Supplement Delivery Systems

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INTRODUCTION

Livestock that are grazing New Mexico rangelands may require supplemental nutrients in order to meet production goals. Range forages are often deficient in protein and minerals; therefore, these are the nutrients most commonly provided in supplements. The primary goal of any supplementation program is to maintain or improve productivity by mediating nutrient deficiencies. To efficiently meet this goal, 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. The objective of this guide is to describe some of the supplement delivery methods available to livestock producers and to discuss their advantages and disadvantages.

HAND-FEEDING VERSUS 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., hardened molasses 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, since delivery times are designed to be less frequent than with hand-feeding. However, if livestock are checked at times other than feeding, the savings in labor and associated costs may be less than expected. For supplements that are targeted for more than 1 lb 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 (for example, mineral supplements), then self-feeding may be very cost effective.

Fig. 1. Self-fed supplement delivery can be an effective way to provide nutrients to livestock.

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. Scientists at both New Mexico State University and Texas A&M University's San Angelo Experiment Station have shown that hand feeding protein supplements once a week results in the same level of performance as feeding three times per week or daily (Huston et al., 1999; Wallace et al., 1992). Therefore, when supplementing protein the labor required for hand-feeding can be similar to self-feeding (table 1).

Based on this comparison, if a self-fed supplement costs significantly more than a hand-fed supplement, any labor cost savings may be offset. However, for energy or mineral supplements (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

Table 1. Labor cost comparison of hand-fed and self-fed supplements for one week.

Item	Daily	3X per week	1X per week	Self-fed[a]
Vehicle Costs[b]				
Feeding	75.60	32.40	10.80	0
Checking cows[c]	0	0	10.80	21.60
Labor Costs				
Feeding[d]	126.00	54.00	18.00	0
Checking cows[e]	0	0	13.50	27.00
Total Daily Costs				
Vehicle	75.60	32.40	21.60	21.60
Labor	126.00	54.00	31.50	27.00
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 9.00/hr. Feeding requires 1 hr driving and 1hr feeding.

[e]Checks require 1 hr driving and .5 hr observing cows.

and supplement formulations and found that 5% of hand-fed animals failed to consume any supplement, while 19% of self-fed animals did not consume any supplement (Bowman et al., 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 the performance responses to these 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., cake, block, liquid) 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

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.

Meals. Meals typically are combinations of dry ingredients mixed together with no further processing. Meals are a common form of range mineral supplements, because ingredients in these supplements are difficult to bind together, and the loose form encourages consumption. With this form, it is easy to include a large amount of salt for self-feeding. Salt-limited protein meals have been used successfully in the past. Animals may develop a tolerance to salt over time (and increase intake of the supplement), but with meal supplements, producers can add salt by hand to adjust intake to desired levels. This is an advantage for a self-feeding program.

A disadvantage of meals is that they must be placed into some type of trough or feeder, because feeding on the ground results in excessive waste of supplement. Fortunately, since mineral supplements are delivered in

relatively low quantities, only a small investment in storage and trough space is required. For energy and protein supplements, more trough space is required, and therefore, a potentially larger investment in equipment is needed.

The design of feed troughs or bunks is also important for several reasons. Intake limiters, such as salt or phosphoric acid, may corrode metal feeders, reducing their useful life. Constructing troughs that last longer may reduce portability and limit flexibility in location of feeding areas. Additionally, trough space greatly influences the variation in intake and the number animals that fail to eat supplement (Bowman et al., 1997). Trough space of 2.5 ft per head appears to be ideal for range cows to minimize intake variation and allow more cattle to consume the supplement (Wagnon, 1966). For sheep, ideal trough space is approximately 10 in per head (Arnold et al., 1974).

Crumbles. Crumbles are dry feeds that are mixed and pelleted, then crushed to produce smaller particles. Crumbles are most often associated with poultry feeds, but some manufacturers have produced mineral supplements in this form. These mineral supplements have been marketed as having higher environmental (wind and moisture) resistance than loose mineral meals. Research from New Mexico State University indicates that wind losses are minimal with loose mineral mixes (Dean et al., 1999). Therefore, this benefit may only be realized in extremely windy locations. Crumbles may reduce sifting of fine materials and leaching of ingredients due to precipitation, but this has not been well documented for mineral supplements.

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. 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 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 led to a desirable feeding area. Cubes often are fed on the ground, but this may be difficult in snow or mud. For hand-fed supplements, cubes usually have the lowest variation in supplement intake by animals (Bowman et al., 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 intake may increase over time. With self-fed cubes, it is difficult for producers to adjust intake by adding salt, since particle size differences will result in sorting.

Fig. 2. Hand-feeding cake is an excellent method to control livestock location and movement, while minimizing variation in supplement intake.

CUBES USUALLY RESULT IN THE LOWEST VARIATION IN SUPPLEMENT INTAKE

Dry or Pressed Blocks. Dry or pressed blocks are essentially very large cubes. 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 increase 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, according to a review conducted by Montana State University researchers, the number of non-eaters is still relatively low and similar to that of pelleted supplements (Bowman et al., 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, 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 range 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 example of table 1). 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.

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.

Fig. 3. Mineral supplements can be delivered in the form of pressed blocks. Protein and energy supplements can also be delivered as blocks.

Non-protein nitrogen (NPN) sources like urea or liquid fermentation byproducts may provide an excellent opportunity to reduce overall feed costs by 10 to 15%. It is important to remember that the utilization of NPN is limited with low quality diets (NRC, 1989). 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. Excessive NPN in the supplement, coupled with slow energy release from dormant forage, can result in inefficient NPN use, potentially reducing animal performance.

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% (Bowman et al., 1997). In a New Mexico State University trial conducted over 2 years, 17% of the cows did not consume any liquid supplement. Supplement intake ranged from 0 to 5.4 lb per day (Pulsipher, 2000), which is consistent with the range 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.

Hardened Molasses Blocks. Hardened molasses blocks (often referred to as "tubs" or "soft-pours") share some characteristics with both pressed blocks and liquid

Fig. 4. Liquid supplements in lick tanks large enough that they are filled less than once a week.

Table 2. Intake variability and proportion of non-eaters of hardened molasses blocks, hand-fed dry supplements, and self-fed liquid supplements.

Item	Molasses Blocks[a]	Dry Supplement[b]	Liquid Supplements[a]
Intake range, lb	0 – 6.0	0 – 3.5	0 – 5.8
Non-eaters, %	14.3	5.0	23.5

[a]Self-fed

[b]Hand-fed

[c]Based on target consumption of 2 lb/head/day

[d]Estimated intake range includes the middle 97% of animals consuming supplement (some extremes may occur)

feeds. This type of supplement is generally made from a molasses base, like a liquid feed, but is cooked or chemically hardened to create a block-type feed. These supplements can incorporate a higher percentage of dry ingredients than liquid feeds. Due to the amount of molasses in the formulation, typically have lower amounts of dry feedstuffs than pressed blocks.

Hardened molasses blocks are self-fed supplements. As animals lick the block, saliva softens the surface and allows the animals to scrape off the softened portion. Intake is dependent on the rate of softening. Harder blocks are designed for slower consumption (lower intake) and do not soften as 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 2; Bowman et al., 1997).

Molasses blocks are more environmentally resistant than pressed blocks; therefore the delivery frequency can be decreased. However, since livestock must be checked periodically, the total labor cost associated with feeding hardened molasses blocks may not be significantly less than feeding dry supplements once per week.

GENERAL CONCLUSIONS

A variety of supplement types are available to range 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 on a daily or every other day basis. 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 (up to once per week) is as effective as daily delivery, and labor costs may be reduced to levels similar to that of self-fed supplements with less intake variation.

Fig. 5. Soft-pours are commonly used as a self-fed method to deliver supplements.

Different supplement delivery systems have different advantages and disadvantages. The overall benefit of using a particular system depends on the individual situation. Supplement delivery systems can be ranked (1= best) based on several different criteria.

Flexibility of least cost formulation:

1. Cubes or meals
2. Pressed blocks
3. Hardened molasses blocks
4. Liquid feeds

Labor and delivery costs:

1. Liquid feeds, dealer filling feeders
2. Hardened molasses blocks
3. Small package meals (e.g., mineral)
4. Pressed blocks
5. Hand-fed cubes

Flexibility of feeding location:

1. Cubes
2. Small package meals
3. Blocks (any type)
4. Liquids
5. Large package meals (protein or energy)

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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