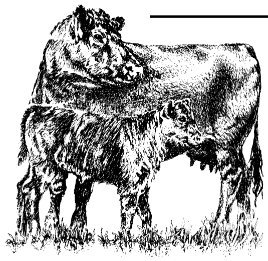

Western Beef Resource Committee

Cattle Producer's Library

Nutrition Section CL318

Supplementation Strategies for Grazing Beef Cattle

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In grazing operations, there are times when forage quality and availability are limited and ruminants are unable to consume enough nutrients from pasture forage to fulfill requirements. During such situations supplemental feeding is necessary to meet production goals.

Numerous commercial feed supplements are available to producers, who have an unlimited number of options for the development of custom supplements. It may be difficult to decide which supplement type (i.e., energy, protein, etc.) best fits the goals of the livestock production system.

A fundamental understanding of ruminant nutrition is helpful in making these decisions. It is also important to choose a delivery method that provides the targeted amount of desired nutrients to each animal in the herd and minimizes input costs.

The objectives of this publication are to aid producers in deciding the supplement type needed for grazing beef cattle and to describe the characteristics of supplement delivery methods.

General Ruminant Nutrition

Ruminants are different from pigs and humans in that they have a rumen that allows for fermentation of ingested feedstuffs before it reaches the stomach (called the abomasum in the cow). The rumen provides an optimal environment for the existence and growth of microorganisms.

Rumen microorganisms have their own nutrient requirements. To fulfill these requirements they "break down" or digest feed consumed by the animal and use it for energy to support microbial growth. At the same time, rumen microorganisms release volatile fatty acids that are used by the ruminant as the major source of energy (calories).

The bodies or cells of the microorganisms eventually pass out of the rumen. Once they reach the small intestine they can be digested by the ruminant, and since these cells contain approximately 50 percent protein, they contribute to the protein supplied to the animal.

This symbiotic relationship allows ruminants to utilize forages much more efficiently than nonruminants. However, this relationship also adds to the complexity of predicting and effectively meeting the nutrient requirements of ruminant animals.

Ruminants must have energy to survive; nevertheless, it is the microorganisms in the rumen that must "unlock" (digest) the energy in the forage to make it available to the ruminant. In order to digest forage, the microorganisms must have nitrogen that is primarily found in protein. Generally, when protein is supplemented to grazing cattle it is to ensure that the rumen microbes have enough nitrogen to digest forage efficiently.

The availability of forage and its chemical composition (primarily crude protein content) are the first factors that must be considered in developing an effective grazing nutrition program. If the objective is to meet the nutrient requirements as economically and efficiently as possible, the first limiting nutrient must be identified and supplemented in a cost-effective manner. The decision to feed a protein supplement, energy supplement, or a combination supplement, should be dependent on forage supply, protein content, and cow body condition.

Protein Supplementation

The primary factor limiting cattle performance on forage diets is energy intake. However, intake of mature or dormant forages is often limited because these forages have an inadequate amount of crude protein. An

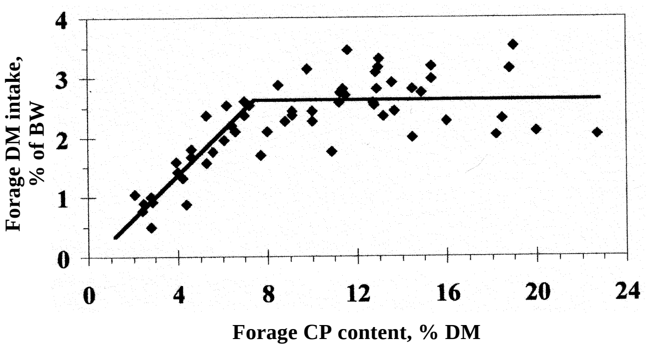

Fig. 1. Forage dry matter (DM) intake relative to the forage crude protein (CP) content. (Adapted from Moore and Kunkle, 1995)

example of the relationship between crude protein content of forages and forage intake is presented in Fig. 1.

Intake declines rapidly as forage crude protein falls below about 7 percent, a relationship attributed to a deficiency of nitrogen (protein) in the rumen that limits microbial activity. For example, in Fig. 1, at a crude protein content of 5 percent, forage intake is about 1.6 percent of body weight. However, when forage crude protein is 7 percent, forage intake is 44 percent higher at about 2.3 percent of body weight.

Because forage is the primary source of energy, improved forage intake boosts energy intake and demonstrates why correcting a protein deficiency is usually the first supplementation priority. Protein supplements not only stimulate forage intake but may enhance the microbial digestion of forage as well. When the benefits of improved forage intake and improved digestion are combined, it is evident that energy intake can be greatly enhanced.

In Table 1, the estimated impact of protein supplementation on energy status of a 1,200-pound cow is shown. Forage intake increased 31 percent in response to 2 pounds of protein supplement, resulting in a 49 percent increase in total digestible nutrients (TDN; an estimate of energy) intake by the cow.

The forage crude protein content threshold below which an intake response is observed varies with forage type and with the individual animal used for evaluation.

Table 1. An example of the impact of protein supplementation on the energy status of a 1,200-pound cow.[a]

	Unsupplemented	Supplemented	Increase, %
Forage crude protein, %	5	5	
Forage TDN[b], %	45	45	
Supplement CP, %		42.	
Supplement TDN, %		76	
Supplement intake, lb		2.0	
Forage intake, lb	19.0	25.0	+31
Total daily intake, lb	19.0	27.0	+42
Total diet CP, %	5.0	7.7	
TDN intake, lb	8.6	12.8	+49

[a]Adapted from McCollum 1997.
[b]Total digestible nutrients.

Table 2. Average improvement in low-quality forage intake in response to various concentrations of crude protein.

Supplement protein content, %	Improvement in forage intake above unsupplemented, %
Less than 15	3
15 to 20	10
20 to 30	21
Greater than 30	44

Heldt 1998.

Evidence of this variation in intake level among forages with similar crude protein content is seen in Fig. 1. However, 7 percent protein is a useful guideline to follow when evaluating the potential for an intake response to protein supplementation.

Numerous commercial protein supplements are available, with the majority ranging from 15 to 40 percent crude protein. A review by Heldt (1998) categorized supplements based on the protein content to evaluate the impact of supplementation on low quality forage (< 7 percent crude protein) intake (Table 2). Therefore, if the objective is to optimize intake and digestion of low-quality forages, supplements should contain more than 30 percent crude protein, although, supplements containing less than 30 percent crude protein may still yield a slight enhancement in forage intake.

Energy Supplementation

When protein needs are met, performance may still be limited by inadequate energy intake. This situation may occur during periods of high nutrient requirements or when forage availability is low. Most energy limitations can be managed with proper gazing management. However, directly increasing energy intake with an energy supplement (low protein, high energy) may be cost-effective in some scenarios. Energy supplements typically cost less per ton than protein supplements, but the responses to energy supplementation can be variable, making results less predictable.

A common result of feeding supplemental energy sources is the "substitution effect." Substitution occurs when the supplemental feed reduces forage intake. One of the chief concerns when providing energy supplements to grazing beef cows is the starch content of the supplement.

Research has demonstrated that when high starch supplements (i.e., corn, grain sorghum, wheat, barley, etc.) are fed to cattle consuming forages (especially when protein is deficient), forage intake and digestion are often suppressed, ultimately reducing the energy derived from the basal forage diet. Therefore, to truly "supplement" energy to grazing cattle, highly digestible fiber sources (i.e., soyhulls, wheat bran, wheat middlings, and corn gluten feed) are generally most desirable.

Anytime substitution occurs, the energy intake of the animal may not be increased to the desired level because of a concomitant reduction in forage intake. As a general rule, 1 pound of an energy-dense feed reduces forage dry matter intake by 0.5 to 1 pound. Feeding high levels of hay may also result in substitution.

As the amount of hay fed daily increases, forage intake from the pasture will decrease because hay will replace pasture forage. Generally, a pound of hay replaces about a pound of pasture forage.

Deciding What Percent Protein to Feed

Supplemental feeds for livestock are often classified as energy or protein supplements by considering the percentage protein alone. This is because the primary feedstuffs used in supplements are generally between 75 and 90 percent TDN, yet the protein content of the high protein feedstuffs, such as cottonseed meal or soybean meal, are three- to five-fold higher than grains such as corn and milo.

Because of this relationship, the primary difference in nutrient content of a 20 percent and 40 percent protein supplement is the protein concentration, not energy. Thus, supplements are often categorized as protein or energy supplements based on the protein content alone.

Developing a cost-effective supplementation program is dependent upon identifying the nutrient most limiting to productivity and providing the limiting nutrient(s) at the lowest cost (for more information on supplement pricing, see CL309).

If protein is deficient (i.e., < 7 percent crude protein), supplements should be evaluated based on cost per pound of protein. Similarly, if forage supply is limited and energy is deficient, supplements should be evaluated based on cost per pound of TDN (energy). Sometimes both energy and protein are limiting, so a balanced approach to provide supplemental protein and energy is recommended.

Generally, high protein feedstuffs are more expensive than grains or energy byproducts. Since high protein feedstuffs are more expensive per ton, they are more expensive than low protein supplements. However, it is critically important to evaluate potential supplements based on cost per unit of nutrient needed.

Fig. 2 provides a simple guide to using forage quality (protein content; estimated based on color), supply, and cow condition to help decide what percent protein is needed in a supplement. This decision guide may be useful in developing a low-cost supplementation program but is only a general guide and is not as accurate as measuring actual forage quality and quantity to develop a strategic supplementation program for a specific class of cattle.

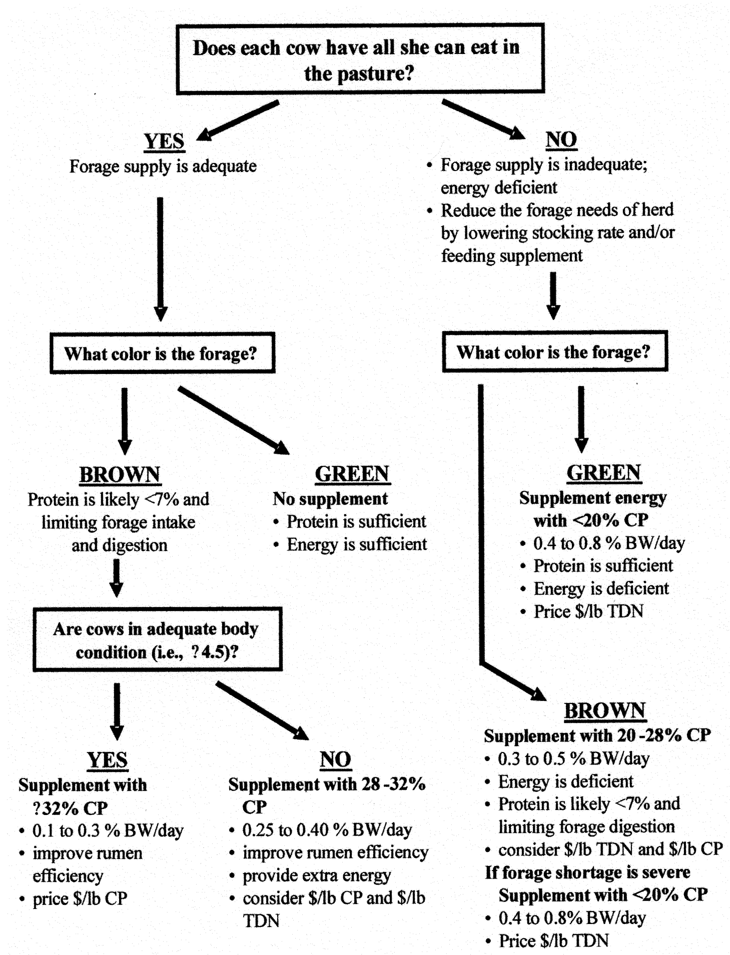

Fig. 2. Beef cow supplement decision guide.*

*This decision guide is a general tool and is not as accurate as measuring actual forage quality and quantity to develop a strategic supplementation program for specific class of cattle.

Frequency of Supplementation

Feeding frequency (daily vs. three times per week vs. once a week) of some supplements may affect animal response. Feeding smaller amounts of protein or energy supplements more frequently decreases the potential for negative impacts on forage intake. However, scientists at New Mexico State University and Texas A&M University have shown (Table 3) that hand feeding high-protein supplements once a week results in no significant reduction in performance when

Table 3. Comparison of supplementing the same total amount of cottonseed cake (41% CP) to yearling heifers once weekly vs. three times weekly during the winter-spring dormant season of two consecutive years.

Component	Year 1		Year 2	
Times fed/wk	1	3	1	3
Amount fed/feeding, lb/hd	6.9	2.3	10.5	3.5
Protein fed/feeding, lb/hd	2.8	.95	4.3	1.43
No. of heifers/treatment	43	40	27	18
Average initial weight, lb	495	495	502	491
Average daily gain, lb	.50	.47	.34	.37
Conception rate, %	93	90	89	89

Adapted from Wallace and Parker 1992.

Table 4. Comparison of grain cubes for supplementing energy to yearling heifers either daily or twice weekly for 156 days during the winter-spring dormant season.[a]

Component	Trial 1	Trial 2
Times fed/wk	2	7
Amount fed/feeding, lb/hd	6.40	1.83
TDN fed/feeding, lb/hd[b]	5.32	1.52
No. of heifers/treatment	32	32
Average initial weight, lb	544	539
Average daily gain, lb	-0.03	0.14
Conception rate, %	68	94

[a]Adapted from Wallace and Parker, 1992.
[b]Total digestible nutrients.

compared to feeding supplement three times per week (Wallace and Parker 1992) or daily (Huston et al. 1999). Additionally, transportation and labor costs are reduced with less frequent distribution.

New Mexico State University researchers have also demonstrated (Table 4) that heifer performance (weight gain and conception rate) significantly declined when the frequency of energy supplementation was decreased from daily to twice per week (Wallace and Parker 1992). These findings indicate that protein supplements (i.e., ≥ 30 percent crude protein) can be delivered as infrequently as once or twice per week, while energy supplements (≤ 20 percent crude protein) should not be fed less frequently than every other day.

Supplement Delivery

To efficiently meet production goals, it is important to choose a delivery method that provides the targeted amount of desired nutrients to each animal in the herd. Ideally, this is achieved with a minimum of input costs for labor, equipment, and supplemental feed. A variety of factors influence the usefulness of a particular delivery method.

Hand-Feeding vs. Self-Feeding

Supplement delivery methods may be broadly classified as self-fed or hand-fed systems. Hand-feeding implies that the supplement is regularly delivered to the animals in a form and amount that is immediately consumed. Self-fed supplements are made available in bulk amounts at infrequent intervals, with the expectation of continuous, low-level consumption by livestock.

Self-fed supplements are designed to limit intake so that animals consume only small portions of the available feed at each meal. Intake may be limited by the supplement's physical form (e.g., tubs or blocks), a palatability factor (salt, phosphoric acid, etc.), or a combination of these methods.

Self-fed supplements have several advantages. They can reduce labor costs because delivery times are designed to be less frequent than hand-feeding. However, if livestock are checked at times other than feeding, the savings in labor and associated costs may be less than expected.

Table 5. Labor cost comparison of hand-fed and self-fed supplements for one week.

	Feeding frequency			
Item	Daily	3X per week	1X per week	Self-fed[a]
Vehicle cost[b]				
Feeding, $	75.60	32.40	10.80	0
Checking cows[c], $	0	0	10.80	21.60
Labor cost				
Feeding[d], $	126.00	54.00	18.00	0
Checking cows[e], $	0	0	13.50	27.00
Total daily cost				
Vehicle, $	75.60	32.40	21.60	21.60
Labor, $	126.00	54.00	31.50	27.00
Total weekly cost, $	201.60	86.40	53.10	48.60

[a]Self-fed supplement delivered to the pasture by the feed dealer.
[b]Vehicle cost of $0.36/mile; assume 30-mile round-trip.
[c]Assumes cows are checked a minimum of twice weekly.
[d]Labor cost of $9/hr. Feeding requires 1 hr driving and 1 hr feeding.
[e]Checks require 1 hr driving and 0.5 hr observing cows.

For supplements that are targeted for more than a pound per day consumption, weekly delivery may still be required due to lack of feed bunk volume or the desire to keep feeds fresh. If supplements are to be consumed at low amounts (e.g., mineral supplements), then self-feeding may be most cost effective.

Another advantage of self-feeding systems is that animals can consume supplement every day. This is mainly an advantage with energy or mineral supplements, which are most effective when delivered daily, and less important for protein supplements that can be delivered as infrequently as once or twice per week. Therefore, when supplementing protein the labor required for hand-feeding can be similar to self-feeding (Table 5).

Based on this comparison, if a self-fed protein supplement costs significantly more than a hand-fed supplement, any labor cost savings may be offset. However, for energy or mineral delivery (which require every day or alternate day feeding), self-fed supplements may be more economical even at a higher price per ton because both labor and transportation costs are reduced.

Furthermore, in rough or poorly accessible areas, self-fed supplements may be the only viable solution since the producer may have limited ability to deliver feed to the animals.

Supplemental feeds are designed to provide a given level of nutrients to each animal in the herd. Much of the variation in response to supplementation programs has been attributed to variation in supplement intake by individual animals (Huston 2000).

Researchers at Montana State University compiled intake data from both sheep and cattle under a wide variety of environments and supplement formulations. Their results indicated that 5 percent of hand-fed animals failed to consume any supplement, while 19 percent of self-fed animals did not consume any supplement (Bowman and Sowell 1997).

The total variation in supplement intake was twice as high for self-feeding compared to hand-feeding. This may result in substantial variation in response to a supplemental feeding program since many animals fail to consume the targeted amount, while others consume in excess.

Intake variation also occurs with hand-fed supplements, but the variation is generally less dramatic. Depending on the acceptance of the supplement and the effectiveness of the intake limiter, more variation in animal performance may occur with self-fed supplements. Supplement intake variation depends on factors unique to each operation. However, producers should be aware of the potential for larger variability in self-fed supplement intake, and therefore, more variability in performance responses to self-fed supplements.

Hand-feeding is often used as a method to control livestock location and movements. This may be an advantage or a disadvantage, depending upon circumstances. When animals become accustomed to coming to a vehicle and receiving feed, they may be easier to gather and/or check. However, on public land or private land with easements, animals may begin following all vehicles, which can be a problem. In this situation, self-fed supplements may be more desirable.

Supplement Form

The practicality of supplement delivery systems on a particular ranch is often strongly influenced by the form (e.g., cube, block, liquid, tubs) of the supplemental feed. The various forms of supplements each offer advantages and disadvantages. This section will cover the forms of supplements available, how they are fed, and important considerations for producers regarding each form.

Dry feeds are primarily composed of dry ingredients (some dry feeds include a small amount of molasses to improve palatability and binding characteristics) combined to meet nutrient specifications. These feeds may be further processed into various forms or left as an unprocessed mix (meals).

A potential advantage of all dry feeds is flexibility in formulation. Once nutrient specifications are determined, a formulation based on the least cost combination of ingredients can be created to minimize cost. For example, if cottonseed meal becomes expensive, then another protein source such as sunflower meal might be easily substituted into the formula. Individual types of dry feeds also offer some advantages and disadvantages.

Cubes/Cake/Pellets—Cubes, cake, or pellets all refer to essentially the same feed form. Cubes, the most common form of dry feed used for hand-fed range protein supplements, are available in a variety of sizes (5/8-inch to 1-inch; round or octagonal). They may be ordered in bulk for distribution by a bulk feeder or purchased in sacks.

Bulk feeds reduce the labor associated with handling and often reduce the unit price of the supplement, but they require a relatively large initial investment in storage and equipment. Pellet feeding allows some control over livestock distribution, as animals can usually be enticed to a desirable feeding area. Cubes often are fed on the ground, which can be difficult in snow or mud.

For hand-fed supplements, cubes usually have the lowest variation in supplement intake by animals (Bowman and Sowell 1997). This is especially evident when feed is provided three or fewer times per week (Huston 2000).

A few manufacturers offer self-fed cubes that include an intake limiter (usually salt). As with other self-fed supplements, a feeder is required. This type of self-feeding system may be acceptable under some conditions. However, animals may develop a tolerance for the intake limiter and increase intake over time. With self-fed cubes, it is difficult for producers to adjust intake by adding salt, because particle size differences will result in sorting.

Blocks—Blocks are generally dry ingredients in a pressed or extruded form and are essentially large cubes (33.3 to 50 pounds). These blocks offer similar advantages for formulation flexibility as other dry feeds. Blocks offer an intermediate option between a true self-fed system and a hand-fed system. They can be manufactured with varying degrees of hardness to influence supplement intake.

Harder blocks reduce intake, while softer blocks allow greater intake. Depending on the targeted intake amount, proper hardness can be determined, and the blocks can be used as a self-fed supplement. Blocks that are excessively hard may result in poor consumption or even tooth damage and loss, while extremely soft blocks may encourage over consumption of supplement.

Regardless of the delivery frequency, old blocks should be completely eaten before the new ones are delivered to ensure adequate nutrient intake. Individual animal consumption of blocks may be more variable than cubes or meals of the same formulation (Kendall et al. 1983). However, the number of non-eaters is still relatively low and similar to cubes (Bowman and Sowell 1997). In principle, block feeding allows more timid animals the opportunity to consume the supplement, since they can wait until other animals have left the feeding area.

The compact size and shape of blocks may make handling easier, often reducing labor and mileage requirements. For example, if more blocks can be loaded than cubes, then producers may not need to return to the storage site when delivering feed to several areas of the ranch.

Liquid Feeds—Liquid feed use has grown significantly in the past 20 years. Liquid feeds for pasture use are almost exclusively self-fed products and have many of the same advantages and disadvantages of other self-feeding systems. Many liquid feed dealers offer a delivery service, which can eliminate the labor and handling requirements associated with supplementation (as shown in the Table 5).

However, feed dealers account for their delivery cost when pricing these products so that ranchers must carefully examine the cost of labor and cost per unit of nutrient delivered to assess the value of this delivery form. Pricing of these supplements must be done on a DM basis in order to account for differences in moisture content of liquid compared to dry supplements.

A potential drawback with liquid feeds is the limited number of ingredients that can be utilized in formulations. While this may stabilize prices, it also reduces the opportunity to take advantage of less expensive commodities.

Although suspension technologies are improving, it is still difficult to incorporate many dry ingredients into liquid feeds. Therefore, most protein sources used in liquid feeds contain a high proportion of non-protein nitrogen and highly soluble natural proteins.

Non-protein nitrogen (NPN) sources such as urea or liquid fermentation byproducts may provide an excellent opportunity to reduce overall feed costs by 5 to 15 percent. It is important to remember that the utilization of NPN may be limited with low quality diets (NRC 1985). Non-protein nitrogen occurs naturally in many feedstuffs (an example is lush pasture, such as wheat) and is well utilized in the rumen if adequate energy is present in the diet.

New technology in liquid feed formulations has increased the availability of feeds with a high proportion of added fat, a high-quality energy source. Although small amounts of fat can be added to dry supplements, liquid feeds can incorporate a higher fat concentration. This may make liquid feeds attractive energy supplements, especially when the reduced labor requirement of liquid supplements is compared to daily delivery of dry energy supplements.

As with other self feeding systems, liquid supplement intake is more variable than that of hand-fed supplements. When data from several studies of group-fed animals were compiled, the percentage of animals that did not eat any liquid feed ranged from 17 to 49 percent (Bowman and Sowell 1997).

In a New Mexico State University trial conducted over 2 years, 17 percent of the cows did not consume any liquid supplement. Supplement intake ranged from 0 to 5.4 pounds per day (Pulsipher 2000), which is consistent with the ranges reported in other studies. This indicates that while the average performance of a herd may be similar among liquid feeds and dry feeds, the uniformity of individual animal performance response may be lower with liquid supplements. Very few research trials have attempted to directly address this question.

Tubs—Hardened molasses blocks are often referred to as "tubs" or "soft-pours" and share some characteristics with both blocks and liquid feeds. This type of supplement is generally made from a molasses base, such as a liquid feed, but is cooked or chemically hardened to create a block-type feed packaged in steel, plastic, or fiber containers. These supplements can incorporate a higher percentage of dry ingredients than liquid feeds. Due to the amount of molasses in the formulation, tubs typically have lower amounts of dry feedstuffs than pressed blocks.

Tubs are self-fed supplements. As animals lick the tub, saliva softens the surface and allows the animals to scrape off the softened portion. Intake is dependent on the rate of softening. Harder tubs are designed for slower consumption (lower intake) and do not soften easily. However, increasing block hardness to reduce intake of molasses blocks also increases intake variability (Kendall et al. 1983). When compared with hand-fed dry supplements or liquid feeds under a variety of conditions, molasses blocks had the highest variation in individual animal intake (Table 6; Bowman and Sowell 1997).

Molasses tubs are more environmentally resistant than pressed blocks; therefore, tubs can be delivered less frequently. These tubs generally are between 125 to 250 pounds. However, since livestock must be checked periodically, the total labor cost associated with feeding tubs may not be significantly less than feeding dry supplements once per week.

Conclusions

Supplemental feeding accounts for a significant economic input to most beef production enterprises. It is important that money is only spent on nutrients that are limiting animal performance. There are many approaches to strategically providing supplemental nutrients.

The primary considerations when purchasing or formulating supplements for grazing cattle are estimating and budgeting forage supply and estimating or measuring forage crude protein content. Although not all forages and cattle will respond the same to supplementation, the "Beef Cow Supplement Decision Guide" (Fig. 2) may

Table 6. Intake variability and proportion of non-eaters of hand-fed dry cubes or blocks and self-fed tubs or liquid supplements.[a]

Item	Hand-fed dry cubes or blocks	Self-fed tubs or liquids
Intake range, lb[b]	0 – 3.5	0 – 5.5
Non-eaters, %	5	19

[a]Adapted from Bowman and Sowell 1997.

[b]Based on target consumption of 2 lb/hd/day. Estimated intake range includes the middle 97% of animals consuming supplement (some extremes may occur).

serve as a beneficial tool to help producers determine what percent protein supplement amount might be most cost-effective.

A variety of supplement types are available to livestock producers. The most efficient and effective supplement delivery system depends on individual circumstances and may vary from ranch to ranch. For energy and mineral supplementation, self-fed delivery methods are probably more labor efficient since these supplements should be consumed daily or every other day.

With energy supplements, large quantities are usually supplied, and even with self-fed supplements the supply may need to be replenished frequently. When feeding protein supplements, less frequent feeding (once or twice a week) can be as effective as daily delivery, and labor costs may be reduced to levels similar to that of self-fed supplements with less intake variation.

Cubes, blocks, tubs, and liquids have different advantages and disadvantages. The overall benefit of using a particular supplement form depends on the individual situation. Supplement delivery methods and forms can be ranked (1= best) based on several different criteria:

Intake variability:

1. Hand-fed (cubes and blocks)
2. Self-fed (tubs and liquids)

Flexibility of least cost formulation:

1. Cubes
2. Blocks
3. Tubs
4. Liquid feeds

Labor associated with delivery:

1. Liquid feeds (dealer filling feeders)
2. Tubs
3. Blocks
4. Cubes (hand-fed)

The primary goal of any supplementation program is to deliver targeted amounts of specific nutrients in a uniform and consistent manner to generate predictable results. Variability in supplement intake is a major cause of variable performance responses to a supplemental feeding program. Some systems may deliver nutrients more precisely, but the costs and benefits of each system should be evaluated.

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