of cattle. In general, the breeds of cows that have higher milk production have higher maintenance requirements. This is due to the fact that higher milking cows tend to have larger internal organ weights, which have very high energy needs.

In the case of pregnant cows, the energy requirement for pregnancy is also calculated. This varies with the birth weight of the calf, which the user inputs into the program. Lactation is also a large energy requirement that the new system calculates based on the amount of milk given at peak milk production. Even though it is obvious that high milk producing cows have higher energy requirements than low milking cows, peak milk production obviously is not practical to determine in range cattle. Consequently, the new publication gives guidelines for peak milk production quantities based on weaning weight.

After all of the energy requirements for maintenance, pregnancy and/or lactation are met, the remaining energy can be utilized for body weight gain. If the energy demands for maintenance and production are not met, weight loss of the cow will result, plus possibly lowered milk production will occur. The new system predicts the number of days that it will take to gain or lose one condition score (approximately 75-80 lbs. of body weight).

Feedstuffs analysis reports include both NEm and NEg. In beef cow rations the new system only utilizes the NEm of the feeds for the various energy components. The analysis for net energy levels of feeds is not actually determined directly, however is estimated based on the fiber (acid detergent fiber - ADF) level of the feed. Total digestible nutrients are also estimated in feed analysis. Formulas have been published to determine (estimate) NEm and NEg, if TDN content is known (or estimated).

PROTEIN

Perhaps the biggest change and most difficult to apply is the new protein requirements. In the past crude protein has been utilized. It has long been recognized that the crude protein system has many flaws, and in fact is a fairly crude measurement of protein availability in feeds and the animal requirements. For example, with the crude protein system it is assumed that protein from non-protein nitrogen, such as urea, is equal to protein from all natural sources, such as soybean meal or cottonseed meal. We have known for years that this is simply not true. We also know that the rumen microorganisms in beef animals have nitrogen or protein requirements, yet the animal has protein requirements for maintenance of the digestive tract, nervous system, muscle structure, etc., plus muscle growth. In the past the crude protein only assumed one requirement for the entire animal. The crude protein system worked relatively well as long as the limitations were recognized and appropriate adjustments were made.

The 1996 NRC requirements utilizes metabolizable protein which establishes separate requirements for the rumen microorganisms and the animal. Metabolizable protein is the protein that reaches the small intestine and is made up of microbial protein (protein that is made by rumen microorganisms) and undegradable intake protein (UIP). In the past UIP has been referred to as by-pass protein or the protein that escapes or bypasses the rumen microorganisms without breakdown. In the small intestine, protein is digested efficiently, similar to digestion in monogastric animals. The requirements for the rumen microorganisms is referred to as degradable intake protein (DIP) and is derived from protein that is digested or broken down in the rumen. It is important that the DIP requirement be met to provide a high level of microbial activity and to assure optimum levels of fiber digestion. Some of the DIP can come from non-protein nitrogen (NPN) sources such as urea. The amount of NPN that is utilized in high roughage diets for bacteria protein synthesis continues to be debated. It is known that there are limitations on how much is incorporated into microbial protein, however in the ration formulation model, that is supplied with the 1996 manual, it assumes that NPN from urea is utilized with the same efficiency as degraded natural protein from sources such as alfalfa hay. The protein in alfalfa is approximately 85% degraded in the rumen. It appears that the rumen bacteria can utilize the nitrogen from NPN just as effectively as from degraded protein from alfalfa or soybean meal, however when natural proteins are degraded they supply branch chained fatty acids, which appears to be very important in bacterial protein synthesis. It is also known that urea breaks down at a much faster rate in the rumen than carbohydrates are broken down in forages. Because of the lack of synchrony, one would not expect the nitrogen from NPN to be utilized as effectively as nitrogen from natural proteins, which break down slower. Fortunately, the ruminant animal has the ability to recycle nitrogen through the saliva otherwise very little of the nitrogen from NPN would be utilized. The debate will continue on how efficiently NPN will be utilized under the various conditions encountered with the range beef cow. Even though many trials have been conducted to determine NPN utilization, the committee that published the 1996 requirements simply stated, "Until more information is available it is advisable to use caution when using urea in low-protein, high-forage diets."

In order to determine the level of metabolizable protein that reaches the small intestine, the level of microbial protein must be estimated as well as knowing the level of UIP in the feed or the amount of the fed or grazed protein that escapes the rumen undigested. Tables are available to give estimates of UTP for many feeds and are used in ration formulation. Currently commercial laboratories do not analyze for UIP and DIP which is a limitation when utilizing the metabolism protein system. Feeds can still be analyzed for crude protein and then UIP and DIP estimated.

In addition to knowing how much protein that bypasses the rumen (UIP) and reaches the small intestine, the portion of microbial protein that is produced needs to be estimated. The new NRC model assumes that the amount of microbial protein produced is in relation to the amount of energy in the ration. They use TDN as the indicator of energy. In general they assume that microbial protein synthesis is 13% of the TDN in the ration; however this efficiency factor can be altered in the model. In low-energy, high-roughage rations a factor of 8 to 9% appears to be more accurate in predicting microbial protein yield. If the 1996 NRC computer model is used, there is an opportunity to change the microbial yield factor from 13 to a different number. Until more definitive research is conducted, it is recommended that 9 be used as an appropriate factor.

INTAKE

One of the major problems of any accurate ration formulation is determining intake accurately. This is especially a major problem in grazing animals. The formulation is only as accurate as the accuracy of determining the level of nutrients that the animal is consuming. This depends on the amount and the nutrient content of feeds consumed. Because this is often not known, it requires rough guidelines and commonsense. Fortunately, the new NRC requirements provide estimates of intake. This is based on the type and size of animal, stage of production, and the type of ration. These estimates of intakes are based on research trials where actual intake was determined under various conditions. Unless intake is known or research under similar conditions in your area is utilized, it is recommended that the intake calculated by the 1996 model be used as intake estimates.

ANIMAL AND ENVIRONMENTAL FACTORS

The new 1996 model allows for input in accounting for the size, breed, stage of production, level of milk production expected and body condition of the cow. Adjustments in maintenance are made based on breed. Body condition is used and the output estimates the number of days to gain or lose one condition score rather than predict daily gain or loss.

Environmental factors include temperature, wind speed, coat of the animal and the effects of grazing or dry lot conditions. These factors certainly do effect nutrient requirements in "real world" situations, however are very difficult to utilize with accuracy in ration formulations. Milk production can be roughly estimated from weaning weight and research data, however any estimate under practical conditions would be a very rough estimate. The model makes very precise calculations based on often rough estimates. Environmental factors, such as wind and temperature, are important, however the user is usually making estimates in the future which is always subject to large differences to what is actually encountered. Also temperatures and wind speeds from the weather bureau should be modified to predict actual temperatures for the cattle. The amount of natural protection that cattle utilize is important. Cattle will use one another for protection and aline their bodies to minimize weather effects.

The model assumes approximately 40% higher maintenance requirements for grazing animals versus those in dry lot. Even though there is a cost of maintenance when animals are traveling to graze and the model's cost of maintenance is based on research data, personal observations and experience would indicate the model's estimates of increased maintenance while grazing may be too high for the intermountain high plains area. After working with the model, it appears that several animal and environmental factors have relatively large effects on the requirements and as a consequence a high level of commonsense and experience under practical conditions are needed for the best diet recommendations.

FEEDING RECOMMENDATIONS

Will we feed or supplement cattle differently utilizing the 1996 NRC requirements compared to what we have used in the past? Under many practical feeding or grazing conditions, it does not appear major changes will be needed to meet the animals' requirements as published in the new publication. The system does allow for fine tuning of diets in both protein and energy supplementation. For example, many lactating cows are fed prairie or meadow hay and supplemented with 2.5-3.0 lb. of a 30% soybean meal-wheat mids blended supplement, and good performance is achieved. However, when these feeds are calculated in the model, it shows that the ration is deficient in metabolizable protein although DIP is in excess. The model would predict that the digestibility of the forage would be at the maximum level and the microbes would produce maximum level of microbial protein, but cow performance would still be reduced because inadequate protein would be present in the small intestine. Higher levels of the 30% supplement would partially offset this problem, however the most economical and practical way would be to incorporate a low level of a source of protein that is high in UIP (by-pass) protein, such as blood meal. This deficiency can be corrected with 0.4 lb. of blood meal. The need for UIP appears to be more critical in younger 2 year old first calf heifers.

Another area where fine tuning of rations can be achieved is designing feeding programs to achieve a specific condition score at a given point in time. For example, let's assume that a group of cows is in body condition 4, approximately 90 days before calving and it is desired to increase their condition one score before calving. By utilizing the new model, rations can be designed to theoretically meet this goal. The model can also be utilized to balance rations for yearling replacement heifers to meet gain expectations.

There are many situations that will cause some changes in what would be recommended utilizing the new model compared to what we have been using. It is not possible to address all of the minor and major differences that the new model presents in this paper. The 1996 NRC publication addresses all of the various changes and if in-depth knowledge is desired then reading the publication and utilizing the new software will be needed.

An article in the 1998 Nebraska Beef Cattle Report by Lardy, et al., used the new model to evaluate nutrient balances for grazing beef cattle that were involved in various experiments at the Nebraska Gudmundsen Sandhills Laboratory. They found that the NRC model generally predicted that nutrient balances were similar to what was experienced in the cows on various research trials. They confirmed that microbial efficiency is lower for forages that are lower in digestibility.

SUMMARY

The 1996 NRC requirements have two significant changes that will change the way nutritionists balance rations. Rather than utilizing TDN as the energy term, net energy for maintenance and gain is utilized. Crude protein was replaced with two protein fractions - Undegradable Intake Protein (UIP) formally called by-pass protein and Degradable Intake Protein (DIP). The new metabolizable protein (UIP + DIP) system will correct some of past erroneous assumption that all crude protein is equal, which has long been known to be inaccurate. The new protein system establishes requirements for the rumen microorganisms and for the animal. Even though the new system will be more difficult to apply under practical conditions, the concepts are more precise, and accurate predictors of performance will provide more economical cost of production. Factors that involve the animal characteristics and environmental factors can cause major differences in requirements. As with any good feeding program, commonsense is needed to carry out a practical and economical feeding system.

REFERENCES

Nutrient Requirements of Beef Cattle, 7th Revised Edition, 1996. National Research Council, Washington, D.C., National Academy Press. Available through most Beef Extension Specialists or write to: National Academy Press, 2101 Constitution Avenue, NW, Lockbox 285, Washington, DC 20055 (1-800-624-6242). Price: $29.95

Lardy, Greg, Don Adams, Terry Klopfenstein and Dennis Brink. 1998. Use of the NRC model for evaluating nutrient balances of grazing beef cattle. Nebraska Beef Cattle Report MP 69-A.