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Guidelines for Choosing Self-Fed Supplements for Beef Cattle

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Feeding supplemental protein or energy to beef cattle consuming a forage-based diet should be viewed as an investment in cattle health and performance. Considering the large selection of supplemental feeds available, selecting the right feed is a daunting task. As an investment, supplemental feed is necessary to complement the forage resources, which may be insufficient to maintain herd productivity.

Once the decision to supplement is made, choosing the correct supplement begins. The supplemental feed investment options range from hand-feeding grain or byproduct-based supplements to self-fed liquid feedstuffs. Self-fed supplements offer the appeal of convenience; however, the type of supplemental feed (liquid feed, tubs, byproducts, etc.) should be determined after the nutrient deficiency (protein and/or energy) is determined. The objective of this fact sheet is to review the factors to consider when deciding whether or not to supplement the cattle herd by self-feeding.

Assessing the Function of Supplementation

Supplemental feeding should be approached as an investment decision with a clear purpose of restoring deficient nutrients to enhance productivity. Productivity could include calf crop percentage, body condition or stocker gains. The value of the additional production needs to exceed the cost of the supplement.

Arkansas beef cattle producers rely primarily on forages for cow-calf and stocker calf production. Therefore, identifying the nutrients in the forage that are most likely to limit animal performance is the first step toward determining the best supplemental feed option. This is **best accomplished through a forage analysis**.

The most limiting nutrient or nutrients will differ between grazed and harvested forages, forage species, forage maturity and soil fertility. Since many factors contribute to forage quality, never assume the supplement that works for your neighbor will work just as well for you! Throughout this fact sheet, examples are used based on Arkansas averages to demonstrate specific points about assessing deficiencies in forage quality relative to animal requirements. Don't assume these Arkansas averages fit your farm. **Always complete a forage analysis.**

Forage Quality Deficiencies in Arkansas

Pasture samples submitted to the University of Arkansas Diagnostics Testing Laboratory from March through October (n = 617) were compared to a lactating beef cow's requirement for protein (CP) and energy (total digestible nutrients, TDN) to determine the incidence of CP and TDN deficiencies. The March through October period corresponds to the growing season of the cool-season and warm-season grasses grown in Arkansas. Eighty-eight percent and 76 percent

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of the samples analyzed were adequate in CP and TDN, respectively, for lactating beef cows. Therefore, the occurrence of a TDN deficiency from a quality perspective of forages during the growing season is more prevalent than the occurrence of a CP deficiency.

Based on more than 8,000 hay samples analyzed, hays met the CP and TDN requirement of a gestating beef cow 89 and 75 percent of the time, respectively. The percentage of samples meeting a lactating beef cow's requirement for CP and TDN was 59 percent and 29 percent, respectively. Based on these percentages, the chances of a TDN deficiency exceeded the chances of a CP deficiency. The type of deficiency and level of deficiency will impact the effectiveness of the supplemental feeding program (hand-fed or self-fed).

Supplemental CP Versus TDN

The nutrient and level of deficiency (based on the forage analysis) dictate the type of supplemental feeding program. In general, self-fed supplements are better suited for correcting CP and mineral or vitamin deficiencies than an energy deficiency. This is because many self-fed supplements are designed to limit supplement intake to 1 or 1.5 pounds per day.

To demonstrate, the results of providing a 30 percent CP and 78 percent TDN self-fed supplement with a 1-pound-per-day intake were modeled against hay qualities of cool- and warm-season grass hays analyzed in Arkansas. Using an average CP (12.3 percent) and TDN (55.7 percent), a random sample of 1,000 hay quality combinations was generated. The percentage of samples that were inadequate in CP or TDN before and after, including supplementation in the model, is presented in Table 1. In addition, the table also shows the percentage of samples that were adequate in CP and TDN regardless of supplementation.

When examining the results for beef cows in late gestation, CP was inadequate 9 percent of the time before supplementation and 3 percent of the time with supplementation (Table 1). The self-fed supplement reduced the occurrence of a protein deficiency by 67 percent. For gestating beef cows, the 1-pound supplement reduced the expected occurrence of a TDN deficiency by 54 percent. While this shows the positive impact of 1 pound of supplement on reducing CP and TDN deficiencies during gestation, recognize that 72 percent and 91 percent of the samples were already adequate for TDN and CP, thus requiring no additional CP and TDN supplementation. This demonstrates the **value of a forage test** and segregating hay lots that need supplementation from hay lots that don't require supplementation.

The CP and TDN deficiencies were greater across the same quality of hays when compared to a lactating beef cow's requirement during peak lactation. Table 1 indicates that 1 pound of supplement reduced CP deficiencies from 41 percent to 31 percent (24 percent reduction); however, the chance of the self-fed supplement meeting the TDN deficiency dropped from 86 percent to 78 percent deficient (9 percent). The 1-pound supplement was more effective at reducing the chances of a CP deficiency versus a TDN deficiency. This is because the increase in the daily CP need of a cow during the transition from gestation to lactation is approximately 1 pound per day, whereas the TDN requirement during lactation is approximately 4 pounds per day greater than the requirement during late gestation. Improving the chances of meeting a lactating cow's daily energy needs can only be accomplished by increasing the amount of supplement consumed beyond 1 pound. If supplement intake remains at 1 pound per day, nearly one-third of the hays remain CP deficient and 78 percent of the hays remain TDN deficient in the modeled dataset.

Based on the hays analyzed in Arkansas, it's **not the quality** of self-fed supplements that limits the beef cow's ability to maintain performance (body condition, etc.), it's simply the cow's inability to consume **the quantity** of supplement that would be needed to sustain performance. Producers sometimes

Table 1. Modeled[1] response of percentage of hay-based diets inadequate for meeting gestating and lactating cow requirements before and after factoring in a self-fed supplementation

	Inadequate before self-fed supplementation	Inadequate with self-fed supplementation	Adequate regardless
Gestation			
CP	9%	3%	91%
TDN	28%	13%	72%
Lactation			
CP	41%	31%	59%
TDN	86%	78%	14%

[1] Modeled inputs included a multivariate normal sample (n = 1,000) for CP (12.3 ± 3.4%) and TDN (55.7± 4.7%) with a correlation of 0.72. Intake was modeled for a 1,100-lb cow using NRC prediction. When forage TDN:CP exceed 7:1, predicted intake was increased whereby the % increase in forage intake/0.22 lb supplemental CP = 24.69 - 2.33 × forage CP; otherwise, supplement replaced hay based on the ratio of the hay energy to supplement energy.

report cattle losing body condition using self-fed supplements. In some cases, this was perceived as a problem with supplement quality or urea toxicity. When cattle lose weight and body condition and the self-fed supplement represents no more than 5 percent of the cattle's ration, the problem usually lies within the quality of the remaining 95 percent of the diet, which is generally hay.

Determining the Amount of Supplement Needed

Table 2 shows the amount of supplement supplied versus needed to balance moderate quality hay (12.4 percent CP and 56 percent TDN) for early lactation using the OSU Cowculator ration balancing spreadsheet program. This forage quality is sufficient for gestation without supplementation when offered free choice. Without supplementation, lactating cows consuming this quality of hay would be expected to lose 1 BCS in 108 days. One pound of a 30 percent CP and 78 percent TDN self-fed supplement extends this period for which a cow will lose 1 BCS by 38 days. The optimum self-fed supplementation rate to suspend BCS loss is 3.8 pounds per day, which is beyond the design of the supplement. The self-fed supplement is beneficial from the standpoint that cattle are consuming additional energy. In this example, the additional protein is not necessary because 12.4 percent CP hay already exceeds the lactating cow's requirement (10.9 percent). While the optimal supplementation rate of a 78 percent TDN self-fed supplement would be 3.8 pounds per day, the final supplementation decision must consider the length of supplementation, weather conditions and the herd's body condition going into the supplemental feeding period.

Table 2. Predicted intake and performance response for moderate quality hay without supplementation and with two levels of supplementation

	Hay Only	Hay and 1 lb/day Supplement	Hay and Supplement Balanced for Energy
[1] Hay Intake, lb/d	28	27.2	25.9
[2] Supplement Intake, lb/d	0	1	3.8
Protein needs met, %	122%	129%	148%
Average daily gain, lb	-0.7	-0.5	0.00
Days to lose 1 BCS	108	146	Infinite

[1] Hay: 12.4% CP and 56% TDN.

[2] Supplement: 30% CP and 78% TDN self-fed supplement.

Feeding Frequency

"How often should supplement be fed?" is a valid question. The answer is dependent upon the type and amount of supplement the herd needs, which is best determined by a forage test. If CP is deficient, supplementing mature cows' CP two or three times per week is sufficient. For example, if 1 pound per day cottonseed meal is sufficient to overcome a CP deficiency, 3.5 pounds twice a week is acceptable. Research has also shown supplementing CP to mature beef cows as infrequently as once every 6 days was adequate.

Unlike protein, supplemental TDN must be provided more often, and the supplementation rate will dictate whether or not supplemental TDN should be offered daily (where self-feeding may become more viable in certain situations) or if alternate day feeding is an acceptable alternative to self-feeding. A good rule of thumb for growing cattle is if supplement is offered at less than 0.5 percent body weight, feeding every other day is acceptable. A research study conducted over several grazing seasons for five combined studies in Arkansas found similar average daily gain and supplemental feed conversion for growing cattle fed supplement at 0.72 percent body weight every other day compared to 0.36 percent body weight daily. A reduction in average daily gain may occur if feeding corn at a high rate every other day.

Using Self-Fed Supplements to Improve Forage Intake

One of the most common promotion tools for self-fed supplements pertains to their effect on forage intake and digestibility. Since many self-fed supplements are designed to provide supplemental protein, a common marketing claim is the additional protein (provided by the self-fed supplement) improves forage intake and digestibility. The validity of this statement is dependent upon forage quality. Mature native grasses are known to be low in CP. The digestibility of these plants is limited by the lack of CP available to the rumen micro flora. When these forages are supplemented with CP, the rumen microbes proliferate, and this enhancement to the rumen environment promotes greater forage digestion. When forage digestion increases, an increase in forage consumption is observed.

For most Arkansas hay samples analyzed, the ratio of TDN:CP is less than 7:1. This usually means there is sufficient CP for the amount of TDN available, and supplements (protein and energy) will likely result in no change or a reduction in forage intake. Based on the TDN:CP ratio of Arkansas hay samples,

forage CP tends to be adequate in relationship to forage TDN; therefore, supplemental CP in most cases would be based on meeting the beef cow's maintenance requirement instead of using CP to improve forage utilization. A review of research on protein supplementation of grazing livestock published in 1990 showed that for every 1 percent increase in forage CP, the improvement in forage intake associated with protein supplementation diminished by a factor of 2.3. At 10 percent CP in the forage, the supplemental feed response approached no improvement in forage intake. The normal range for CP among Arkansas hay tests is 9 to 16 percent. This is the reason why **forage testing is so important**.

All-Natural Versus Non-Protein Nitrogen

Non-protein nitrogen such as urea is a common protein substitute in self-fed supplements. This option may help lower the cost of the self-fed supplement. The combination of urea with readily available carbohydrates permits the rumen micro flora to assimilate the non-protein nitrogen into usable microbial protein. Research has shown that urea can replace 20 to 40 percent of the rumen-degradable protein without adversely affecting performance. Cattle on forage-based diets use all-natural proteins more efficiently than cattle fed non-protein nitrogen due to either a better synchrony between protein and energy release to and uptake by rumen microbes or because supplemented all-natural protein can be used as a source of energy. Urea is used most effectively by cattle fed a high-concentrate diet (such as cattle in a feedlot) and cattle fed a grain-crop silage diet. Urea is used least effectively by cattle fed a low-quality grass hay diet.

Toxicity Concerns With Self-Feeding

Toxicity concerns can exist with any self-fed supplement. Urea toxicity would result from a mixing error. Measuring and mixing protocols are important quality assurance steps toward safeguarding cattle against dangerous levels of urea intake. The Merck Veterinary Manual indicates urea should not exceed 3 percent of the concentrate portion or 1 percent of the total diet. For example, Feed A contains 30 percent CP and not more than 15 percent CP equivalent from non-protein nitrogen. Using 281 percent CP equivalent for urea, urea represents $15 \div 181 \times 100 = 8.3$ percent of the supplement. If a 1,100-pound cow is expected to consume 24 pounds of forage and 1 pound of supplement, urea as a percentage of the diet is $1 \times 0.083 \div 24 \times 100 = 0.35$ percent and is not expected to be a health concern.

Many producers utilize salt as a limiter in self-fed supplements. Salt is a viable option when higher rates of supplement intake are needed (3 to 5 pounds of supplement for mature cattle). There is no maximum tolerable level for sodium or chlorine (the two elements found in salt). However, salt toxicity may occur when salt-based, self-fed supplements are used and water intake is limited due to pipe rupture, pump failure, overcrowding or freezing.

High sulfur intake can be another concern with some liquid feed options today. Because of its high sulfur content (0.5 to 1.7 percent sulfur, dry matter), the ethanol industry byproduct, condensed distiller's solubles, should not be used as a self-fed slurry supplement.

Controlled Intake Self-Feeding Methods

Liquid feeders and lick tubs. Liquid feeders and lick tubs are popular options for providing supplemental protein. The supplement is often molasses based; however, some companies provide liquid feeds that are byproducts from grain processing. Intake can vary with forage quality but is usually reported at approximately 1 pound per day. Restricted intake often makes these supplements less effective for supplementing TDN deficiencies. In recent years, lick tubs have been developed specifically for mineral supplementation.

Mineral salts. Mineral salts can be used to control intake of self-fed protein and TDN supplements. Sodium chloride (plain white salt) is a very common intake limiter, and a common rule of thumb for using plain white salt to limit intake is 0.1 pound of salt per 100 pounds of body weight. For example, if the goal is to provide 3 pounds of supplement to a 1,200-pound cow as a free-choice supplement, the mix would contain 28.6 percent plain white salt. Minerals and vitamins that might otherwise be offered in a free-choice mineral mix should be added because the plain white salt intake of the supplement may reduce consumption of a free-choice mineral mix. Other salts such as calcium chloride have been used to control intake of self-fed supplements. Intake response can be variable with mineral salts and adjustments often having to be made to achieve the target intake.

Oils. One product stands out in this area, Purina's Accuration. This product has been around a very long time. Accuration is often blended with corn to achieve the desired intake, and unlike other self-fed options, this product can achieve higher rates of self-fed TDN supplementation. Cattle producers who do not like the idea of feeding high rates of salt, have

concerns with salt deterioration of equipment or need higher TDN intakes often use this type of product when self-feeding is necessary.

Automated feeders. Another option to consider with self-feeding is the use of an automated feeder. Deer hunters have applied a small-scale version of this technology for years. Recently, companies have manufactured portable, large-capacity automated feeders for livestock. The Solar Feeder, manufactured in Fort Smith, Arkansas, is one example. This type of feeder would be most beneficial for targeting higher rates of TDN supplementation. The Solar Feeder was tested in a demonstration project at the University of Arkansas, Savoy research unit in 2012. Supplementing growing, weaned calves at 1 percent body weight daily using the Solar Feeder was compared to a self-fed plain white salt method of delivery or hand-feeding daily. Overall, target corn gluten feed supplement intake (7 pounds per day) was achieved by all three methods, and calves gained 1.6 pounds per day on average. The long-term benefit of the automated self-feeder would include reduced feeding labor when daily feeding is warranted and eliminating wasteful salt feeding.

Unit Cost of Feed

Comparing the unit cost of any supplement is important in making the right supplement choice. Unit cost can take various approaches. For example, Feed A costs $12.50 per bag and Feed B costs $100 per tub. Since these two feeds come in different forms (bag vs. tub), they must be compared on an equal weight basis. If Feed A is a 50-pound sack and Feed B contains 250 pounds of feed, then Feed A costs $0.25 per pound and Feed B costs $0.40 per pound. To further evaluate feed cost, compare the cost on a per-unit basis for the nutrient that is most limiting. For example, if the primary nutrient of interest is protein and Feed A contains 20 percent CP (as-is) and Feed B contains 30 percent CP (as-is), the cost per pound of protein for Feed A would be 0.25 ÷ 0.2 = $1.25 per pound CP and Feed B would be 0.40 ÷ 0.3 = $1.33 per pound CP. To recap, the sack feed costs less per bag, less per pound, but almost the same per pound of CP.

Now consider TDN as the most limiting nutrient. If Feed A and Feed B contain 74 percent and 68.4 percent TDN (as-is), the cost per pound of TDN for Feed A would be 0.25 ÷ 0.74 = $0.34 per pound TDN and Feed B would be 0.4 ÷ 0.68 = $0.59 per pound TDN. To recap, the sack feed costs less per bag, less per pound, and even though it contains less TDN, its cost per pound of TDN is lower. For the cost of feeding 1 pound of TDN from Feed B (tub), 1.74 pounds of TDN from Feed A (sack) can be supplemented for the same feed cost (0.59 ÷ 0.34 = 1.74).

Summary Points

1. Use a forage test to determine if and which nutrients fall below the beef animal's requirement.
2. Based on the magnitude of the deficiency, determine the required supplemental feeding rate for the supplemental feed options available.
3. Determine if the supplemental feeding rate and management complement or complicate self-fed options.

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