Feeding Beef Cattle I: The Realities of Low-Quality Forages

WASHINGTON STATE UNIVERSITY EXTENSION • EM053E

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The Feeding Beef Cattle Series

This article is the first in a series of publications that will focus on current feeding topics of interest to beef cattle producers. The information in this collection will give producers a fundamental understanding of beef-cattle-feeding practices, as wells as the effects these practices have on beef cattle health and performance. In addition, future articles will discuss feeding practices as they relate to long-term performance of progeny, nutritional effects on health and reproduction, effective forage management, as well as other timely issues.

Introduction

Beef cattle are able to survive, and even thrive, on low-quality feeds. As ruminants, their ability to convert fibrous material into useful products and to maintain, reproduce, grow, and lactate play an important role in our global ecology.

For beef cattle producers, the need to control feeding costs is always important, and the relationship between nutrition and reproduction is well established. A report by Neibergs and Nelson (2008) suggests that feed is the largest annual production cost in raising beef cows in Washington State. Total feed (i.e., pasture, rangeland, and all related nutritional inputs) and supplemental feed (i.e., hay, supplements, and minerals) represent approximately 60% and 30%, respectively, of the total annual costs for cow-calf producers. While these costs depend on commodity prices, producers focused on reducing feed costs can still make significant progress toward profitability. Typically, as hay and grain prices rise, there is renewed interest in replacing high-cost feeds with low-quality forages. A basic understanding of the nutritional makeup of forage is essential in order to use low-quality forages effectively.

Available Nutrients and Nutrient Requirements

In developing beef cow feeding programs, it is essential to know and understand *what you have* before you can determine *what you need* in order to provide a balanced feed to your herd. Determining the feeding value of base forage and supplements is fairly straight-forward and is based on their chemical composition. However, determining the nutrient requirements of the herd is a function of many factors, such as biological priority for nutrients (i.e., maintenance, growth, lactation, and reproduction), stage of production, age, physical activity, milk-producing capacity, body condition, body weight, and weather, to name a few. In addition, the nutrient requirements of beef cows increase by about 30% to 40% and forage intake usually increases 30% upon calving (Marston et al. 1998). Beef producers need to plan their feeding programs around these dynamic factors and be ready to respond to the shifting nutritional needs of the cow herd.

Producers are strongly encouraged to obtain a copy of "Nutrient Requirements of Beef Cattle," a publication from the National Research Council and the National Academy Press (NRC, Seventh Revised Edition, Updated in 2000) (http://www.nap.edu/catalog.php?record_id=9791). This comprehensive publication (which can be purchased online) is an essential resource for producers trying to match feed to the changing nutrient requirements of their cattle. Other resources (based on the NRC requirements), such as computer-based nutrition balancers are also available. Free products like the Cow-Culator, which is available from Oklahoma State University (http://beefextension.com/new%20site%202/cccalc.html) and the Protein Supplement calculator from the Noble Foundation (http://www.noble.org/Tools/index.html) can help producers develop effective feeding programs. Additionally, more sophisticated software packages, such as the BRANDS® program, can be purchased from the Iowa Beef Center (www.iowabeefcenter.org). Nutrient requirements are entered into these programs and are linked to easily updatable feed libraries that include feed costs, which enable users to make more accurate economic comparisons between rations.

Forage Nutrition

By definition, *forages* are the edible parts of plants (other than grain) that provide feed for animals or can be harvested for feeding. Browse and mast (i.e., nuts and seeds) may also be part of the ruminant diet (Barnes and Nelson 2003). *Roughages* refer to forages that are particularly high in fiber. For beef cattle producers in the Pacific Northwest, grasses and legumes are the predominate sources of forage. These sources include plant materials on rangeland and pastures (native and introduced species; irrigated and non-irrigated), harvested forages (hays and silages), stockpiled forages, and a host of crop residues (including corn stover, small grain straws, and residues from the grass seed industry). Each forage type or forage mix must be evaluated to determine its feeding value and the level of beef cow performance that can be expected.

The Relationship between Forage Nutrition and Beef Cattle Performance

Beef cattle performance can be measured in a variety of ways depending on the age class and physiological state of the beef cattle being evaluated. There is a well-documented relationship between body condition score (BCS) and reproductive efficiency, which demonstrates the importance of providing enough nutrition for cows to maintain sufficient body condition to ensure reproductive efficiency. Adequate BCS during calving is essential if cows are to return to estrous cycles in a timely manner (Richards et al. 1986; Selk et al. 1988). Dzuik and Bellows (1983) managed cows for a BCS rating of 5 (on a scale of 1 to 9) at calving to ensure that they were prepared to breed back. Tracking weight and BCS changes in beef cows provides insight into reproductive performance. Growth and body weight change are the standard measures used for the performance of calves. Postnatal health also strongly affects a calf's growth. In the first 30 days of life, calf scours is a major cause of mortality (Schumann et al. 1990; DEFRA 2003) and Sanderson and Dargatz (2000) noted that of all the diseases of young calves, scours is the most expensive to treat. Maternal nutrition can also affect the subsequent growth and health of the calf and has been associated with calf morbidity and mortality (Corah et al. 1975).

Chemical Analysis of Harvested and Standing Forage

Producers should pay close attention to the physical characteristics of forage when determining quality, but from a nutritional standpoint, the quality of a forage is reflected in its chemical composition. Understanding chemical composition allows producers to determine which forages are sufficient enough to meet their production goals. Knowing the chemical composition will also assist producers in correcting for nutrient imbalances.

Forage testing is another important tool available to beef cattle producers. When using forage testing, it is essential to send *representative* samples to the laboratory and to use a laboratory that is certified by The National Forage Testing Association (NFTA). Using a NFTA-certified laboratory will ensure accurate test results using recognized reference methods. Collins et al. (2000) state that when sampling hay, it is essential to identify the *lot*, that is, the hay that is from the same field, as well as cutting, species, variety, maturity, and hay stored under similar conditions. A representative sample must also be collected in order to account for the amount of *variation* within a *lot*. Hay quality changes in the stack over time, so it is important to sample the hay close to the time of feeding to ensure that the actual quality is the same as the quality reflected in the analysis. Sending flakes or grab samples is not enough to obtain accurate results.

Hay-probing devices are available from several manufacturers (http://www.foragetesting.org/index.php?page=hay_probes) and should be employed to sample deeper into the layers of the bales. In general, a minimum of 20 core samples per lot should be collected from as many areas in the stack as possible. For large square bales, two or three samples per bale should be sufficient. For both large and small square bales, sample from the ends between the strings. For large round bales, the probe should be inserted from the side and directed toward the center of the bale. Sampling to a depth of 12 to 24 inches will provide a sample of approximately 200 g for analysis. A probe 14 to 24 inches long with a diameter of 3/8 to 5/8 inches should be used (Collins et al. 2000). Once the samples have been collected, the material should be sealed in a plastic bag and stored in a cool place. Deliver the samples to the laboratory as soon as practical.

At times it is advisable to measure the quality of standing forage. While sampling methods are somewhat different, standing forage samples can be submitted to a laboratory like harvested hay samples. Griggs et al. (2010) suggests that sampling forage may be necessary if animal performance is limited by the quality of the forage. A minimum of 20 forage clippings per pasture collected in a grid pattern works effectively. Cattle select a diet that they find most palatable, and this should be taken into account when sampling. Clip the standing forage at each site to the approximate grazing level. The samples can be delivered immediately to the laboratory, refrigerated or frozen, or they can be dried at 140°F to stabilize them for storage. If the weather is particularly warm, place the samples in a portable cooler to prevent deterioration.

Forage Analysis and Quality Terminology

A detailed discussion of forage nutritional value is provided in Chapter 11 of "Pasture and Grazing Management in the Northwest" (Griggs et al. 2010). Focusing on a few key forage components will give producers sufficient information to determine the usefulness of forages for beef cows. These components can be seen in a forage analysis, which typically reports crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), total digestible nutrients (TDN), estimates of net energy (NE) (for growth or lactation), and mineral composition. Analysis to determine dry matter (DM) content is also useful when comparing feeds with differing moisture contents and is especially useful when comparing feeds with high moisture content, such as silage and immature forages. Forage analysis also provides useful information on *antiquality* components, such as lignin, cutin, and silica, which have beneficial protective and structural roles in plants, but can negatively affect digestion and utilization of forage by beef cattle.

Generally, feed CP is quantified by determining its nitrogen (N) content. Crude protein (CP) can be calculated from nitrogen (N) using the equation: %CP = %N x 6.25, assuming that amino acids (i.e., the building blocks of protein) contain approximately 16% N (Lloyd et al. 1978). Because feeds contain small amounts of non-protein nitrogen from other chemical constituents (i.e., components from cell nuclei, such as DNA and RNA), these sources are included in the final CP content. Protein that is broken down by the microbial population in a cow's rumen becomes a source of nitrogen that can be used to carry out digestive and metabolic activities of the microbes. Nitrogen from protein can be converted to ammonia and used by the rumen microbes to make microbial protein, which eventually becomes nutritionally available to the animal. Ammonia is the preferred nitrogen source for rumen bacteria that digest the fibrous components of forages.

To understand the use of low-quality forages, it is essential to have a basic understanding of the fate of dietary protein. When feeding low-quality forages, protein is commonly regarded as the first-limiting nutrient (Köster 1995). This means that when protein is not present in sufficient quantities in a feed, maximizing beef cattle performance cannot occur, even if all the other essential nutrients are present in adequate amounts. Some of the nutritional aspects of protein are not reflected in CP alone. In beef cattle nutrition, protein can be divided into two categories, each having two synonymous names. Ruminally degradable protein (RDP), also known as degradable intake protein (DIP), refers to that proportion of the CP that is used in the cow's rumen for the benefit of the rumen microbes. Protein is synthesized by the rumen microbes using N derived from protein in the animal's diet. Eventually, as the rumen microbes die off and move out of the rumen, the microbial protein is available for digestion in the small intestine. Ruminally undegradable protein (RUP), also known as undegraded intake protein (UIP), is that portion of the CP that escapes rumen degradation and is eventually digested in the small intestine. RUP or UIP is sometimes referred to as rumen escape protein. The relative degradability of feedstuffs in the rumen varies by type of feed and can be affected during feed processing or in circumstances where feed becomes heated. Unlike animals with simple stomachs, the required metabolizable protein (MP), or true protein, absorbed by the intestine of beef cattle is met in two ways—by microbial protein and by dietary escape protein (NRC 2000). The digestibility of microbial and escape protein is a factor that helps determine the amount of protein that is ultimately absorbed by the animal.

The Van Soest detergent system was developed to replace the crude-fiber system for determining the insoluble constituents of plant cell walls in ruminant diets. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) are measures of a forage's fiber content. The NDF fraction contains hemicelluloses, cellulose, and lignin, while the ADF fraction contains only cellulose and lignin (Van Soest 1994). Depending on the method of reporting, test results may or may not include the residual ash (mineral) content of the forage. In terms of forage quality, increases in NDF and ADF are most often negatively correlated with the CP. NDF and ADF values reflect forage intake, digestion, and utilization, and as their concentrations in a forage increase, intake and digestion decrease.

While originally calculated using digestibility coefficients from proximate analysis of feeds, TDN values may also be calculated by employing empirically derived prediction equations using the ADF analysis. This is the method used for most feed analyses. It is important to note that TDN values are estimates of organic matter (OM) digestion and only account for fecal losses, whereas the more complex system of net energy (NE) values account for energy losses incurred during the digestive processes. Furthermore, NE values in forage analysis reports can be obtained by using the TDN values. The negative relationships between dry matter intake and NDF, and between ADF and dry matter digestibility provide additional information about forages (Schroeder 1994).

Macro- and microminerals are essential for many metabolic and life-sustaining processes in beef cattle, and they affect bone formation, hormone components and secretion, enzyme components and activators, water balance, amino acid components, glucose tolerance, components of vitamins, and antioxidation. There are at least 17 minerals that beef cattle are known to require (NRC 2000). Meeting these mineral needs requires an initial accounting of the minerals supplied by the available forage, followed by a determination of which minerals need to be supplemented. This practice is common on most beef cattle operations.

Comparing Forage Quality

What constitutes a low-quality forage? The reviews of McCollum and Horn (1990) and Moore and Kunkle (1995) suggest that when forages have a crude protein (CP) content of less than 7%, protein supplementation may be beneficial. This recommendation implies that forages with less than 7% CP in the forage dry matter are considered low in quality. However, there are additional factors that contribute to forage quality.

For grazing beef cattle, unlike beef cattle fed in confinement, facilitating nutrient intake to meet nutritional requirements can be difficult due to the ever-changing availability of nutrients in forages, as well as nutrient demand. These changes are the result of both how forage quality is changing (i.e., from immature to full vegetative maturity) and when in the beef cattle production cycle nutrient requirements are being assessed (e.g., growing heifers, pregnant and lactating cows, dry and pregnant cows). Hart (1991) noted that a challenge for producers is the fact that availability or quality of forage does not necessarily follow the seasonal pattern of beef cow nutritional needs. Examples of seasonal changes in Pacific Northwest forage quality are presented in Figure 1.

A common misconception about forages is that low-quality forages serve only as *fillers* and have little value as feed. If this were universally true, wild ruminants would not be able to survive on low-quality forages. However, ruminants are highly adapted to harsh conditions. In a practical sense, forages are able to meet the nutritional requirements of beef cattle in varying degrees. Table 1 compares alfalfa (a high quality/high value forage) with wheat straw (a low-quality roughage).

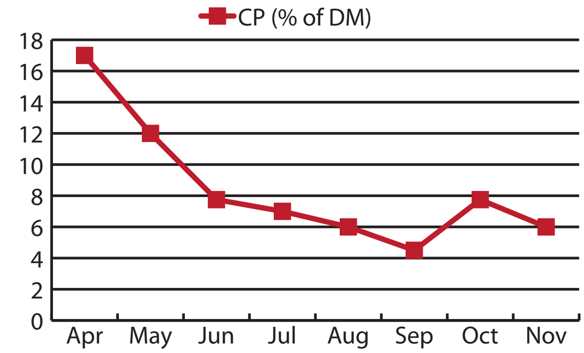


*Figure 1. Seasonal changes in average crude protein (CP) content of seven common grasses in the Northern Great Basin.**

Adapted from Ganskopp and Bohnert (2001)

*Bluebunch Wheatgrass, Bottlebrush Squirreltail, Cheatgrass, Giant Wildrye, Idaho Fescue, Sanberg's Bluegrass, Thurber's Needlegrass

When comparing alfalfa hay and wheat straw, we are attempting to identify differences and also gain insight into the expectations for performance. When comparing the chemical composition of the two forages (as it relates to rumen metabolism), there is a significant difference in CP and the RDP content, with wheat straw having lower values. This indicates that in addition to the protein content being lower, less of it will be degraded in the rumen for the benefit of the rumen microbes. As previously discussed, when NDF increases, there will likely be a decrease in voluntary intake. Therefore, based on compositional data alone, it is likely that beef cattle will consume

Table 1. Comparison of nutritional chemical composition of alfalfa hay and wheat straw.

	Forage/Feed	
Composition	**Alfalfa Hay***	**Wheat Straw**
	--------- Percent (%) ---------	
Dry matter	100.0	100.0
Crude protein (CP)	17.0	3.5
RDP/DIP (% of CP)	82.0	31.0
Neutral detergent fiber (NDF)	49.0	78.9
Lignin (% of NDF)	18.9	16.5
Total digestable nutrients (TDN)	60.0	41.0
Fat	2.4	2.0
Ash	8.6	7.7
	--------- Mcal/kg ---------	
Metabolizable energy (ME)	2.2	1.48
Net energy for maintenance (NE_m)	1.3	0.64
Net energy for grain (NE_g)	0.74	0.11

Adapted from NRC (2000)
*mid-bloom hay

significantly less wheat straw than alfalfa hay. As mentioned earlier, the fiber fraction and lignin (an *antiquality* component) are also associated with TDN as an estimate of digestibility. In our example, wheat straw has a TDN value of 41% *vs*. 60% for alfalfa hay, and it has lower NE values (which make a more thorough accounting of energy losses), so it is clear that feeding such low-quality forage has its challenges. One might ask why alfalfa is considered a higher quality feed given that its lignin content is higher as a percent of NDF. The answer depends on the amount and site of deposition of the antiquality components. These antiquality characteristics are not consistent across forage species (i.e., stems vs. leaves), and some plant parts are used better than others depending on these two factors. Beef cattle producers should approach the use of feeds, such as wheat straw or other roughages as an opportunity to reduce feed costs by effectively using these low quality, inexpensive feeds.

Both alfalfa hay and wheat straw contain essential nutrients, but the major difference is in *utilization*. The primary concern in effectively using low-quality forages is being able to unlock as much potential nutritional value as possible. A producer's main focus in using low-quality forages is on managing cattle to maximize intake of these forages and to digest as much as possible of what they consume. While maximizing intake will decrease digestibility because of greater throughput of material, more nutrients will be delivered to the animal. An impediment to using low-quality forages is insufficient nutrient content (which can compromise intake and digestion and *antiquality* components, which are physical or chemical barriers to digestion). Although managing cattle using low-quality forages may appear straightforward in theory, planning is central to its practical application.

Effective Use of Low-Quality Forages—Unlocking Their Potential

While low-quality forages cannot be used as the sole source of nutrients, they can reduce overall feed costs during phases in the production cycle when nutrient requirements are low. When using low-quality forages, it is key that producers know the nutrient content of the forage; therefore, forage testing should be an integral part of all beef cattle operations. Knowing what nutrients beef cattle require is essential in determining whether these requirements are being met. Knowing both the content of the forages and the nutrient requirements of the beef cattle allows producers to correct for deficiencies that may occur. In order to use low-quality forages effectively, management practices, such as protein supplementation and other feeding technologies may be needed.

Protein Supplementation

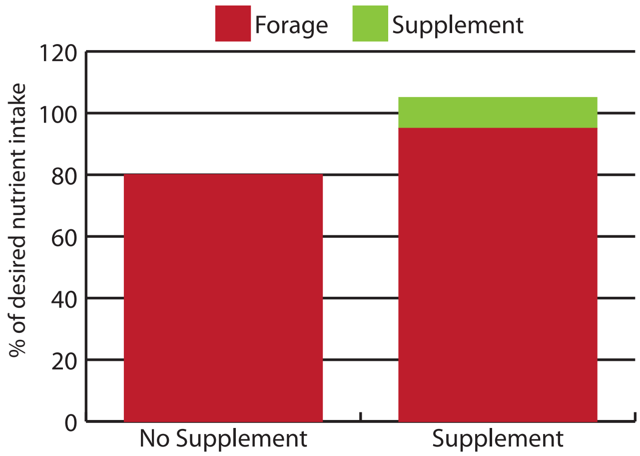
Beef cattle consuming low-quality forages usually respond well to supplemental RDP/DIP (Olson et al. 1999; Mathis et al. 2000). In addition, Church and Santos (1981) and Köster (1995) have noted that the greatest response from supplemental RDP is achieved by the first increments delivered. This means that the more protein deficient the forage is, the greater the expected response.

Providing supplemental RDP to effectively unlock the potential of low-quality forages has been investigated for more than three decades. Supplemental RDP has been employed in a variety of production scenarios to enhance use of low-quality forages. Supplemental RDP investigations include supplementing winter-grazing beef cows and heifers, stocker cattle in the late summer and fall, and beef cows in the fall.

Protein supplementation has some basic requirements: First, the low-quality forage must be readily available. Also, it must be understood that the limited supplemental RDP is provided primarily for the well-being of the rumen microbial population because RDP allows the rumen microbes to more effectively digest the available forage. And although supplemental RDP supplies a modicum of nutrition to the host, its main benefit is in the additional nutrition gained directly from increased intake and/or digestion. The primary reason for giving supplemental RDP is to stimulate cattle to eat more and digest more of what they consume. However, the physiological response is dependent on the type of forage consumed (i.e., cool- vs. warm-season grass species). Recent investigations suggest that intake and digestibility of cool- and warm-season forages of similar quality are not equal and that the response to supplemental protein is greater for the warm-season species. It has been determined that unsupplemented cool-season grasses provide for greater intake and digestibility compared to unsupplemented warm-season grasses (Bohnert et al. 2011), which is important information for producers in the Pacific Northwest, where rangelands are dominated by cool-season forages.

In describing strategies for protein supplementation, McCollum (1997) proposed the following three scenarios as they apply to grazing beef cows or yearlings:

Scenario 1. Beef cattle performance is not meeting production goals, forage is unlimited, but the quality is low. Figure 2 shows the relationship between nutrient intake and protein supplementation.

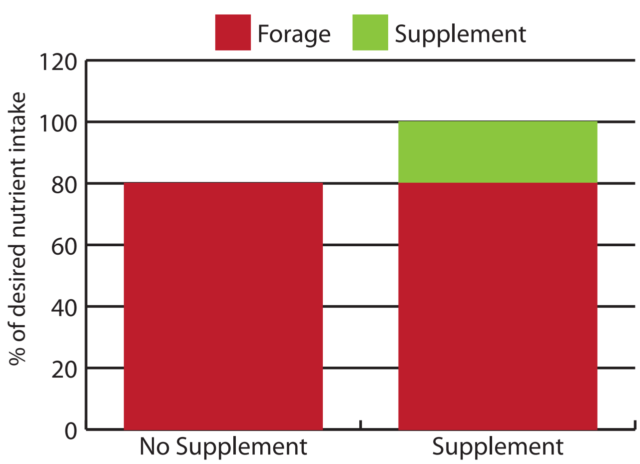


Adapted from McCollum (1997)

Figure 2. Ruminally Degradable Protein (RDP) supplementation of abundant low-quality forage.

Under these conditions, the increase in intake from the supplement itself is very small. So the increases in nutrient intake are a result of more favorable conditions for the rumen microbial populations, which allow for enhanced digestion and therefore greater forage intake.

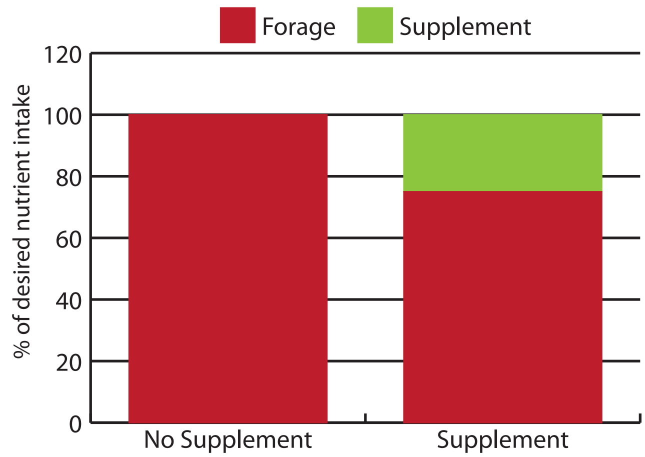
Scenario 2. Production goals are greater than the capabilities of the forage, which may or may not be limiting. Figure 3 shows that despite being given RDP and energy supplementation, nutrient intake from the forage equaled forage intake when supplement was provided. The increase in nutrient intake comes solely from the supplement.



Adapted from McCollum (1997)

Figure 3. Ruminally Degradable Protein (RDP) and energy supplementation when production goals are greater than forage capabilities.

Scenario 3. Forage supplies are limited. Figure 4 shows the relationship between forage and supplement intake when forage supplies are limited. When this limitation occurs and supplement is provided, forage intake is displaced by the supplement.



Adapted from McCollum (1997)

Figure 4. Ruminally Degradable Protein (RDP) and energy supplementation when forage supplies are limited.

Recall that when RDP is provided to cattle grazing low-quality forages, the goal is to increase forage intake and maintain as much forage digestion as possible, thereby delivering more nutrients to the animal. When *energy* (starchy) feed, such as corn, barley, or other grains is fed to beef cattle, forage utilization may be affected. Mixing RDP sources with grains is a common practice used to meet the protein requirement of beef cattle, while also supplying additional energy (from the grain). The displacement of forage in response to a starchy *energy* feed is referred to as the *substitution effect*, and it has both positive and negative implications for forage utilization. Producers can anticipate that for each pound of concentrate (i.e., grain or other starchy feed), forage intake will likely decrease by approximately 0.5 pounds. While at first glance one might consider a reduction in forage use to be a negative, it is possible to use the *substitution effect* as a tool in regulating forage consumption. During drought conditions or when a producer needs to increase stocking rate, using the *substitution effect* may be advantageous. When additional energy is needed, highly digestible fiber sources, rather than starchy feeds, can be employed to moderate the substitution effect and maintain forage utilization. Some sources of digestible fiber are wheat middlings, corn gluten feed, and soybean hulls.

Supplemental Protein Sources

Delivering protein to beef cattle should not be a confusing practice. Once the nutrient requirements of the particular class of beef cattle are determined, as well as the nutrient content of the base feed , it is not difficult to provide sufficient nutrients to make up for what is lacking in the diet.

Today, there are a wide variety of protein-rich feeds that can be used to correct nutrient imbalance. Protein sources such as alfalfa hay have been used successfully in the Pacific Northwest (PNW). More recent additions to the available feeds include byproducts from the biofuel industry, such as corn distiller's grains and Canola meal. Traditionally, soybean and cottonseed meal are reliable protein sources in areas where they are readily available. All of these feeds (and many others) have the capacity to elicit the intake and digestion responses that have just been discussed. However, each protein source has its own characteristics and chemical composition, which must be considered before feeding to ensure that the nutrient requirements are being met appropriately.

Examples of Protein Supplementation in Practice

Supplementing with RDP is a very efficient means of increasing weight gain in growing cattle (Table 2) because the stimulation of the rumen microbes unlocks more nutrition from the base forage. Lusby et al. (1982) demonstrated the efficacy and efficiency of feeding a 39% CP soybean-meal-based (high RDP) supplement to summer stocker cattle on low-quality forage at a rate of only 0.14% of body weight (steers weighed approximately 570 lb). They found that gains were approximately 0.44 lb/day greater for the calves that received RDP than those who did not (Table 2).

Perhaps the most interesting finding was that the supplementation efficiency (i.e., pounds of additional BW gain above the controls for each pound of supplement provided), was 1.8:1. From the producers' standpoint, this means that very small amounts of RDP can significantly improve performance. Providing protein to the 0.25% of BW level also increased weight gain to 1.97 lb/day. However, when corn, an energy supplement, was provided, the efficiency of weight gain was affected, and the pounds of feed required for each pound of additional weight (beyond the controls) increased to 8.8:1.

Likewise, it is possible to use similar management and achieve efficient performance by providing beef cow herds with supplemental RDP to increase body weight and energy reserves. Llewellyn et al. (2006) fed a supplement of cottonseed meal and soybean meal to spring-calving beef cows during the fall grazing period. Results showed that when cows were supplemented at 0.14% of BW from fall weaning until the start of the winter grazing period, they gained 34.4 lb more weight and lost 0.34 less body condition than the non-supplemented cows (Tables 3 and 4).

The feed efficiency that brought about additional weight gain in this study was 2.4:1 (from weaning to the start of the winter grazing season). The efficiency of additional weight gain is a function of the additional energy supplied by the forage; consequently, producers can increase weight gain by using supplements to release nutrients from the forage.

Delivering Protein Supplements

There are several options for delivering protein supplements to beef cattle. Hand-feeding supplements, such as hay and byproduct feeds is one option. Another is to use self-feeding supplements (in both liquid and block form). While supplement sources differ widely, and each has its own characteristics and idiosyncrasies, they all have the potential to elicit a rumen microbial response and positively affect forage utilization.

Table 2. Effect of protein and energy supplementation on weight gain in steers grazing native range (July 16 to October 20).

Item	Control	0.8 lb/day[a] 39% CP SBM-based supplement[b]	1.4 lb/day[a] 43% CP SBM-based supplement[b]	3.1 lb/day[a] 10% CP corn-based supplement
Weight gain, lb/day (96 days)[c]	1.44	1.88	1.97	1.78
Pounds of supplement/ lb of added gain (96 days)	0.0	1.8	2.8	8.8

Adapted from Lusby et al. (1982)
[a]Supplements fed 3 days/week
[b]SBM = soybean meal
[c]Control vs. all supplementation treatments ($P<0.05$)

Table 3. Influence of low-level fall protein supplementation on beef cow body condition score (BCS).[a]

	Treatment[b]				Statistical comparisons (P-values)[c]		
Item	**Control**	**Pre- & post-weaning**	**Post-weaning**	**SEM[d]**	**Pre-weaning vs. none**	**Pre- & post-weaning vs. Post-weaning**	**Control vs. Pre- & post-weaning and Post-weaning**
No. of cows	46	44	46				
Initial BCS	4.77	4.76	4.76	.018			
Pre-weaning BCS changes							
Aug 14–Oct 15	.42	.51	.31	.075	.16	NA	NA
Post-weaning BCS changes							
Oct 15–Dec 14	-.44	-.09	-.11	.089	NA	.86	.02
Cumulative BCS changes							
Aug 14–Dec 14	-.02	.42	.20	.108	NA	.19	.04
Aug 14–Calving	-.15	-.01	-.05	.087	NA	.75	.30
Dec 15–Calving	-.14	-.43	-.25	.103	NA	.25	.15
Calving BCS[e]	4.60	4.75	4.70	.086	NA	.74	.28

Adapted from Llewellyn et al. (2006)
[a]Body condition score (BCS): 1= emaciated; 9 = obese
[b]Treatment: Control = no fall supplementation; Pre- & post-weaning = supplementation during the entire fall period; Post-weaning = supplementation beginning after calves were weaned on Oct. 15
[c]NA = not applicable. Statistical comparison under consideration was not applicable to the designated period.
[d]SEM = standard error of the mean; n = 136
[e]Average calving date = March 7

Table 4. Influence of low-level fall protein supplementation on beef cow body weight.

	Treatment[a]				Statistical comparisons (P-values)[b]		
Item	**Control**	**Pre- & post-weaning**	**Post-weaning**	**SEM[c]**	**Pre-weaning vs. none**	**Pre- & post-weaning vs. Post-weaning**	**Control vs. Pre- & post-weaning and Post-weaning**
No. of cows	46	44	46				
Initial weight	1078.0	1083.0	1083.0	6.10			
Pre-weaning weight changes (lb)							
Aug 14–Oct 15	98.3	115.3	86.4	6.77	.03	NA	NA
Post-weaning weight changes (lb)							
Oct 15–Dec 14	29.5	60.4	67.3	9.33	NA	.63	.02
Cumulative weight changes							
Aug 14–Dec 14	128.1	175.7	153.0	14.11	NA	.30	.08
Aug 14–Calving	6.8	32.2	18.3	6.33	NA	.16	.05
Dec 15–Calving	-121.6	-143.2	-134.8	8.92	NA	.52	.16
Calving weight[d]	1087.0	1116.0	1100.0	8.95	NA	.29	.12

Adapted from Llewellyn et al. (2006)
[a]Treatment: Control = no fall supplementation; Pre- & post-weaning = supplementation during the entire fall period; Post-weaning = supplementation beginning after calves were weaned on Oct. 15
[b]NA = not applicable. Statistical comparison under consideration was not applicable to the designated period.
[c]SEM = standard error of the mean; n = 136
[d]Average calving date = March 7

It is important to note that hand-fed protein supplements do not necessarily need to be given every day. In the interest of reducing labor and fuel costs, researchers have studied frequency as it relates to hand-fed supplements. Supplements that are high in RDP can be given two or three days per week without significantly reducing beef cow performance (Beaty et al. 1994 and Farmer et al. 2001). This is because ruminants have the ability to recycle nitrogen back to the rumen for the benefit of the rumen microbes. Bohnert et al. (2002) investigated both RDP and RUP protein sources and found that, under the conditions of their study, animal performance could be maintained with supplements given as infrequently as every six days.

When it is cost effective, supplements with non-protein nitrogen, such as urea, can be used. Urea is broken down to ammonia in the rumen. Ammonia is generally the preferred nitrogen source for fiber-digesting microbes, and it provides the nitrogen needed to manufacture microbial protein (Farmer et al. 2004). When producers include urea in the 15% to 30% of RDP range, beef cow body weight and body condition usually improve.

Conclusion

As demonstrated, low-quality forages can potentially be a significant source of nutrition for beef herds if managed effectively. Using these forages successfully depends on whether producers know what nutrients are contained in these forages and whether they can determine if nutrient deficiencies exist. Success also depends on whether producers are able to employ feeding and management strategies to correct for any nutritional imbalances. Additionally, recent research suggests that not only does the beef cow benefit from supplemental protein, but also offspring performance may benefit when dams receive protein supplements during pregnancy (Stalker et al. 2007; Martin et al. 2007; Larson et al. 2009). The next article in this series, “Feeding Beef Cattle II,” will discuss the effects of feeding and management practices on the subsequent performance of beef cattle progeny.

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