Range Management for Optimal Beef Cow Fertility

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Reproductive success of cows depends on providing sufficient lutenizing hormone to support formation and stability of the egg for maximum exposure to viable sperm provided by the bull. An important precursor to this important reproductive hormone is cholesterol, which is highly influenced by the level of stored body fat, the amount of circulating fat in the blood stream, mineral balance and the level of energy in the diet above maintenance requirements. Perhaps the most important indicator of breeding success under extensive grazing situations is the use of body condition scoring. However, body condition is a reflection of past nutrition but is not useful to determine the rate of change in relative short time frames. Recent advances in nutritional monitoring systems using the emerging NIRS/NUTBAL nutritional management system allows ranchers to track diet quality in terms of protein, energy and phosphorus, all important nutrients affecting the ability of the animal to attain a given body condition score. Understanding how the land provides nutrients throughout the year relative to the needs of the animal helps identify when nutrients can be prescribed to meet reproductive goals of a cow herd.

This paper will focus on:

1) Fundamental anatomical features that indicate different body condition scores,
2) Relationship of body condition and pregnancy rates and calving intervals,
3) Role of protein and energy affecting changes in body condition,
4) Role of phosphorus and other minerals in impacting pregnancy rates,
5) Strategies for managing body condition using prescriptive application of nutrients with the NIRS/NUTBAL nutritional management system to management objectives in terms of desired pregnancy rates.

Anatomical Features Used in Body Condition Scoring

Perhaps one of the most important management skills of livestock producers is the ability to body condition score their animals and track progress toward meeting a desired degree of fatness to meet a given reproductive goal in a herd. Body condition scoring is an index to the degree of fatness expressed in the anatomy of the animal that can be viewed by the human eye. Essentially, body condition scoring is a systematic process of attempting to visualize the degree of underlying skeletal features that can be detected by observing the animal.

Body condition scoring has to be approached in a systematic manner. A 1-9 system is used to describe animals that are extremely emaciated to animals that are so fat they have difficulty walking. The threshold body condition score is considered a 5 for a 1-9 indexing system. The key anatomical feature that distinguishes an animal below average fatness (<5) is the visible expression of the 12th and 13th ribs (last two ribs in the rib cage) (Figure 1). In standard European beef breeds (*Bos taurus*), if you can observe the 12th and 13th rib they are classified as a 4 or less. Zebu or *Bos indicus* breeds store more internal fat and are scored below a 5 if more than the upper crest of the 12th and 13th rib are showing (about 0.5 score higher than *Bos taurus*). If the short ribs or transverse processes are not showing, the animal is classified as a 4. If the short ribs are showing and a moderate "V" has formed between the hooks and pins down to the trochanter major, the animal is a solid 3. However, if the foreribs are distinct, the transverse processes showing, the vertebrae in the tail head are showing and a strong "V" is evident between the hooks and pins, the animal is classified as a 2. An animal in score 1, has a distinct hipbone showing with an strong "V" effect between the hooks and pins, ribs are distinct, no tissue can support the tail head and the animal appears near death.

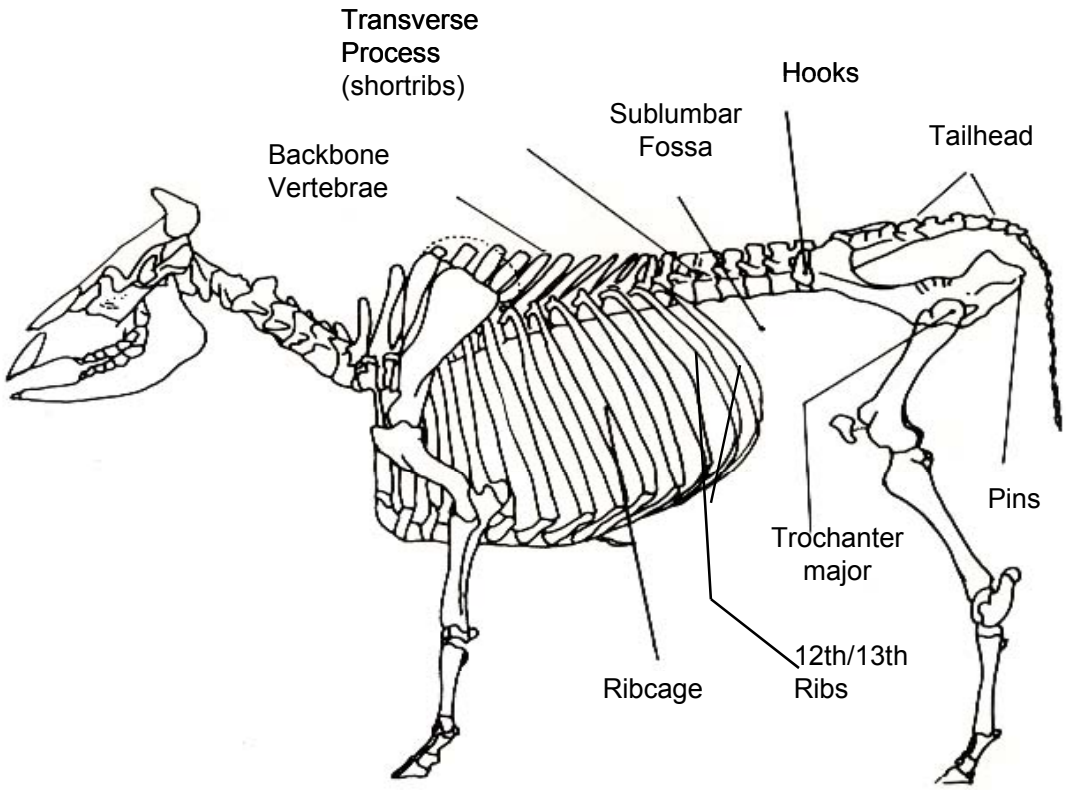


Figure 1. Key anatomical features of a cow that are used in body condition scoring systems (Adapted from International Livestock Research Institute, Nairobi).

Animals in body condition score 5 have no 12th and 13th rib showing and exhibit a slight inverted "V" across the back when viewed from the rear. There is a slight "U" effect between the hooks and pins. If the back appears smooth to near level without any indention along the spine and there is a very shallow "U" effect between the hooks and pins, the animal is classified as a 6. If a "U" effect is not evident between the hooks and pins and no anatomical features express themselves with a slight indention along the spine, the animal is considered a 7. If the indention along the spine is deep and there is evidence of pockets of excess fat expressed across the body, the animal is scored as an 8. An animal appearing excessively fat and walking in an awkward manner is scored as a 9.

All producers are urged to develop the skill to body condition score their animals and conduct periodic sampling of their herds using a simple whole number scoring system. Individuals who improve their scoring skills can assign partial scores such as 5+, 5- or just a 5 (middle value). The most critical element to successful body condition scoring is approaching the animal in a systematic manner. Identifying the 12th and 13th rib, locating the short ribs (transverse processes), recognizing the "U"/"V" effect, observing the degree of fat deposition at the tail head and distinctness of the ribs in the ribcage are major points of interest that affect the scoring process. The web site of GANLab (http://cnrit.tamu.edu/ganlab) provides links to numerous body condition scoring systems and photos.

The USDA's National Animal Health Monitoring System (NAHMS) surveyed 2,713 producers from 23 of the major cattle producing states or 85.7% of the US cow herd (http://www.aphis.usda.gov/vs/ceah/cahm/Beef_Cow-Calf/beef.htm. The 1997 study covered approximately 85% of beef cattle operations. Approximately, 23% of cattle producers indicated that they use body condition scoring as a management tool. However, producers with over <50, 50-99, 100-299 and >300 head of brood cows used body condition scoring systems 19.8%, 26.1% , 37.9% and 48.9% of the time, respectively. Body condition scoring is a highly valued management tool critical to the ranch firm's monitoring system.

Body Condition and Pregnancy

To attain high pregnancy rates, one must manage for a 5+ to 6 score to insure sufficient fatness for reproductive fitness. Scores higher than 7 do not provide any meaningful levels of improvement in pregnancy rates, as fertility rates begin to limit pregnancy rates more than nutrition at this degree of fatness. As condition falls below a 5 so will pregnancy rates and calving intervals. However, the timing can result in different assessments of potential pregnancy rates.

Figure 2 provides a generalized relationship between pregnancy rates of cows when scored at weaning, breeding and calving. Generally, scoring of cows is most convenient at weaning since the cows are being gathered and calves separated from the cows. However, this production phase is the least sensitive to predicting the likely pregnancy rate of a cow, e.g. Cows that are in body condition score 5 (average fatness at weaning have time to recover, posing a problem for predicting likely reproductive success.) The most sensitive time to condition score animals is at calving followed by scoring at breeding. However, both stages give similar assessments of potential pregnancy rates.

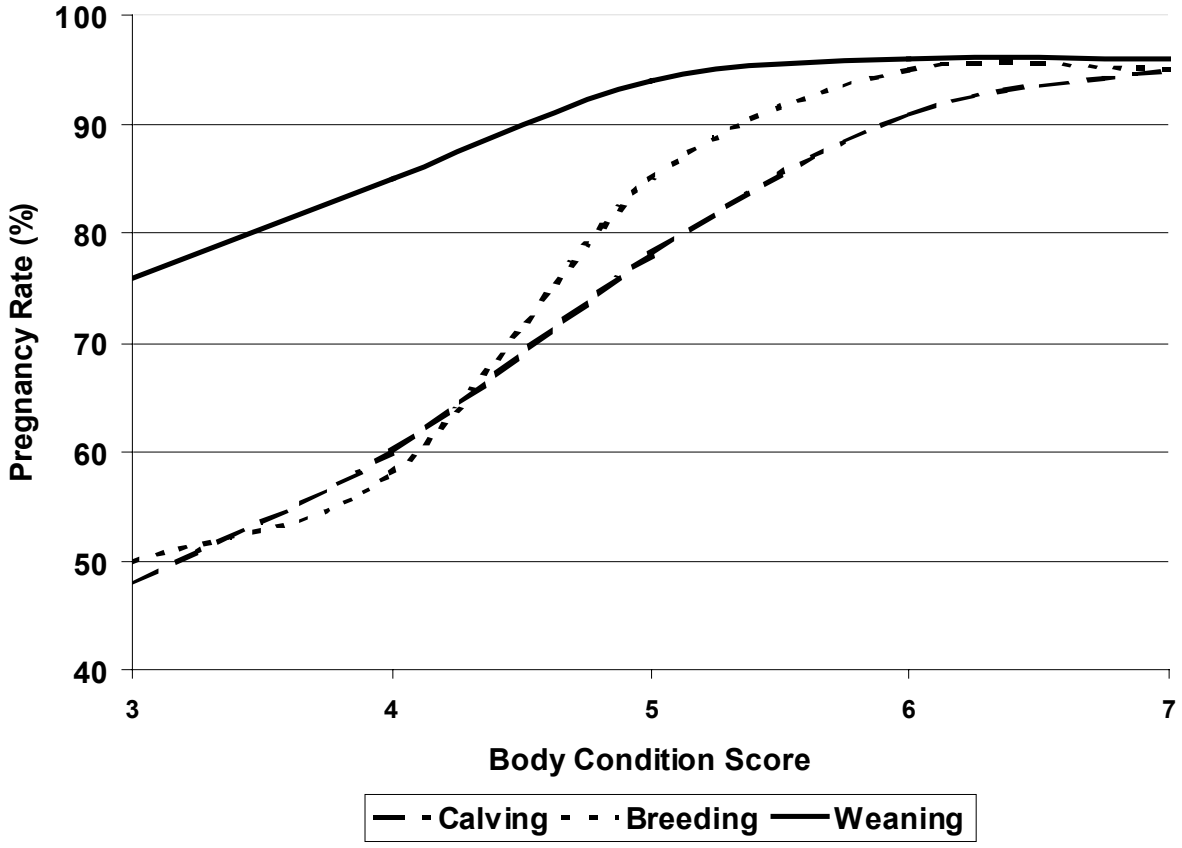


Figure 2. Relationship between body condition score and pregnancy rates of cows by production stage of the animal.

Once an animal falls to a score of 3, nutritional management to attain good levels of pregnancy in a herd becomes difficult and probably uneconomical to recover. Scores below a 3 at breeding can lead to uneconomical levels of herd performance.

Animals who slip from a 5 to a 4 at the start of breeding season will result in delayed cycling of the animals, resulting in a smaller percentage of animals born in the first estrus cycle (Figure 3). However, if they decline in condition below a 4 at breeding, birthing times can be delayed 50-65 days in those reduced number of animals that do become pregnant.

How can an animal in lower body condition become pregnant? The current plane of nutrition and the 3-5 weeks level of nutrition of the animal prior to breeding, can overcome some of the suppressing effects of low fatness if the animal is on an elevated plane of nutrition, (e.g. Energy and protein intake exceed maintenance requirements) particularly if they are in the upper part of a given score. Feeding high levels of fats 3-4 weeks prior to breeding can also change reproductive success. However, one must be careful to provide fats high in linolenic acid and be prepared to

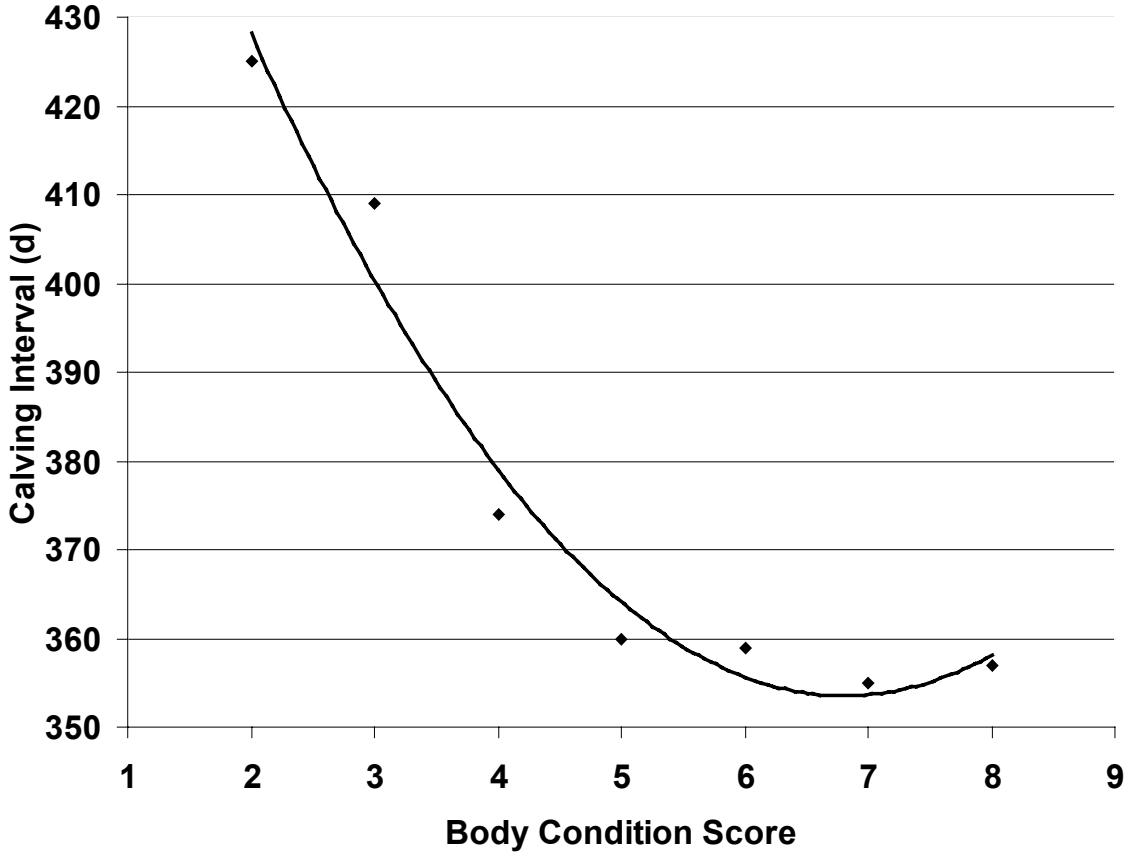


Figure 3. Impact of body condition on calving interval.

"push" the animal's condition upward to prevent having to deal with an animal that is lactating in poor condition. Allowing the animals access to a good phosphorus mineral source during breeding and during the first third of lactation is also critical to maintaining the reproductive health of the animal.

Effective nutritional management of cows on rangelands requires that the livestock producer establish a reasonable, attainable goal for the level of pregnancy rates that they desire and then establish a nutritional management system that meets those goals. Recent experience in monitoring nutritional status of the animal has shown greater management flexibility in use of supplements when the animal is maintained at a 5 to 6 score year round. As they slip from a 5 to 4 and down to a 3, management options diminish and the rancher is forced to make hard decisions concerning costly feed inputs, accepting low reproductive performance, or eliminating animals that cannot be brought back into sync with the herd due to excessively low condition. Use of a monitoring system such as the NIRS/NUTBAL nutritional management system coupled with an active body condition scoring system can help alleviate the unexpected changes in body condition throughout the year.

Assessing the composition of body condition of a herd can help identify opportunities for separating animals for special nutrient inputs or culling to help synchronize the nutrition of the

herd. The example below is a small example. The herd of 85 cows appear on the surface to be primarily 5 and 6 score animals with some 4's and a few 3 's. However, when the pregnancy rate:condition score relationship is applied, only 67 of the 85 are projected to get pregnant, and when a 3% death loss is factored for the calves only 65 calves are raised to be sold, resulting in a 77% calf crop. The culprit is the 11 cows with a score of 3. Simply removing them from the herd and providing nutrients at a more accelerated rate, or culling the animals would shift this herd to a 85-89% calf crop, a significant economic incentive to manage for body condition and employ prescriptive nutrient management systems.

Table 1. Impact of body condition score composition of animals at the start of breeding season on subsequent pregnancy rates and ultimate calf crops of a herd of 85 beef cows on rangeland.

Score	No. Head	% Pregnant	No. Pregnant
3	11	52	5
4	17	73	12
5	48	86	41
6	9	96	9

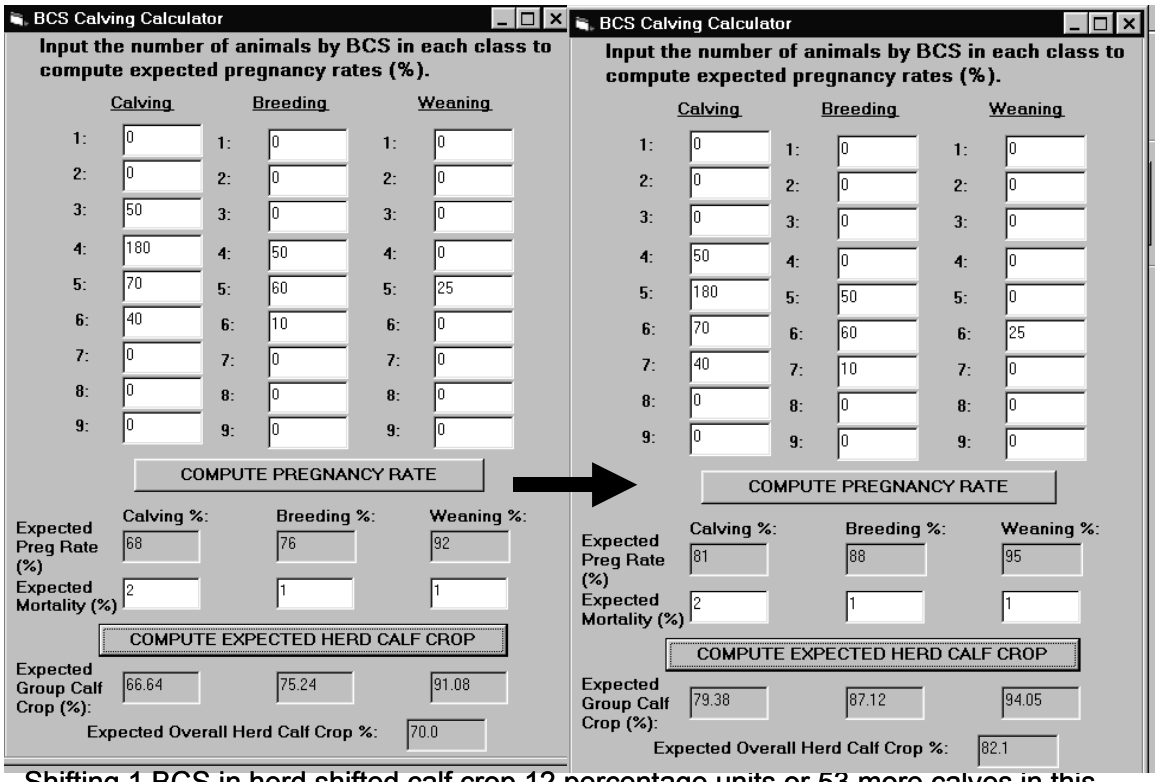
Total Pregnant	67
% Pregnant	79
% DeathLoss	3
Total Calves	65
% Calf Crop	77

To capture the affects of body condition scores on resulting calf crops, the NUTBAL PRO software has a utility that can reflect the composition or inventory of cows by body condition score class and stage of production (calving, breeding, weaning). An example of this BCSCalving Calculator is provided in Figure 4.

Role of Protein and Energy in Affecting Pregnancy Rates in Cattle

Female cattle greater than 55-65% of their mature weight begin to partition excess nutrients, particularly energy, more to the formation of fat instead of protein. As they increase in size this preference for fat partitioning increases. Therefore, managing the level of nutrients either by selecting proper stocking rates, rotating animals in a optimum manner or allocation of supplements becomes a task of knowing when to apply excess nutrients (greater than requirements) when you need the animal to be in a higher body condition or implement a controlled weight loss when the desired body condition is less than the current body condition.

The requirements of cows varies with stage of production (open, pregnancy, lactation), environmental conditions (temperature, terrain, wind, coat condition), forage quality (crude protein (CP), digestible organic matter (DOM), forage supply (kg/ha), application of metabolic modifies



Shifting 1 BCS in herd shifted calf crop 12 percentage units or 53 more calves in this example of a mixed calving herd. The poor BCS cows currently calving are the primary source of poor calf crops.

Figure 4. Example of the BCSCalving Calculator used in the NUTBAL PRO software to assist livestock managers in isolating causes of low calf crops in cattle.

(ionophores, implants), and level of parasite loading (ticks, worms). Detailed description of these factors can be found in another document presented at this conference by the author.

Animals in the latter 3 months of gestation, progressively reduce intake due to rumen volume displacement of the fetus. Lactation increases both protein and energy requirements, peaking about 45 to 60 days after birth of the calf. However, the cow can eat more forage about l6 weeks after this peak due to increased gut capacity. When temperatures are above 25° C, intake is progressively suppressed and energy requirements increase. Temperatures below 15° C will result in increased nutrient requirements but increased intake by the animal. Typically DOM/CP ratios of 4 result in optimum levels of nutrient intake by an animal with peak fermentation rates in the rumen. However, when DOM/CP ratios are greater than 7-8 there is insufficient protein to meet the needs of microbes in the rumen and nutrient intake will not be able to compensate for the loss in microbial efficiency. Low DOM levels result in low intakes while high levels result in high intake. Typically, most rangelands possess high energy content (POM) but lose protein as the plant reduces growth rate or goes into dormancy. Application of protein supplement at that time is critical to maintain condition of the animal. Use of the NIRS fecal profiling technology can assist ranchers in monitoring these changes in diet quality and adjust nutrient input.

When DOM/CP ratios are below a 4, intake is suppressed with reductions up to 65% when the ratio approaches 2.5. This is a common problem with cool-season grasses such as ryegrass, oat, wheat, bromegrass, orchardgrass, etc. Allowing access of good quality hay increases the ratio, which in turn increases appetite drive and subsequent intake of the animal under these kinds of conditions. Use of highly fermentable carbohydrates such as wheat middlings, beet pulp and soybean hulls can also be used effectively to manage the negative effects of excess ammonia formation in the rumen when the animal consumes low DOM/CP ratios.

Perhaps one of the greatest nutritional problems encountered by cattle is more of a grazing management problem associated with over stocking and restricted intakes of forage. High stock densities of 1-1.5 ha/cow and/or standing crops of < 1000 kg/ha can result in significant reductions in intake of animals even though forage quality is high. Special computer programs in the NUTBAL utilities can assist ranchers in assessing whether intake is restricted due to limited forage supply. However, the rancher needs to develop the skill of assessing the average standing crop (kg/ha) of their forage. A simple photo-guide could prove useful in supporting this type of assessment.

Use of metabolic modifiers can increase the energy value of the feed ingested and in many cases increase intake unless digestibility is higher than 62% DOM. Higher DOM values will reduce intake but still allow the animal to garner more energy from the forage. Special care must be exercised in using these "ionophores" to prevent consumption by horses as they are poisonous to cecal animals and monogastrics.

Minerals and Reproductive Success of Cattle

A wide array of minerals interact with the physiology of the cow to impact reproductive processes. One of the most important minerals on rangeland is phosphorus. Typically, if protein and energy are meeting maintenance requirements of the animal, phosphorus is not limiting. However, during the period of high lactation (first 3 months), low phosphorus levels can be a problem even when animal needs for protein and energy are being met. This is a critical period affecting both body condition and circulating fatty acids at the time of breeding.

Establishing critical levels of dietary phosphorus intake depends on the same array of factors listed for protein and energy. However, assessment of the levels in the diet has remained an elusive target for most managers resulting in over or underfeeding of minerals due to limited ability to monitor, and poor quality control of the manufacture of mineral supplements. Recent breakthroughs in profiling fecal material with NIRS technology, and the prediction of fecal and dietary levels of phosphorus is providing new insights into mechanisms to assess the mineral status of animals.

Much debate has emerged about what are appropriate trace minerals to use under rangeland conditions such as copper, zinc, selenium, manganese, iron and sulfur. The second most common mineral problem encountered on rangeland is copper deficiency due to negative interactions with iron, sulfur, and manganese. Selenium levels are critical for maintaining proper immune response but can be toxic at high levels. There is some evidence that high iron soils can result in a phenomenon referred to as phosphorus spillage, which causes the animal to trigger diversion of

phosphorus to the urinary tract instead of the feces. Typically almost all phosphorus is excreted via the feces and milk. Once a "spill" occurs the body creates an internal deficiency and low fecal phosphorus levels will occur even though high consumption of phosphorus mineral is taking place. To stop this phenomena, all mineral must be removed and allow the system to equilibrate before reintroduction of the phosphorus supplement.

Until better, economical monitoring techniques can be made available to producers, trace mineral application will always be an art form shrouded with the need to meet all of the animal's needs with external minerals. We simply cannot monitor mineral intake under rangeland conditions. We can approximate it from hand-plucked forage samples and water samples via lab analysis but the human has a poor record of mimicking the food items that an animal will eat in large rangeland pastures and it is difficult to determine the sources and amounts of water consumed under extensive grazingland conditions. Ranchers should concentrate on phosphorus as their primary mineral of concern using fecal phosphorus levels as a key to mineral needs. For instance, open or early gestation cows with fecal phosphorus levels above 0.17% should be getting adequate levels of dietary phosphorus. Late gestation cows need to exhibit fecal phosphorus levels above 0.21% while early lactation cows should have levels above 0.27% and increasing to .31% for high milking ability breeds. Levels above 0.26% are needed for late lactation cows.

Visits with local veterinarians can also help determine if local trace mineral problems exist. However, if pastures are overgrazed, protein or energy is deficient and parasites are not controlled, mineral problems are the least of the problems facing ranchers. Application of minerals can be as much an economic consideration as a biological issues in cattle management given the limited ability to monitor and detect deficiency levels in a timely manner.

Recent breakthroughs in NIRS technology are indicating that animals can be categorized into deficient, non-deficient and high levels of copper, iron and selenium. This technology may represent the first practical, non-invasive way to determine trace mineral status of free-ranging livestock.

Prescriptive Nutritional Management for Reproductive Success

To establish a good nutritional management program, livestock producers must establish a goal for the desired level of calf crop needed to sustain the ranch business. For instance, given the land area, financial obligations and lifestyle chosen by the rancher, a calf crop of at least 90% may be required to meet those biophysical economic and psychological constraints placed on the operation. This means that all cows must be at least a 5+ score going into calving season, a 6- at the start of breeding season and no lower than a 5- at weaning.

To get a program in sync with management goals, the herd should then be profiled in terms of body condition score composition (see prior section). Those animals that are not meeting these body condition score milestones should either be separated and given special nutrition programs designed to accelerate gain to increase condition or be eliminated from the herd and younger replacement heifers brought in and put under a more consistent management regime. Once the herd has been stratified, monthly fecal profiling with the NIRS/NUTBAL system will allow the rancher

to assess current performance, project likely changes in future condition and make nutritional adjustments according to the target body condition scores established for the various production stages. A detailed description of this system is found in another section of this volume. In brief, the NIRS fecal profiling technology allows prediction of dietary CP and DOM under free-ranging conditions; while the NUTBAL computer system blends information on the breedtype, the environmental conditions, the NIRS predicted diet quality, feed and metabolic modifiers used and level of grazing pressure to assess protein and energy balance, gain, and change in body condition over time. The tool can then be used to determine a least-cost solution to meet the needed performance of the animals to keep them on track with the body condition score established for each decision point in the production cycle of the cow. The need for general recommendations is completely eliminated with the system moving nutritional management away from purely trial and error to prescriptive management.

Studies in the USA indicate that over 60% of users of the NIRS/NUTBAL system will receive approximately $28 US per exposed cow each year in the program using 1999 dollars or $38 with 2001 market conditions. Over 50% of the producers will change feed suppliers and over 80% reported greater understanding of forage quality, management of cow nutrition, and developed a greater appreciation of the linkage between good grazing and conservation management of their resources and the nutrition of their cattle. The days of general nutrition recommendations that cover all situations and fit none are rapidly coming to a close with this new technology. Trial and error nutrition is slowly going to give way to prescriptive nutrition tightly linked with reproductive goals of the cattle producer. Improved monitoring technology and analytical tools are ushering in a new era for livestock managers to better survive in a business climate of ever increasing demand for greater production efficiency with minimization of risk. Effective monitoring and analysis is one of the few technologies that address both aspects of these financial realities. To establish a nutritional management system with the NIRS/NUTBAL system contact the Grazingland Animal Nutrition Lab at Texas A&M University at 979-845-5838.

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