Dealing With High Fertilizer Costs in Forage Production Systems[1]

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Introduction

Fertilizer costs have increased tremendously over the last few decades. For instance, nitrogen (N) fertilizer prices have doubled in the last two years. Unfortunately, this trend is expected to continue in the future in response to high energy demand and decreased reserves of fossil fuels. Commercial fertilizers are the most costly input in warm-season grass forage production. Thus, it is important that fertilizers are used efficiently, so the investment return can be optimized. This document addresses some important issues relative to fertilizer efficiency as well as alternatives for reducing fertilizer use and reducing production costs for forage production.

Soil Testing

Adequate soil fertility is one key to successful forage and livestock production in Florida. Most soils in Florida are deficient to some degree in more than a single essential plant nutrient. Unless all required nutrients are supplied in adequate amounts, the benefits of a single nutrient application are not fully maximized.

Soil testing is still the best management tool to monitor soil fertility levels. Routine soil tests can help identify nutrient deficiencies and inadequate soil pH. Similarly, soil test results can also indicate which nutrients are present at adequate levels in the soil so fertilizer can be omitted. In addition to the money saved by limiting application to required fertilizers, losses and associated environmental problems can also be minimized. Based on soil test results, cost-effective fertilization programs can be developed to meet forage nutrient requirements and minimize production costs.

Although soil testing is a vital component of soil fertility programs for forage crops, the results and interpretation of a soil test are only applicable if the soil samples have been properly collected. Soil samples submitted to the laboratory should accurately represent the area of interest. A minimum of 15 to 20 subsamples (0 to 6 inches in depth) should be collected from each field. Areas that are managed or cropped differently should be sampled separately. Similarly, areas that show clear problem signs (i.e., poor forage production, disease) should also be sampled and analyzed separately. After collecting a minimum of 15-20 subsamples, soil should be mixed in a clean plastic bucket. A hand full (~1 pint) of soil should be sent to a reputable laboratory for analysis. Soil testing should be repeated at least every 3 years.

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Soil pH

Often overlooked, maintenance of adequate soil pH is an extremely important step in soil fertility programs for forage crops. Soil pH is one of the most important soil properties because it controls nutrient availability to plants, root development and fertilizer efficiency. Optimum soil pH promotes better root growth, which, in turn, results in more efficient fertilizer and water utilization by the plants. For instance, N fertilization efficiency in forage systems can increase 2.5 times by increasing soil pH from 4.5 to 5.5. Similarly, P and K fertilization efficiency is also increased when soil pH is adequate.

Florida soils often exhibit low pH and are considered "acidic". Lime is frequently used to raise soil pH. By raising the soil pH, macronutrient (i.e. N, P, and K) availability is typically increased. However, at high soil pH (> 6.5) micronutrients become less available. Therefore, it is important that adequate amounts of lime material are applied to the soil to bring the pH to a desirable range.

Forage crops require different soil fertility conditions and target pH varies according to the forage species. In general, warm-season grasses are more tolerant of soil acidity than legumes. Liming frequency as well as application rates will depend on the soil's characteristics and management practices. Nitrogen fertilization and decomposition of organic materials contribute to soil acidity. It is important to closely monitor pH and soil fertility status by testing the soil regularly. Routine soil testing provides the soil pH levels as well as the recommended lime application rates.

Choosing the Most Adequate Fertilizer Source

Several fertilizer sources are commercially available to supply N, P, K, and micronutrients to forage crops. In this section, we will focus on commercial N sources, but the same considerations should be applied to other essential nutrients.

Ammonium nitrate, ammonium sulfate, and urea are the major N sources used on pastures in Florida. Organic sources such as biosolids and animal manure also represent important sources of N that can be used in pastures. When choosing the right fertilizer source, it is important to consider important factors, such as price, fertilizer effectiveness, method and rate of application.

Cost of fertilizer should be calculated in terms of dollars per pound of nutrient. Below is an example how this can be easily calculated. Please note the fertilizer prices used here are just an example, so please check with your local fertilizer dealer the current fertilizer cost.

- Ammonium nitrate (34% N) costs $350/Ton. 2000 lb ammonium nitrate contains 680 lb N (2000 X 0.34 = 680). Thus, the price per lb of N is $0.51 (350/680= 0.51)
- Ammonium sulfate (21% N) costs $300/Ton2000 lb ammonium sulfate contains 420 lb N (2000 X 0.21 = 420). Thus, the price per lb of N is $0.71 (300/420= 0.71)

In addition to fertilizer costs, it is also important to consider the acidity potential of each N fertilizer source. Regardless of the source, N fertilization typically reduces soil pH. However, some N sources can cause a reduction in soil pH more rapidly than others. Thus, when choosing a N source, it is also important to account for additional costs associated with lime application. For instance, ammonium nitrate requires 0.61 lb of lime per lb of fertilizer, while ammonium sulfate and urea require 1.10 and 0.81 lb of lb of lime per lb of fertilizer to maintain soil pH.

Commercial fertilizer mix often provides multiple nutrients, which can be most economical in some situations. However, the N:P:K ratio of the fertilizer formula should coincide with the soil test recommendations to avoid unnecessary nutrient application. For instance, if a soil test indicates that P levels are adequate, producers should select fertilizer mixes that contain no P (i.e. 20-0-20).

Organic fertilizer sources such as animal manure and biosolids can satisfactorily provide N and other nutrients to forage grasses. When properly applied, these organic sources can be beneficial to agriculture with no negative impact on the environment. Another advantage of organic sources is that, because of the alkaline nature of some of these materials (i.e., lime-stabilized biosolids), they can increase soil pH and reduce costs associated with liming.

One important aspect to consider when using organic amendments is that the N present in these sources is not readily available to plants and total N is often a poor indicator of N availability. For instance, while only 40% of the total N in some biosolids materials may become available in the first year, up to 80 to 90% of the total N present in chicken manure may be available during the same period. As the organic compounds mineralize, N and other essential nutrients become available to the plants. Factors such as source, time and rate of application and environmental conditions can impact the effectiveness of organic materials in providing N to pastures. From an environmental prospective, because improper application of organic amendments may lead to excessive soil P concentrations and increase soil pH above the desirable range, it is important to monitor soil fertility after manure and/or biosolids application.

Timing and Rate of Fertilizer Application

Fertilizer should be applied when the forage is actively growing. For most warm-season grasses commonly used in Florida, such as bahiagrass, growing season does not start until night temperatures reach 60°F, which typically occurs in early spring. For establishment of new plantings, fertilizer should not be applied until plants have emerged. Nitrogen and K should be split-applied into two applications: after emergence and 30 to 50 days later. For hayfields, N and K should be applied after each cutting.

Unlike P and K recommendations, N application rates are not based on soil test results, but rather they are calculated based on expected yields. From an economic perspective, it is important to consider realistic yield expectations when calculating the amount of N that a pasture will receive. Improved grasses such as bermudagrass and stargrass usually require higher fertilizer application rates than bahiagrass pastures. Beside the forage species, another important aspect that should be considered is how much grass is needed. Do not fertilize pastures if forage production will not be consumed by grazing animals and/or harvested for hay. For instance, N fertilization will likely increase forage production and nutritive value but these benefits may not be economical if not converted into animal product. Thus, adequate stocking rate is another important variable to consider when choosing N rates.

Utilization of Forage N-Fixing Forage Legumes

Nitrogen-fixing legumes have the ability to convert atmospheric N into compounds that plants can use. Symbiotic fixation of N is achieved by the association of bacteria and the roots of legumes species. Normally the association between legume and bacteria species is very specific, so the efficiency of the symbiosis is largely dependent on the presence of the bacteria. Legumes are only able to fix N from the air if specific strains of bacteria are present in nodules on their roots. The seed must be inoculated before planting to ensure that the best strain of bacteria is present for each legume species. In addition, soil fertility (i.e. pH and cations) and environmental conditions also affect the efficiency of N fixation. The primary driving force in calculation of N fixation is legume yield. High yielding legumes fix more N.

Cool-season legumes grow the most in the spring when temperature and rainfall are favorable. Cool-season legumes are more widely used in North Florida because they more adapted to well drained soils and mild temperatures. Some clovers such as arrowleaf, ball, rose, and white clover produce a high percentage of hard seed which allows them to reseed if managed properly. Cool-season legumes are high in nutritive value and when grazed by beef cattle provide excellent animal performance. Annual clovers can contribute with about 75–100 lbs N/acre for the subsequent grass crop.

The most common warm-season legumes species adapted to Florida's conditions are perennial peanut (North-Central regions of the state), and aeschynomene (South region). Perennial peanut has primarily been used for hay production, while aeschynomene, an annual warm-season legume, is commonly used in beef cattle grazing systems.

The majority of the legume-N is transferred to the soil by unused plant material and/or animal excreta. Grazing animals can return more than 80% of the consumed nutrients to the soil through the feces and urine. If the legume crop is harvested and removed from the pasture as hay, haylage, or silage, the contribution of legume-N to the subsequent crop is reduced.

Grazing Management

Because a large proportion of nutrients are returned to the soil via animal excreta, grazing management can have significant impacts on soil fertility status. Significant amounts of N, P, Ca, Mg, and micronutrients can be recycled to the soil via animal feces and urine. However, because grazing animals tend to excrete near to water, shade and feeding area, homogeneous distribution of excreted minerals is typically a major challenge. The heterogeneous distribution of nutrients is not only undesirable in terms of forage management, but it may also result in high concentration of nutrients in small areas.

Grazing management can have a major role in maximizing the benefits of nutrient recycling in grazing pastures and, consequently, reducing the dependence on commercial fertilizer. Stocking rate and grazing method (rotational versus continuous) are important factors that may affect nutrient redistribution. Typically rotational grazing leads to a more homogeneous distribution of excreta. Research in Florida has shown that short grazing periods can increase the uniformity of excreta return as well as the efficiency of nutrient recycling compared to continuous grazing. Similarly, increasing the stocking rate may increase nutrient concentration and redistribution across the pasture but it may also lead to excessive nutrient accumulation in the soil. Environmental factors such as daily temperature and animal type may also affect animal grazing behavior and, consequently, nutrient redistribution in pastures.