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DELIVERY OF SUPPLEMENTS ON RANGELANDS

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INTRODUCTION

Supplementation of cows grazing rangelands is often beneficial to overcome nutrient deficiencies or imbalances. However, supplemental feeds and their delivery to the cow herd are expenses and thus supplementation decisions should be carefully made to ensure that costs are minimized and benefits in terms of cow performance exceed supplementation costs. 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. The first among these is the type of supplement to be provided 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 range forage, whereas the wrong feedstuff can reduce utilization of range forage and possibly simply become a substitute for grazed forage. Once the correct supplemental feedstuff is chosen based on its nutrient composition, opportunities to deliver that feedstuff need to be considered to meet two goals: (1) reduce the cost of supplement delivery and (2) ensure that the feedstuff is consumed as uniformly as possible by all cows in the herd. Other goals for cow herd and grazing management may also need to be considered. This paper will address some options for supplement delivery and the economics of those options.

PROTEIN VS. ENERGY SUPPLEMENTATION

In general, options for altering the effectiveness and costs of supplement delivery involve the options of hand-fed vs. self fed supplements and the frequency with which hand-fed supplements are delivered to the cow herd. In general, hand-fed means the supplement is delivered to the animals in a form that is readily and immediately consumed. Self-fed means that the supplemental feedstuff is packaged in a manner so that it can be delivered infrequently in bulk and the package limits intake so animals consume it in a relatively continuous, low-level pattern. Consideration of these options can only be made after the question of what to supplement has been answered. Four specific scenarios (Mathis, 2003) should be considered:

Scenario 1: Forage supply is unlimited and crude protein content of standing forage is greater than 5%.

Scenario 2: Forage supply is abundant; however crude protein content is below 5%.

Scenario 3: Forage supply is limited, but it has greater than 5% crude protein.

Scenario 4: Forage supply is limited and crude protein content is less than 5%.

Each of these scenarios requires a different approach to supplementation to meet the needs of cows grazing native range. Scenario 1 is the ideal situation. In this situation, there is adequate energy and the cattle will select a diet that will meet their protein requirements as well as the requirements of the rumen microbes. Therefore a supplement is not typically needed unless cows are in poor condition and need extra nutrients to gain weight. In general, 7% crude protein is considered the minimum in cattle diets to maintain microbial function and therefore forage digestion in the rumen. However, cattle will select a diet that is higher in protein than the average of the standing forage in native range pasture. Thus, even though 5% crude protein is less than the requirement, selectivity should allow them to meet it. To do this, however, the cow must have adequate forage available to allow her to be selective. If not, then she will either be forced to consume a protein deficient diet or lower her intake to maintain selectivity. In either case, nutrient intake becomes limited and performance will not meet expectations.

In Scenario 2, the cows have plenty of forage available, however it is low in quality and they are not receiving an adequate amount of protein for the rumen microbes to efficiently utilize the forage or to meet the requirements of the cow. In this situation, a high protein supplement should be provided, which could be high protein seeds (cottonseed, peas, soybeans, etc), oilseed meals (cottonseed meal, soybean meal, etc) or by-product feeds such as fishmeal, feathermeal, and dry distiller's grains (Huston et al., 2002). It is important to consider palatability when utilizing by-product feeds to ensure targeted consumption of the supplemental feeds is met. Once the protein needs of the rumen microbes are met, they will be able to ferment the fiber in the range forage, increasing the energy available to the cow. Thus, the cows' supply of protein and energy are both augmented because the supplement caused increased nutrient utilization from the low-quality forage. This is the most likely of these four scenarios for supplementation practices to be effective from both a cow performance and cost basis.

With protein being sufficient, energy is the limiting factor in Scenario 3 because of a lack of forage to extract energy from. In this situation, an energy supplement may be an option. When evaluating which feeds to use as an energy supplement, it is important to understand how that supplemental feedstuff will affect the rumen environment. The high grain (starchy) feeds that can be utilized typically contain less than 15% crude protein and are highly and rapidly fermented by the microorganisms in the rumen. The species of microbes shift from fiber digesting types to starch digesting types. The rapid fermentation increases the acidity of the rumen, which further reduces the function of fiber digesters. It could also result in lactic acidosis if the dietary change is made too abruptly and a large amount of grain is fed. Lactic acidosis is a physiological crisis for the animal and could cause death. However, if grain is introduced gradually and fed **frequently**, the rumen

microbes can adapt to the change and be able to utilize the added energy source (Huston, 2000). If adequate protein is available in the rumen, this could possibly increase fiber digestion to a degree. Typically, the cows' supply of protein and energy are not augmented, and often are negatively affected compared to no supplement. It is better to utilize high fiber feeds, such as soyhulls, wheat middlings, and corn gluten feed. These feeds do not ferment as rapidly in the rumen environment and do not create the negative associative effects related to forage digestion that can be caused by high starch feeds such as corn, grain sorghum, wheat, and barley. These highly digestible fiber sources are less likely to substitute for range forage. However, even with these feeds, supplementation above some level will result in the animal substituting the supplement for the available forage, which results in a higher cost to the producer. The "substitution effect" occurs if the supplemental feed substitutes for the forage and results in reduced forage intake. If this occurs, the total energy intake may stay the same or decrease, which does not meet the goals of your supplementation program. This substitution rate will depend on forage protein content, level of protein in the supplement, type of energy sources, and feeding rate (Mathis, 2003). Another option for this scenario is to reduce the number of animals to match their demand with the forage supply so there is not a forage shortage.

Scenario 4 provides the greatest challenge for any cow/calf producer. In this situation a supplement providing protein and energy would need to be provided to meet requirements. The recommendation is for a 20 to 30 percent protein supplement to be provided. Alfalfa hay can be a good source of protein and energy to meet these requirements. 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 may need to be made.

PROTEIN SUPPLEMENTATION FREQUENCY

There is more flexibility with protein supplementation frequency than with energy supplementation frequency. Numerous research studies have evaluated the differences between daily, three times per week, two times per week, and once a week supplementation. When evaluating cow performance, Schauer et al. (2005) indicated that supplementation frequency did not affect cow body weight or body condition score (BCS) when cows were supplemented with cottonseed meal daily or every 6th day while grazing low-quality forage. This data was supported by Huston et al. (1999) in a study that evaluated daily, every third day, or once a week supplementation. This study indicated that supplementing as infrequently as once a week reduced losses in body weight and body condition score when compared to non-supplemented cows, and was as effective as daily supplementation. Bohnert et al. (2002) conducted a supplementation frequency study using Angus X Hereford cows grazing low-quality (5% crude protein) meadow forage. Cows were supplemented daily, every 3rd day or every 6th day with sources of supplemental protein that were either highly degradable or highly undegradable in the rumen. Their results indicated that all cow weight and BCS changes were positive, except for those cows that were in the unsupplemented control group, who lost 86 lb, compared to gains of 17, 37, 7, 9, 13, and 20 lb for the daily degradable, every 3rd day degradable, every 6th day degradable, daily undegradable, every 3rd day

undegradable, and every 6th day undegradable supplements, respectively. There were no differences in BW or BCS associated with supplementation frequency. The reason that infrequent protein supplementation works is that ruminant animals conserve nitrogen from dietary crude protein in their bloodstream and saliva and recycle it back to the rumen so that ruminal microbes can use it to synthesize protein and more microbes. Thus, protein (nitrogen) consumed on days of supplementation is continually circulating and returning to the rumen on days that the supplement is not provided.

Beaty et al. (1994) studied the effect of a sorghum grain and soybean meal supplement fed daily or three times per week to cows consuming wheat straw (3% CP). This study also compared low levels of CP (12%) to high levels (38%) in the supplement across the varying frequencies. Their results indicated that pre-calving BW loss was decreased by daily supplementation compared with three times per week supplementation, however higher protein concentration resulted in higher BW gains and increased BCS. Farmer et al. (2001) compared supplementation frequencies of 2, 3, 5 or 7 days per week and reported an increased BW loss for infrequently supplemented cows compared to frequently supplemented cows. When evaluating these two trials, the magnitude of differences for change in BCS and BW was small and inconsistent throughout the trials. Only extreme differences in frequency (i.e. less than 1 time per week) would result in large differences in cow performance.

Other factors to consider when supplementing cattle are how they will react to supplemental feeds and delivery methods (Bowman and Sowell, 1997). In most cattle herds, there will be a certain percentage of cows that will be non-consumers, especially if you introduce them to a new supplement program or delivery system. This level of non-consumers will generally decrease as they become familiar with the feed and/or delivery system, but seldom completely disappears. If cattle are fed in a trough and the space per animal is decreased, the number of non-consumers will increase due to competition, however, if there is excess trough space (181 cm/hd or 72 in/hd) the dominant cattle will tend to fight and push the more timid cattle away from the bunk (Bowman and Sowell, 1997). When bunk space per animal is limited to 91 cm/hd (36 in/hd), supplement intake was less variable among individual cows.

Another consideration is the amount of supplement that is provided at one feeding, which is directly related to frequency of supplementation. If you are supplementing cattle on a daily basis, there will be a smaller amount of feed allocated per head and the dominant cows will typically consume a larger portion of supplement than they were allotted and the timid cows may not consume the desired amount, if they consume any. By providing supplement on a less frequent basis, there is a larger quantity of feed available, which gives all cows an opportunity to consume supplement as the quantity is too large for the dominant cows to consume in a short period of time (Bowman and Sowell, 1997). For example, if you are feeding 100 cows a 30% crude protein range cube at 2 lbs/hd/d, you would be distributing 200 pounds of the range cube on the ground or in a bunk every day. In this situation, the timid cows may wait until you have finished feeding and the dominant cows may have the feed nearly eaten by the time the others have made their way to the feed. If you were to supplement every 3rd day, then you would increase the

amount of feed provided at each feeding to 600 lbs, which in most cases, if fed on the ground would mean you have a larger area that the feed was delivered across and the timid cows would have more of an opportunity to consume their allotted amount of feed without competing with other cows (Bowman and Sowell, 1997).

To determine the feeding frequency that works best for your operation, you should calculate your costs to deliver the supplement. Take into consideration mileage to and from the cows, time and labor to feed them, and equipment availability. For example, if your cows are 15 miles from the feed and it takes you 1 hr and 15 min to feed when fed daily, what is the cost to feed those cattle on a daily basis, on every 3rd day, or once a week, if you have the necessary equipment available? If we use $0.50/mile and $10.00/hour for your labor, the cost to deliver the feed for daily feeding would be $192.50/week. For every third day feeding, the cost of delivery would be $60.00/week. This includes an additional 15 minutes of labor for the added time in loading and unloading the larger quantity of feed. For once a week feeding, delivery cost would be $32.50/week with an additional 30 minutes compared to daily feeding. To compare the daily versus weekly feeding on a strictly economic basis, you would save $160/week by supplementing once a week. Many producers may want to see their cattle more often than this, so calculate what will work best for you and your operation. You will have to customize these numbers and calculations to meet your operation, but it is critical that you account for your labor when determining the most efficient program for your operation. Don't forget to add in equipment costs if you have to purchase new equipment or upgrade your current equipment to handle the larger quantity of supplement you are feeding.

ENERGY SUPPLEMENTATION FREQUENCY

There is less research on how often energy supplements need to be fed. However, in general, high-grain energy supplements should be fed daily to decrease the rapid change in the rumen environment. Kartchner and Adams (1982) reported that cows receiving corn grain on alternate days gained less body weight than cows that were supplemented daily. Those receiving daily supplement gained BCS while those receiving alternate-day supplementation only maintained BCS. Chase and Hibberd (1985a) found that alternate-day feeding of a high-grain energy supplement reduced intake of native grass hay compared to feeding on a daily basis. In another study, Chase and Hibberd (1985b) found that feeding corn at greater than 2 lbs per day decreased forage intake and digestibility of native grass hay. McCollum (1997) stated that feeding less than 0.3 % of body weight has little impact on forage intake and may sometimes increase forage intake. This 0.3 % of body weight is 3.6 lb per head for a 1200 lb cow. Once this level is pushed higher, forage intake will begin to decline due to substitution and performance will not increase as rapidly as expected. Energy supplementation should occur on a daily basis to decrease the opportunity for constant shifts in fermentation patterns that reduce forage utilization (Kartchner and Adams, 1982), or worse, lead to lactic acidosis and digestive upset.

In summary, frequency of supplementation is an important management and economic option to be considered. In the right circumstances, it provides the opportunity to both

reduce the cost of delivering supplement and to reduce variation in supplement intake among individual cows in the herd. In order to effectively consider this option, you must first determine whether protein or energy supplementation is needed and then what resources you have to provide those supplements to the cattle. In general, it is best to provide energy supplements on a daily basis, whereas protein supplements can be provided as infrequently as once a week to meet the needs of the cow and the rumen microbes. In order to determine the most economic program for frequency of feeding, calculate fuel, labor, and equipment costs and compare the programs you would like to use.

SELF-FED SUPPLEMENTS

As implied earlier, self-fed supplements are designed to limit average daily supplement intake to targeted levels so large, bulk quantities can be delivered infrequently. One mechanism to limit intake is the physical form of the supplement, such as cooked molasses blocks wherein consumption is limited by the hardness of the block or liquid supplements wherein consumption is limited by the rate at which the animals can lick the liquid from the tank. Another intake-limiting mechanism is to use an ingredient such as salt that will affect the palatability of the supplement.

The major advantage of self-fed supplements is the reduced transportation and labor costs because of infrequent delivery. In addition, despite infrequent delivery, animals still have access for daily consumption. This can overcome the problems associated with infrequent delivery of hand-fed energy supplements described earlier. Thus, even though self-fed supplements often cost more per unit of nutrients, they may still be more cost effective to use in rangeland situations because the reduced cost of delivery offsets the increased cost of the feedstuff. Partial budgeting is an economic tool that can provide tremendous value to compare the costs of hand-fed vs. self-fed supplements to determine which provides the best economic value (Torell and Torell, 1996). In short, a partial budget is the summation of costs and benefits between two alternative management practices. In this case, it involves summing the cost of feed and delivery of each potential supplement and determining which is the least-cost alternative to provide supplemental nutrients to cattle. A new partial budget is necessary for each situation because of changes in supplemental nutrient needs, costs of potential feedstuffs, distances traveled, time and labor required to deliver each type of supplement, travel costs, and equipment costs. In a somewhat simplistic example, consider that 0.5 lb of crude protein per day is currently being supplied to 300 cows using a 30% crude protein hand-fed supplement, such as a soybean-meal based range cube. The supplement costs $250 per ton delivered to your ranch. The distance to the cows is 50 miles and it costs $0.50 per mile to deliver it and $50 of labor. If delivered daily, the cost of supplementation per week is $1137.50. The alternative is a 30% crude protein self-fed supplement that costs $550 per ton but only needs to be delivered once per week. Because of the increased amount of supplement in this single weekly trip, the cost of transportation and labor for the trip doubles to $1.00 per mile and $100 of labor. The weekly cost of supplementation in this case costs $1162.50. Thus, the self-fed costs $25.00 more to provide. Differences in feedstuff costs, distance to the cow herd, fuel costs, labor costs, and frequency of delivery of the hand-fed supplement could

all drastically change the outcome of this comparison. The daily delivery of the hand-fed supplement in this example is a major factor in the total cost of delivery; because it is a protein supplement, simply delivering it less frequently could substantially reduce the cost of hand-feeding. Additionally, other considerations may influence your decision. Perhaps you don't have the time or hired labor available to make daily deliveries. Often, producers cite convenience (i.e. less hassle and labor) of using self-fed supplements as being worth the extra cost.

A major disadvantage of self-fed supplements is increased variation of supplement intake among individual animals and increased percentage of non-consumers of the self-fed products (Bowman and Sowell, 1997). This appears to happen in spite of self-fed supplement delivery virtually eliminating issues of feed bunk space/competition issues. Bowman and Sowell (1997) reviewed 20 studies that compared various combinations of dry hand-fed, molasses-block, or liquid supplements. The average coefficient of variation (CV) across all experiments for supplement intake was 79, 60, and 41 % for block, liquid, and hand-fed supplements, respectively (as implied, a higher CV means greater variation of intake among individuals.) Among the studies that directly compared hand-fed to self-fed (both block and liquid) supplements, the percentage of animals that were non-consumers was 5 and 19% for hand- and self-fed, respectively. A variety of factors contributed to variation in intake of supplements (Bowman and Sowell, 1997): For blocks, hardness was an issue. Harder blocks led to reduced intake, but increased variation in intake. Supplements with higher crude protein content led to reduced variation in intake. On the other hand, higher quality forage contributed to reduced intake and increased variation in supplement intake. Animals adjust consumption of feeds containing various nutrients in response to their need for those nutrients (Provenza, 1991), and likely adjust their intake of the supplemental block based on the nutrient level of the range forage and the supplemental feed.

In their review, Bowman and Sowell (1997) reported that cow age influenced self-fed supplement consumption, with younger cows consuming less supplement than older cows. This was apparently in response to social dominance of older, larger cows over younger, smaller ones. In a subsequent study using a liquid self-fed supplement, they (Sowell et al., 2003) provided further support indicating younger cows consumed less supplement than older cows. In contrast, Suverly et al. (2000) found that consumption of hand-fed protein supplements was greater by 4-6-yr-old cows than older cows. This is a critical issue considering that nutrient requirements and therefore need for nutrients from the supplement are greater for younger cows that are still growing as opposed to mature cows.

Finally, supplements can play a role in cattle and range management beyond supplying supplemental nutrients. In particular, a great deal of attention has been directed toward use of cooked molasses tubs to improve grazing distribution. Bailey and Welling (1999) and Bailey et al. (2001) found that placement of cooked molasses blocks in underutilized range locations increased the amount of time that cows spent within 2000 feet of the tub location and increased utilization of forage near the tubs (with concomitant reduction in forage use at further distances from the tub). In both reports, Bailey's group concluded

that cattle could be lured to underutilized rangeland locations by strategic placement of cooked molasses tubs.

CONCLUSIONS

The most common scenario for supplementation of range cows is during the late fall, winter, and early spring when dormant forage is low in quality, and particularly deficient in protein. Abundant research evidence and producer experience supports the use of protein supplements to overcome this protein deficiency and allow cost-effective winter grazing, particularly in non-lactating, late-gestation cows in moderate body condition. Infrequent delivery of hand-fed protein supplements or use of self-fed supplements are viable options to reduce the cost of supplement delivery. Partial budgeting is a viable tool to evaluate the cost effectiveness of these options considering the ongoing changes in costs of inputs such as the supplemental feedstuffs, fuel, equipment, and labor. Choosing which supplement delivery method to use should not only be based on cost effectiveness, but also uniformity of supplement consumption among individual cows in the herd, and ability of supplement delivery technique to meet other goals, such as improved grazing distribution.

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