# BEEF

Chapter 18

## Supplementation of Beef Cows

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## Introduction

Supplementation is defined in this chapter as providing a feedstuff, typically in a limited quantity, to augment the nutritional value of the primary ingredient(s) of the diet (Ensminger et al., 1990). Cattle are most commonly supplemented when they are grazing, whether it is rangeland, seeded pasture, or crop residues, or when they are being fed primarily conserved forage, either as hay or silage. In either case, the supplement is delivered separately from the primary forage as opposed to being an ingredient in a total mixed ration. This chapter focuses primarily on supplemental protein and energy. As indicated in Chapter 14, Nutrient Requirements of Beef Cows, clean water should always be provided as the nutrient required in the largest quantity. Chapter 20, Mineral Nutrition for Beef Cattle, provides information on supplementing mineral nutrients.

### *Philosophy of Supplementation*

Generally speaking, most or all of the forage base for a cow-calf enterprise is produced from the land assets of the operation. As such, forage production can be considered a fixed cost. In most cases, it is also the largest cost of a cow-calf operation. Therefore, the goal of the producer should be to maximize the nutritional value gained from the use of the forage asset. The best way to achieve this goal is to use supplements to augment the value of the base forage, not to diminish it or substitute for it. If supplementation is used, it should be recognized that supplemental feeds and their delivery to the cow herd are additional variable costs so supplementation decisions should be carefully made to ensure that costs are minimized and benefits, in terms of cow performance, exceed supplementation costs. Supplementation should positively impact cow performance to a greater degree than the expense that it adds so that profitability is improved. When supplementing cows, there are questions that producers should ask themselves to determine the best management practices to provide the most cost effective supplement program for their operation.

### Key Points

- The first rule of supplementation is to use supplements only if needed and when they will enhance the nutritional value of the base forage.
- The most likely scenario for effective supplementation is when forage supply is abundant, but quality is low, as characterized by having less than 7% crude protein and/or a TDN:CP ratio greater than seven.
- Protein supplementation can increase the intake and nutritional value of low quality forages.
- Grain-based energy supplements that are high in starch and low in protein have a negative effect on forage intake and digestibility.
- To determine the most cost-effective protein supplement, differences in feed price, crude protein content, moisture content, and transportation costs need to be considered.
- Non-protein nitrogen, usually urea, and alfalfa hay may be cost effective sources of supplemental protein.

The first rule of supplementation should be to only provide a supplement if it is needed and will augment the nutritional value of the base forage. Providing an unneeded supplement will only increase feed costs with little benefit. Thus, the first question should be, When should a supplement be used? Consider the following four specific scenarios (Mathis, 2003):

**Scenario 1:** Forage supply is unlimited and of good quality. This is the ideal situation; there is adequate energy and protein in the forage and with abundant forage to choose from, the cattle can select a diet that will meet their nutrient requirements as well as the requirements of the rumen microbes. Therefore, a supplement is not needed except in extenuating circumstances such as cows being in such poor body condition that they need extra nutrients to gain weight.

**Scenario 2:** Forage supply is abundant, but it is low in quality. Even though plenty of forage is available, it will not meet the nutrient requirements of the cow or the requirements of the rumen microbes to efficiently digest the forage to extract whatever nutrients it contains. This is the most likely scenario for supplementation to be effective from both a cow performance and cost basis.

**Scenario 3:** Forage supply is limited, but is of good quality. Typically, a supplement is intended to overcome deficiencies or imbalances of specific nutrients, not to overcome an overall limitation in available feed. The primary option for this scenario is to reduce the number of animals to match forage demand with forage supply so that there is not a forage shortage. Only rarely would supplementation be designed specifically to substitute for forage, but may be in a drought or other forage shortage.

**Scenario 4:** Forage supply is limited and is low in quality. This scenario provides the greatest challenge for any cow-calf producer. In general, the nutrient deficiency in this situation exceeds the concept of a supplement and an alternative forage source needs to be provided. If this situation persists, the cost of maintaining the cows may be excessive and another decision on whether to decrease herd size or move the herd to a different source of feed needs to be considered.

Once it is determined that supplementation is needed (i.e. scenario 2), factors affecting the success of achieving supplementation goals include determining the supplemental nutrient(s) needed, the type of supplemental feedstuff that provides the nutrient(s), and comparative pricing of alternative potential supplemental feedstuffs. Thus, the second question to consider is: **What type of supplement should be used in terms of whether it will provide the correct nutrient to overcome a deficiency or imbalance?** Selection of the correct supplemental feedstuff based on its nutritional composition can improve the cows' ability to utilize the base forage, whereas, the wrong feedstuff can reduce utilization of forage and possibly become a substitute for the forage.

### *Type of Supplement*

For the purposes of this chapter, supplemental feedstuffs are classified as protein or energy feeds. Protein supplements are high in protein relative to other nutrients. Examples include oilseed meals (e.g., cottonseed meal, soybean meal), high-protein seeds (e.g., cottonseed, peas, soybeans), or some byproduct feeds such as fishmeal, feathermeal, and biofuel coproducts such as distiller's grains (Huston et al., 2002). On the other hand, energy supplements are low in protein relative to other nutrients. Examples include most grain crops (e.g., corn, barley) and byproducts such as sugar beet pulp or soy hulls. Realize that both supplement types contain both protein and energy; they are simply differentiated on the concentration of protein relative to energy.

In the previous scenarios, an abundance of low-quality forage was the most likely situation for a positive outcome from supplementation. For this purpose, the most common definition of low-quality forage is any forage that contains less than 7% crude protein (CP) and is high in fiber (Paterson et al., 1996). As stated previously, this can either be grazed or harvested forage. In general, 7% CP is considered the minimum in cattle diets to maintain rumen microbial function so that the fiber in forage can be digested (Leng, 1990; Van Soest, 1994). Lazzarini et al. (2009) provided recent research supporting this as the level of CP necessary to sustain microbial function for efficient utilization of fiber in low-quality forages. Another approach to defining low-quality forage is to consider the ratio of total digestible nutrients (TDN) to CP (Moore et al., 1999). Because TDN is used as a measure of energy value, TDN:CP greater than 7:1 suggests inadequate CP relative to energy that could potentially be digested from the forage. As such, Moore et al. (1999) suggested that TDN:CP > 7 be utilized as a definition of low-quality forage. By either standard, with low quality forages, protein is the first limiting nutrient because it is inadequate for both the rumen microbes and the cow, and a protein supplement should be provided. Energy is available in the fiber of the forage, but is of little use without protein to stimulate microbial growth to ferment and digest the fiber. In other words, even though other nutrients may also be deficient, protein is the first nutrient to consider supplementing, making it the first limiting nutrient.

Providing a protein supplement with low quality forage provides nitrogen so the rumen microbe population can grow. The rumen microbes digest the protein from the supplement and use the nitrogen and energy from other feedstuffs to synthesize microbial protein, which is then used to grow more rumen microbes. This large population of new rumen microbes increases the capacity to ferment the fiber, thus promoting improved fiber digestion. Not only is a greater amount of the fiber digested, but the rate of digestion and the rate that undigested feed passes out of the rumen to the lower digestive tract are also increased. The amount of low-quality forage that a ruminant animal can consume is limited by the capacity of the rumen and the rate at which the rumen empties to allow space to consume additional feed. Increasing the rate and amount of digestion and passage increases the capacity for more feed, so the ultimate effect of protein supplementation is increased intake of low quality forage. Thus, not only is the animal getting more energy and nutrients from of each lb. of feed consumed, they are also able to increase the amount eaten.

When the undigested feed leaves the rumen and passes to the lower digestive tract, the rumen microbes that digested it travel with it, ultimately being digested in the small intestine and becoming a source of relatively high-quality protein for the cow. Thus, the cows' supply of protein and energy are both augmented because the supplement caused increased nutrient utilization and intake from the low-quality forage. This increase in the energy and nutrient value of the base feed because of a supplement is called a positive associative effect. This is the hallmark of an effective supplementation program because it augments the value of the base forage asset and maximizes the "bang for the buck" invested in the supplementation program.

On the other hand, various kinds of grain are often readily available and less expensive than protein supplements. Unfortunately, response to grain-based energy supplements is the opposite, leading to a negative associative effect. In this case, feeding a high-starch energy feed that is low in protein does not support microbial protein synthesis and does not stimulate increased growth of the rumen microbial population. In fact, not only is the population not stimulated, it also shifts from fiber-fermenting bacteria to starch-fermenting bacteria, exacerbating the decrease in microbes capable of digesting fiber. Additionally, starch in grain-based supplements ferments very rapidly in the rumen, rapidly forming organic acids and lowering the pH (more acidic) in the rumen. The lower pH is toxic to fiber-fermenting bacteria, limiting their capacity to function. To make matters worse, even the fiber-digesting microbes will digest starch first and fiber later, further contributing to depressed fiber digestion. Thus extent and rate of fiber digestion and passage decrease, leading to decreased forage intake. Ultimately, even though additional energy is available from the starch, it substitutes for the lost energy from poorly digested fiber, leading to no net increase in energy intake for the cow, in addition to a continuing deficiency of protein for her.

In a classic study comparing protein vs. grain-based energy supplements, DelCurto et al. (1990a) at Kansas State University evaluated the effect of protein concentration in the supplement on forage utilization by cattle. Dormant, low-quality forage from native tallgrass prairie pasture (2.6% CP) was harvested and fed to steers in individual stalls. Weights of feed consumed and feces excreted by each steer were used to determine the influence of increasing levels of supplemental protein concentration on fiber digestion and forage intake (Table 1).

Table 1: Effect of protein concentration in supplement on forage utilization by cattle. *DelCurto et al., 1990a*

| | % Crude Protein in Supplement | | | |
|---|---|---|---|---|
| | 0 | 12 | 28 | 41 |
| Fiber Digestion (%) | 37.9 | 29.9 | 39.9 | 38.6 |
| Forage intake (%BW) | 0.9 | 0.8 | 1.4 | 1.2 |

A control group (no supplementation), and three levels of supplemental CP concentration ranging from 12 to 41% CP (mixes of soybean meal and milo grain) were compared. To achieve 12% CP, the supplement was primarily milo grain, creating a starch-based energy supplement. The middle CP concentration of 28% was a mixture of soybean meal and milo, while the 41% CP supplement was mostly soybean meal. Because soybean meal and milo grain have the same net energy concentration, all supplements provided an equal level of supplemental energy. Forage digestion of the control group that was not supplemented was low, but typical of low-quality forage. The grain-based supplement substantially depressed digestion and slightly decreased forage intake, as expected. In comparison, both the 28 and 41% CP supplements provided for augmented microbial growth, which only slightly improved digestion, but caused substantial increases in forage intake. This is one example; many other studies have consistently shown similar responses to protein vs. energy supplements.

Table 2: Effect of protein concentration in supplement on cow-calf performance. *DelCurto et al., 1990b*

| | % Crude Protein in Supplement | | |
|---|---|---|---|
| | 13 | 25 | 39 |
| Cow body weight loss (lb.) | -193 | -122 | -97 |
| Cow BCS loss | -1.8 | -1.4 | -0.7 |
| Calf birth weight (lb.) | 76.5 | 78.8 | 81.2 |
| Pregnancy rate (%) | 87 | 93 | 93 |

DelCurto et al., 1990b conducted a companion experiment to evaluate the effect of supplemental protein concentration on cow-calf performance (Table 2). Gestating cows grazed the same dormant tallgrass prairie pastures where the forage was harvested for the digestion experiment. In this case, the no-supplement control was not used because it was obvious that this would be detrimental to cow health and performance.

However, the supplements had similar CP concentrations and composition of soybean meal and milo grain as the digestion experiment. Although all cows lost body weight (BW) and body condition score (BCS) through the winter grazing period, performance was substantially improved by each incremental increase in CP. There was a small increase in calf birth weight as protein concentration increased, but there was not an increase in dystocia (calving difficulty). Ultimately, improved nutrition during gestation because of the higher levels of CP supplementation led to improved reproductive performance during the following breeding season, shown by higher pregnancy rates in the subsequent fall.

Sometimes there is a need to provide supplemental energy, such as with thin cows that need to gain weight or young cows that are still growing. In these situations, a fiber-based energy supplement should be considered. It is better to utilize high fiber feeds, such as soyhulls, sugar beet pulp, or wheat middlings, because they are high in highly-digestible fiber and contain little to no starch or soluble sugar. Thus, if provided in conjunction with a protein feed to support microbial growth, these fiber-based feeds will not depress forage digestion because there is not a shift in microbial population and no competition between starch and fiber for preferential digestion. Additionally, these feeds do not ferment as rapidly in the rumen environment as starchy grains and therefore do not create such a rapid drop in pH. Thus, fibrous by-product feeds, though high in energy, do not create the negative associative effects related to forage digestion that can be caused by high starch feeds such as corn, milo, wheat, and barley grain. These highly digestible fiber sources neither stimulate nor decrease forage digestion and intake if supplemented at reasonable levels.

A comparison of the negative effect of grain-based starch supplements vs. the neutral effect of fiber-based byproduct supplements on forage intake and utilization is illustrated in a pair of Oklahoma

State University experiments (Chase and Hibberd, 1987; Martin and Hibberd, 1990). In the study by Chase and Hibberd (1987), beef cows maintained on low quality native grass hay (4.2% CP) were fed supplements providing 0, 2.2, 4.4, or 6.6 lb/day of ground corn to determine the effect of starch-based energy supplementation on forage utilization and intake. Cottonseed meal was blended with the corn to equalize supplemental protein intake (0.56 lb/day). Both hay intake and digestibility decreased as the level of supplemental corn increased (Table 3). Digestible dry matter intake (DDMI) increased when 2.2 lb of supplemental corn was fed but decreased when 4.4 or 6.6 lb were fed. To clarify, 2.2 lb. of corn grain only slightly depressed hay intake and digestibility by a small enough amount that the additional energy provided by the corn was mostly additive beyond the digestible energy provided by the hay, as indicated by higher DDMI than hay alone. However, at the higher levels of grain supplementation, the reduction in digestible energy from the hay was greater than the additional supplemental energy from the corn grain. When the depression in hay energy value is greater than the added energy from the corn grain, overall DDMI is depressed. Thus, the energy status of the cows actually decreased as corn supplementation increased beyond the 2.2 lb. level. This occurred despite cottonseed meal being provided as a protein supplement to overcome the protein deficiency associated with the low-quality forage used in the experiment. These levels of corn supplementation were approximately equivalent to 0.25, 0.50, and 0.75% of body weight, respectively for 2.2, 4.4, and 6.6 lb of corn. McCollum (1997) stated that feeding low-protein, energy dense supplements at rates of less than 0.3% of body weight had little impact on forage intake and may sometimes slightly increase it. Once grain-based supplements exceed about 0.3% of cow body weight, negative associative effects become progressively worse as the level of grain supplementation increases. In contrast, Martin and Hibberd (1990) illustrated that feeding a highly digestible fiber supplement (soyhulls) to beef cows had minimal effect on utilization of low-quality forage (Table 4). In this study, cows were fed similar low-quality native grass hay (4.1% CP) and fed supplements providing 0, 2.2, 4.4, or 6.6 lb/day of soyhulls to determine the effect of fiber-based energy supplementation on forage utilization and intake. Cottonseed meal was blended with the soyhulls to equalize supplemental protein intake (0.97 lb/day). Hay intake peaked with 2.2 lb of supplemental soyhulls and declined as more hulls were fed. Compared to the control (0 lb soyhulls), hay intake only decreased 1.4 lb/day when 6.6 lb of soyhulls was fed. In the corn supplementation study, feeding 6.6 lb/day of corn decreased hay intake 8.1 lb/day. Soyhulls did not affect fiber digestibility of the diet. Thus, the energy from the corn grain substituted for lost energy from the straw, but energy from the soyhulls was additive to energy from the straw, providing the opportunity to add BW and BCS to cows.

Table 3: Effect of corn-based supplements on forage utilization. *Adapted from Chase and Hibberd, 1987.*

| | **Supplemental corn, lb/day** | | | |
|---|---|---|---|---|
| | **0** | **2.2** | **4.4** | **6.6** |
| Hay intake (lb/day) | 19.3 | 18.0 | 14.1 | 11.2 |
| Hay intake (% BW) | 2.30 | 2.14 | 1.66 | 1.32 |
| Hay OM digestibility (%) | 36.5 | 35.1 | 23.6 | 18.9 |
| Digestible DM intake, lb/day | 7.8 | 8.6 | 7.3 | 7.5 |

Table 4: Effect of soyhull-based supplements on forage utilization. *Adapted from Martin and Hibberd, 1990.*

| | **Supplemental corn, lb/day** | | | |
|---|---|---|---|---|
| | **0** | **2.2** | **4.4** | **6.6** |
| Hay OM intake (lb/day) | 21.4 | 22.3 | 21.6 | 20.0 |
| NDF OM digestibility (%) | 47.7 | 46.8 | 46.7 | 48.1 |
| ADF digestibility (%) | 41.6 | 41.4 | 42.0 | 44.1 |

Even with these digestible-fiber byproduct feeds, supplementation above some level will result in the animal substituting the supplement for the available forage, which will result in a higher cost to the producer. The substitution effect occurs if the supplemental feed is fed at a high enough level to reduce space in the rumen to the point that it limits forage intake. If this occurs, the total energy intake may stay the same or decrease, which will not meet the goals of a supplementation program. The level of supplement that will cause substitution depends on forage protein content, level of protein in the supplement, type of energy source, and feeding rate (Mathis, 2003).

## *Characteristics Of Various Potential Supplemental Feedstuffs*

The next question to consider is: **Which feedstuffs will serve as the correct type of supplement that provides the correct nutrient source?** Examples of several feedstuffs that are commonly available in South Dakota are provided in Table 5 to further illustrate differences in CP and energy content of potential supplements (for more information see Chapter 19: Taking Advantage of Alternative Feeds). Energy content is represented in this table as total digestible nutrients (TDN) which is a common measure provided on a feed test. Notice that all of these feeds have relatively high TDN values, meaning they are sources of high energy. However, there is wide variation in CP content. The oilseed meals at the top of the table are examples of high CP feeds. The byproduct feeds in the center of the table are mid-level sources of CP that can also be considered as protein supplements to use with low-quality forages. The final items at the bottom of the table are energy feeds with lower levels of CP. Again, knowing whether the energy in a feedstuff is from starch, fiber or something else is important in determining their value as a supplement for low-quality forages. For the examples in Table 5, the obvious high-starch feedstuff to avoid is corn grain. Also, be somewhat cautious with peas because about half of their energy value is from starch, with the other half from highly digestible fiber.

Table 5: Typical crude protein (CP) and total digestible nutrient (TDN, a measure of energy content) of common examples of potential supplemental feedstuffs (DM basis).[1]

| Supplemental feedstuffs | CP (%) | TDN (%) |
|---|---|---|
| Soybean meal | 49 | 84 |
| Cottonseed meal | 46 | 77 |
| Distiller's grains | 31 | 96 |
| Wheat middlings | 17 | 75 |
| Corn gluten feed | 23 | 80 |
| Cull field peas | 23 | 85 |
| Corn grain | 9 | 88 |
| Soyhulls | 12 | 74 |
| Sugar beet pulp | 9 | 76 |

[1] CP and TDN values are from the 2015 Feed Composition Table: (http://beefmagazine.com/nutrition/2015-feedcomposition-tables-know-nutritional-value-your-feed).

## *Comparative Pricing Of Potential Supplemental Feedstuffs*

The next question to consider is: **Which is the most cost-effective feedstuff to use as the supplement of choice?** If protein is the limiting nutrient, then pricing to determine the best price per unit of protein would be appropriate. To price supplements on an equal CP basis, one needs to adjust for differences in feed price, CP content, and moisture (or dry matter) content. Examples are provided in Table 6. The cost per unit of CP is calculated by dividing the price of the feedstuff by the DM and CP contents in decimal form (e.g. soybean meal CP $/ton = $500 ÷ .89 ÷ .49 = $1147). It is best to use the most accurate values for DM and CP for the feedstuffs being considered as possible. While table values are available (e.g. BEEF magazine's annual Feed Composition Table)), they are averages and usually do not take variability that naturally exists in feedstuffs into consideration. A given lot of feed can vary considerably from book values. Laboratory test values on the actual lot of a feedstuff under consideration are much better to use. The labeling of nutrient content on manufactured feeds, such as cubes, pellets, pressed blocks, cooked molasses tubs, and liquid feeds is regulated by law. They must list minimum inclusion of various nutrients, but are not required to list DM content. Using the minimum on the label is appropriate for calculations described herein. Using the best reasonable DM content that can be found is also appropriate. Based on the example in Table 6, the best bargain is wet distiller's grains with solubles (WDGS) at $694 per ton of CP. Realize that feed prices are highly variable and that these calculations should be updated as needed to reflect current local prices. Also realize that these prices were determined at the time of this writing at local points of purchase in South Dakota and therefore do not include delivery costs to a given producer's operation. Cost of delivery can become an issue when feedstuffs are available at different locations or when feedstuffs have dramatically different moisture content. Consider that taking delivery on WDGS vs. DDGS means that there is a 55% difference (91 – 36% DM) in the amount of water that is being delivered. The further the distance from the ethanol plant, the more costly transportation of this water becomes. In the case of comparing wet or dried distiller's grains (or any other feedstuffs varying in moisture content), one should calculate the cost of delivery per unit of dry matter (Table 7). As indicated the cost of delivery per ton of DM per mile more than doubles ($0.22 vs. $0.57 per mile for dried vs. wet, respectively). It costs a lot to haul water! Even though the cost per ton of DM of WDGS was nearly $50 less than DDGS, the increased cost of trucking would consume that savings in about 143 miles (the breakeven mileage). This breakeven is calculated as the difference in cost per DM of the feedstuffs divided by the difference in delivery cost per mile (i.e. [264 - 214] / [.57 - .22]). In other words, using these costs, if a producer takes delivery within about 140 miles of the ethanol plant, then they get better value purchasing WDGS. However, if they take delivery further than 140 miles from the plant, they should purchase DDGS because it becomes the best value on a ton of **delivered** CP basis.

Table 6: Examples of calculating cost per ton of crude protein (CP) for various potential protein supplements based on prices on the spot market at the time of writing and typical dry matter (DM) and CP content for each feedstuff.

| Supplemental feedstuffs | Feed $/ton | DM (%) | CP (%) | CP $/ton |
|---|---|---|---|---|
| Soybean meal[1] | 500 | 89 | 49 | 1147 |
| DDGS[1] | 240 | 91 | 30 | 879 |
| WDGS[1] | 75 | 36 | 30 | 694 |
| Alfalfa hay[1] | 175 | 89 | 17 | 1157 |
| 20% range cake[2] | 300 | 85 | 20 | 1765 |
| 30% cooked molasses tub[2] | 960 | 95 | 30 | 3368 |

[1] DM and CP values (on a DM basis) for soybean meal, DDGS, WDGS, and alfalfa hay are from the 2015 Feed Composition Table (beefmagazine.com.)
[2] CP values of 20% or 30% are based on labels from common manufactured feeds, wherein the value indicated is the minimum in the product, as required by feed label regulations. DM values are often not provided on these products because that is not required by feed label regulations. Values listed for DM are typical for these products based on author knowledge.

Table 7: Calculation of cost of delivery on a dry matter basis.

| | Distiller's grains | |
|---|---|---|
| | Dried | Wet |
| Cost per ton, as is | $240 | $75 |
| Dry matter content (%) | 91 | 35 |
| Cost per ton of DM | $264 | $214 |
| Trucking cost per loaded mile | $5 | $5 |
| Truck payload (tons) | 25 | 25 |
| $ per ton (as is) per loaded mile | $0.20 | $0.20 |
| $ per ton of DM per loaded mile | $0.22 | $0.57 |

## *Cost-Saving Alternatives For Protein Supplements*

A final question to consider is: **What other opportunities exist to maximize value of the supplement through cost savings?** Protein feeds are almost always higher priced than energy feeds. A couple of alternatives to consider that may reduce the cost of protein supplementation are using nonprotein nitrogen (NPN, e.g. urea) or alfalfa hay as sources of CP for ruminants.

## *Urea in protein supplements for ruminants*

Rumen microbes can use many sources of nitrogen to form microbial protein so they can grow more of themselves. In fact, they digest as much feed protein as they can and use the nitrogen from it to build microbial protein. Urea is inexpensive and is a highly soluble source of nitrogen that is usable by the microbes as long as they have adequate carbohydrates available to serve as the rest of the structure of the microbial protein they build. Thus, urea is regularly used as an ingredient in commercial protein feeds for ruminants such as pellets, blocks, tubs, and liquid feeds. However, there are limitations on how much urea can effectively be used in combination with low-quality forages. Because urea is highly soluble in the rumen, the nitrogen is released very quickly when it is consumed. However the carbohydrates in the fiber of the forage are digested and released slowly, so only a certain amount of the nitrogen from urea can be utilized before it escapes. Thus, urea should be used as only a portion of the CP in protein supplements for low-quality forages, with the rest being from actual protein. The responses in Table 8 indicate that up to 40% of the CP in the supplement can be from urea with little effect on forage digestion or intake, however there was slightly poorer cow performance at the 40% urea level. Other studies, such as Clanton (1978), have shown that declines in forage utilization and cow performance can be expected at levels of urea greater than 30% of the supplemental CP. Therefore, it is recommended that 30% or less of supplemental CP be provided as urea. In general, nonprotein sources (urea) are more effective in stimulating diet utilization under one or more of the following conditions: > 0.5% of BW concentrate is being fed, dietary protein is marginally deficient (1 to 3% gap), a blend of plant protein and non-protein nitrogen sources are used, and supplemental protein is provided in a form for animals to access more than once per day (Lalman, 2008).

Table 8: Effect of urea substitution in protein supplements. *Köster et al., 2002*

| | Urea, % of CP | | |
|---|---|---|---|
| | 0 | 20 | 40 |
| Forage digestion (%) | 48.5 | 47.8 | 49.5 |
| Forage intake (%BW) | 1.1 | 1.1 | 1.1 |
| Cow BCS change | -0.3 | -0.2 | -0.4 |
| Pregnancy rate (%) | 92.6 | 100 | 86.2 |

### *Alfalfa hay as a protein supplement*

Although we typically think of concentrate feedstuffs as being most appropriate to consider using as supplements, high-protein forages such as legumes can be very effective as sources of supplemental protein. As an example, DelCurto et al. (1990c) conducted a study that compared alfalfa as either long-stem hay or dehydrated pellets (both 17% CP) to a 25% CP range cake based on soybean meal and milo grain. These feedstuffs were allotted to provide equal levels of supplemental CP and metabolizable energy to steers in a digestion trial or to gestating beef cows grazing low-quality, dormant winter range. These supplements were fed 0.48, 0.70, and 0.67% of body weight, respectively, for cake, alfalfa hay, and alfalfa pellets. Forage digestion and intake by steers in the digestion trial, as well as cow BW and BCS responses were similar across all sources of supplemental protein (Table 9). Pregnancy rate after the subsequent breeding season was actually slightly higher for the alfalfa-supplemented cows. Not only was alfalfa a valuable source of supplemental protein, it was as effective when fed as baled hay as when it was dehydrated, ground and pelleted to make it more “concentrated”. Keep in mind that this hay was not fed free-choice. These cows were only provided a small amount of alfalfa (about 6.5 lb) as a supplement. An additional study indicated that different qualities of alfalfa hay were equally effective as long as the amount was adjusted to provide equal levels of CP (Weder et al., 1999). Thus, alfalfa hay should be considered when choosing what source of supplemental protein is most economical. Alfalfa hay was not the most cost effective alternative in the example in Table 6 because it was very expensive at the time of this writing, but has often been the best-value alternative when hay prices were at historic norms.

Table 9: Comparison of alfalfa as a protein supplement to a soybean meal/milo grain based range cake for beef cows grazing dormant winter range. *DelCurto et al., 1990c*

| | Soybean meal/milo | Alfalfa hay | Dehydrated alfalfa |
|---|---|---|---|
| Fiber digestion (%) | 48.5 | 52.6 | 45.8 |
| Forage intake (%BW) | 1.1 | 1.1 | 1.2 |
| Cow body weight loss (lb.) | -111 | -121 | -58 |
| Cow BCS loss | -0.9 | -1.1 | -0.8 |
| Pregnancy rate (%) | 88 | 96 | 97 |

## Summary

Feed costs are always the largest costs associated with cattle production. In cow-calf operations, the base forage is a major ranch asset that must be used as effectively as possible to provide most of the nutrient needs of the cow herd. Supplemental feeds are typically off-ranch imports that require a cash outlay. As a variable cost, it is imperative that their purchase and use be carefully managed to ensure that they are used to augment cattle response to the use of the base forage asset. This approach will maximize cost effectiveness from both the base forage and the supplement.

The most likely scenario for cost-effective supplementation is when there is abundant low-quality forage available, whether it is dormant range or pasture, or harvested feedstuffs such as crop residues. In this scenario, protein is the first limiting nutrient and a protein supplement will create a positive associative effect, meaning it will enhance the value of the low-quality forage by increasing the protein and energy intake of the cow. If additional energy beyond the enhancement to the value of the low-quality forage is needed, then a fiber-based feedstuff should be considered as an energy supplement to avoid the negative associative effect caused by starch-based energy feeds such as cereal grains because starch reduces digestion and utilization of the base forage.

## References


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