Long-Term Cow-Calf Performance on Overseeded Bermudagrass Pastures at Different Stocking Rates and Fertility Regimens: 2022 Fertilizer Prices and Costs of Gain

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The "energy crisis" we thought we had encountered a few years ago was just an appetizer compared to the "servings" we're now experiencing in forage-animal production in 2022. Regardless of current domestic oil and gas production policies, captive supplies, import quotas, future inventories, fuel substitutes, or greed, the costs of living and doing business in the US has experienced dramatic price increases. With increased and seemingly ever-increasing energy prices, the costs of "doing business" have caused many to re-think their operating strategies. For the agricultural producer, not only have they experienced increased prices in fuel, fertilizers, and feed ingredients, but they also have had to deal with appraisal districts and increased taxes for all land uses. Management strategies and implementation options for pastures and beef production were drastically altered by the more than doubling of nitrogen fertilizer prices from 2003 to 2008. However, the 2008 prices for fuel and fertilizers were just the introduction to the policy decisions made in 2020 that caused some drastic increases in prices of fuel and fertilizers for 2021 and into 2022. With the current world-wide energy demands, escalating prices of feed grains, and uncertain supplies of oil and gas, beef producers have been forced into major reassessments of management input and cash-flow alternatives. The economic dilemma for producers is that there is no transition period to adapt to the new pasture-beef production cost paradigm. With no likely price reductions in fuel, fertilizer, and feed grains in either the short-term or long-term future, every cash input must be evaluated and scrutinized for potential returns.

Although there are no archived pasture-animal databases to answer all management concerns, there are some specific, long-term, fertilizer regimen x stocking rate experimental data for both common and Coastal bermudagrass from Texas A&M AgriLife Research at Overton (BeefSys, Rouquette et al, 2003). The text that follows will provide forage-animal experimentation information with discussions on general fertilizer x stocking rate management options and projected pasture production and forage persistence for cow-calf operations.

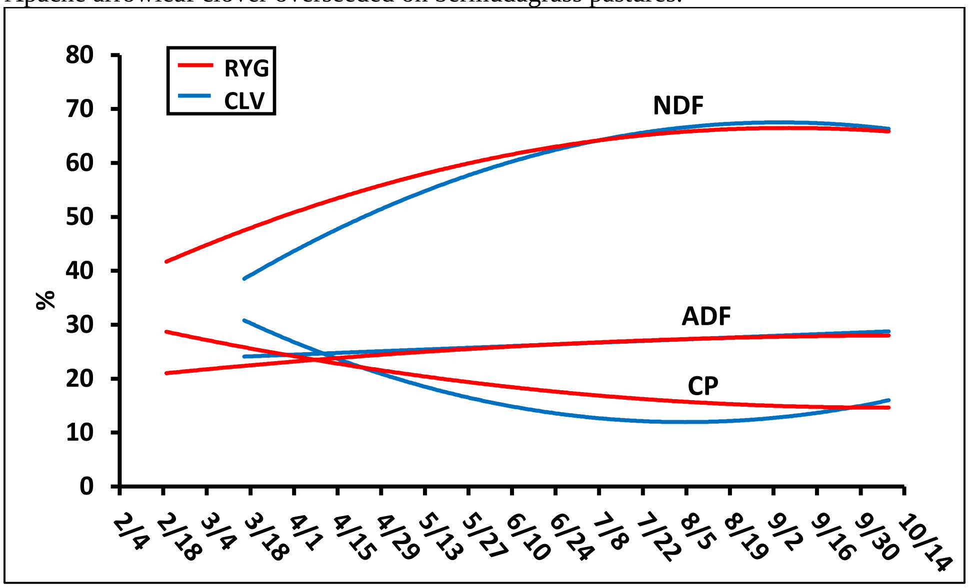
Recycled Nutrients and Cow-Calf Stocking Rates

Background. During the spring of 1968, common and Coastal bermudagrass pastures were established at the Texas A&M AgriLife Research and Extension Center at Overton. Initial pH ranged from 5.7 to 6.4 on these upland, sandy loam Coastal Plain soils. During the year of establishment, all pastures received 2 ton/ac lime (ECCE 65) and split-applications of fertilizer at a rate of 120-65-65 lb/ac N-P_2O_5-K_2O. Grazing was first initiated during the spring of 1969 with three stocking rates based on forage availability. Beginning in 1969, all pastures received a total fertilization rate during the growing period of 200-100-100 lb/ac N-P_2O_5-K_2O. Nitrogen was split applied at 50-65 lb/ac at each time of fertilization, whereas, P_2O_5 and K_2O were applied once at the initial spring fertilization. During the 1969 and 1970 grazing season (April to October) of 180-days, pastures consisted of bermudagrass only and were not overseeded. Common bermudagrass pastures were overseeded in the fall of 1970 with a mixture of 'Gulf' ryegrass and 'Dixie' crimson clover. Coastal bermudagrass pastures were evaluated as pure stands until overseeding with Gulf ryegrass and 'Yuchi' arrowleaf clover in the fall of 1974. From the initiation of grazing overseeded common bermudagrass in 1971 and overseeded Coastal bermudagrass pastures in 1975, all pastures have been overseeded with ryegrass and/or clover through 2022. The original fertilization strategy was to apply N-P_2O_5-K_2O at an approximate ratio of 2:1:1. The average annual fertilizer applications were 200-100-100 lb/ac N-P_2O_5-K_2 from 1969 through 1984.

In the fall of 1984, a nutrient cycling experiment was initiated and all stocking rate pastures for both common and Coastal bermudagrass were sub-divided equally into two fertility x winter annual forage treatments: 1) N + ryegrass, and 2) no N + K_2O + clover (Silveira et al. 2016). Phosphorus fertilizer was not included as a component of either N vs no N-fertility treatments because soil P concentrations were assessed to be adequate for grass or clover production. In addition, we wanted to eliminate long-term residual soil P buildup under stocking conditions. Fertilizer applications of either N-0-0 vs. 0-0-K_2O were used from 1985 through 1997. The N rates varied from an average of 408 lb/ac for four years from 1985-1989, 238 lb/ac from 1990-1994, 290 lb/ac for 1995-1996, 221 lb/ac for 1997, and an average of 250 lb/ac from 1998 through 2022. The annual K_2O rates averaged about 112 lb/ac through 2004, and then averaged about 60 lb/ac until 2022. From 1985-1997, no fertilizer P was applied. Beginning with the 1998 grazing season and continuing through 2022, all pastures received phosphorus, potassium, sulfur, magnesium, and boron. Phosphorus was applied at about 100 lb/ac P_2O_5 from 1998 through 2004, and then 60 lb/ac through 2022. However, only the N + ryegrass pastures received nitrogen fertilizer with 2022 rates of 250-60-60.

Stocking rates have varied by bermudagrass and fertility regimens according to forage mass available for meeting experimental protocol. Samples for forage mass (availability) were taken from each pasture by hand-clipping quadrats to ground level at initiation of stocking and at approximate 28-d intervals. Three stocking rates were achieved using a variable stocking rate (put-and-take) to create three levels of forage mass. The targeted forage mass ranged from 500 to 1000 lb/ac for High stocking rates, 1250 to 2000 lb/ac for Medium stocking rates, and > 2500 lb/ac for Low stocking rates. At approximate 14-d intervals, forage samples from each pasture were collected to assess nutritive value. At several locations in each pasture, hand-plucked forage samples that visually represented animal selectivity were collected. The selected plant parts collected represented >80% leaf and <20% stems. After drying, samples were ground to pass a 1mm screen and a sequential analysis of neutral detergent fiber (NDF) and acid detergent fiber (ADF) was made (Goering and Van Soest, 1970). Forage nitrogen was determined using a block digester colorimetric method via Technicon Auto Analyzer. Figure 1 illustrates changes in nutritive value components during the seasons from cool-season annuals to exclusive bermudagrass (Rouquette et al. 2018).

Figure 1. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and crude protein (CP) of annual ryegrass and Apache arrowleaf clover overseeded on bermudagrass pastures.



Long term, 30-yr, averages for stocking rates from mid-February to late September have approximated 0.95, 1.5, and 2.2 cow-calf pair/ac (1500 lb BW= 1 cow and calf) for common bermudagrass, and about 1.1, 1.7, and 2.8 cow-calf pair/ac for Coastal bermudagrass (Rouquette 2017). To accommodate overall length of cool-season and warm-season stocking seasons, rebreeding and calving season, and pasture size, fall-calving pairs were stocked on overseeded bermudagrass pastures from February to mid-June; whereas, winter-calving pairs were stocked on exclusive bermudagrass pastures from late June to late September or early October. Cattle from both calving seasons were exposed to bulls for 75 days. Animal performance for both calving seasons has been used to provide forage-animal relationships from February to October without disruptions for calving or breeding on test pastures (Rouquette et al. 2018).

Cow-calf Performance and Stocking Rates

The Average daily gain (ADG) responses to stocking rate for both fall-and winter-calving pairs shows season-long effects of stocking rate on both lactating cow and suckling calf for both Coastal (Fig. 2) and common bermudagrass (Fig. 3) overseeded with ryegrass + N or clover without N fertilizer. Both cow and calf ADG decreased with increasing stocking rates as anticipated. However, the impact of lactation showed a buffering effect on stocking rate impact on calf ADG. At low stocking rates with opportunities for selective grazing, calf ADG was more than 2.5 lb/day from either clover or ryegrass. With increased stocking rates, bermudagrass overseeded with ryegrass + N had greater calf ADG than clover without N. Cow ADG was positive at the low and medium stocked Coastal and low stocked common bermudagrass. At high stocking rates, cows lost 1 to 1.5 lb/day and had reduced body condition score (BCS). Additional data analyses showed that bred, lactating Brahman-influenced F-1 cows may be grazed at stocking rates that reduce BCS to 4 or less at weaning and recover BCS on bermudagrass pastures with ad libitum forage mass for 90% rebreeding (Rouquette et al., 2020).

Figure2. 29-yr average relationship of cow and calf ADG to stocking rate on Coastal bermudagrass overseeded with ryegrass (RYG) or clover (CLV)

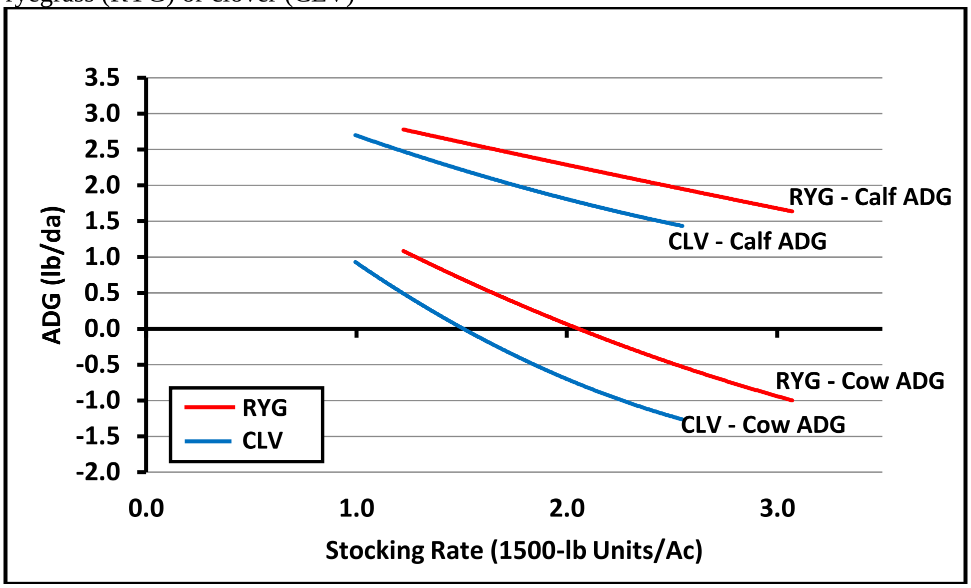


Figure3. 29-yr average relationship of cow and calf ADG to stocking rate on common bermudagrass overseeded with ryegrass (RYG) or clover (CLV)

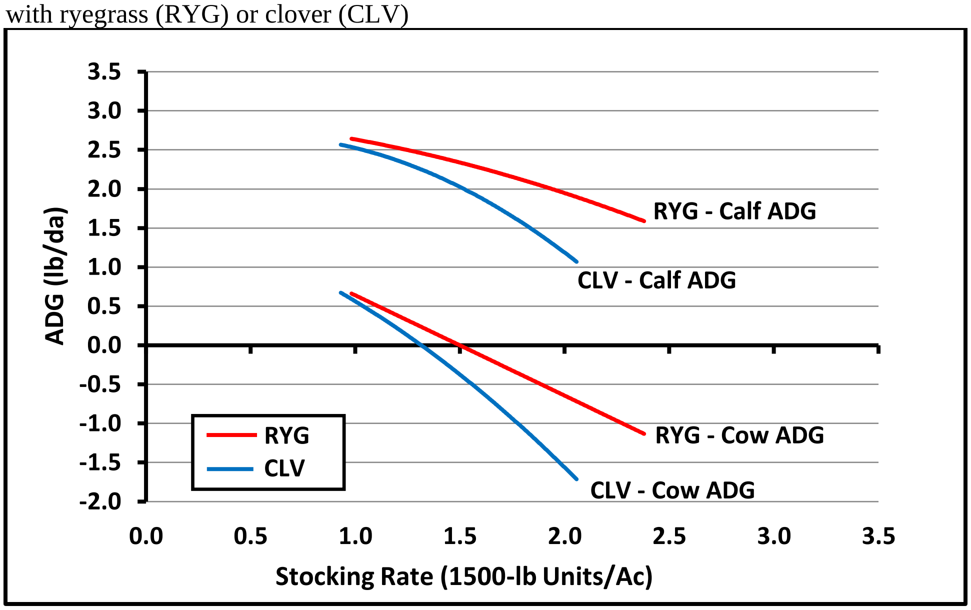
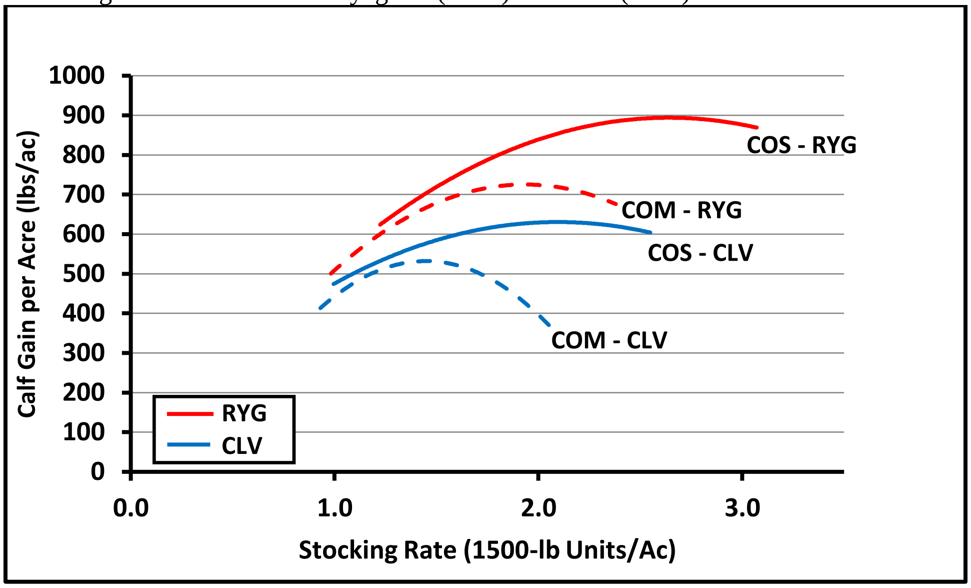


Figure 4 shows the 29-yr average suckling calf gain/ac was greater for Coastal overseeded with ryegrass due to more forage production from N-fertilized pastures. Common bermudagrass overseeded with clover and without N fertilization had the lowest calf gain per ac, and was most negatively affected by high stocking rate due to reduced forage mass.

Figure4. 29-yr average relationship of cow gain to stocking rate on common (COM) and Coastal (COS) bermudagrass overseeded with ryegrass (RYG) or clover (CLV)



The relationship of cow and calf ADG with level of forage mass is shown in Figure 5. Lactating cows required approximately 1800 lb/ac forage mass to maintain body weight. For optimum calf ADG, about 2500 lb/ac bermudagrass mass was required. Figure 6 shows the relationship of ADG with cow and calf forage allowance. Forage allowance is the relationship of forage dry matter (DM) with animal body weight (BW). Thus, the optimum forage allowance for cow ADG showed to be about 1.0 (DM:BW) (Fig 6). The optimum forage allowance for the suckling calf was about 0.90 (DM:BW) with lactation providing a buffer to stocking rate.

Figure5. 29-yr average relationship of cow and calf ADG to forage mass on common and Coastal bermudagrass overseeded with ryegrass or clover

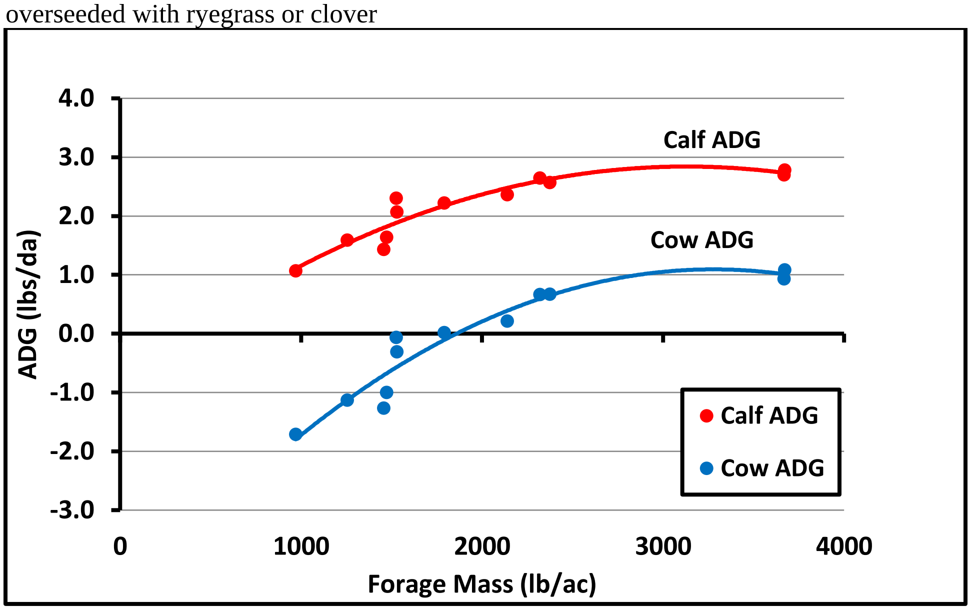
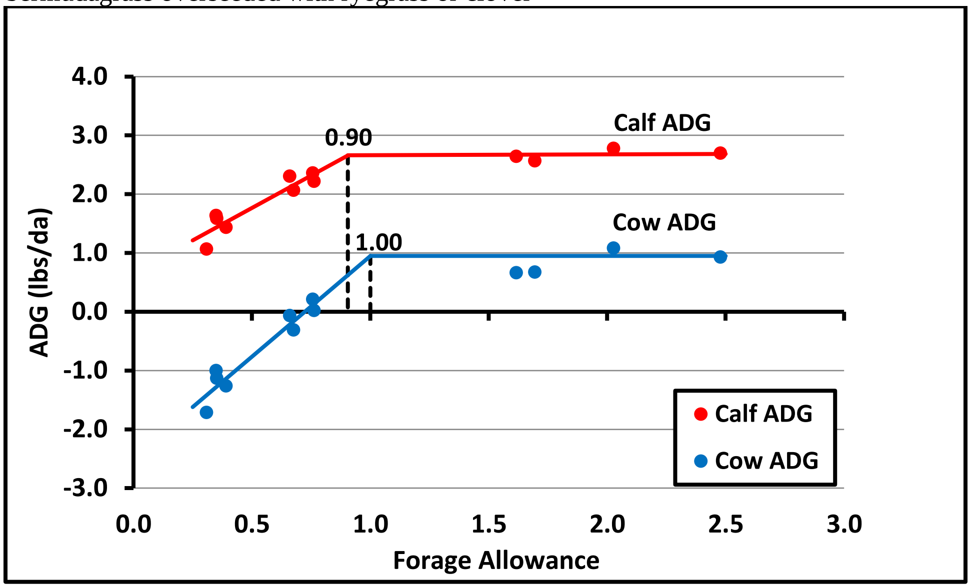


Figure6. 29-yr average relationship of cow and calf ADG to forage allowance on common and Coastal bermudagrass overseeded with ryegrass or clover



Fertilizer Costs

The 29-year average stocking rates and resulting suckling calf gain per acre are shown in Table 1. Calf gain per acre ranged from a low of about 450 to 470 lb/ac for clover without N overseeded on Coastal bermudagrass at a low stocking rate and common bermudagrass at both a low and high stocking rate (Fig 4 and Table 1). Using ryegrass and nitrogen on Coastal bermudagrass, calf gains were about 900 lb/ac at high stocking rates. There are numerous expenditures that may be used for estimating a year-long cow budget. Although seed and fertilizer expenditures represent the major pasture costs for overseeded bermudagrass pastures, only fertilizer prices will be included to provide an estimate of fertilizer costs/lb calf gain. Other costs associated with wintering, land costs, labor, interest, etc. must be included for accurate year-long expenses. Evaluating only fertilizer costs, it becomes readily apparent that the clover overseeded pastures have the least fertilizer costs per lb gain (Table 1). Bermudagrass overseeded with annual ryegrass and fertilized with 250-60-60 had fertilizer costs of $365/ac, with N costs at $1.10/lb. Thus, fertilizer costs/lb gain ranged from $0.40 /lb gain to $0.68 /lb gain. With N fertilizer cost at $0.75/lb, the fertilizer costs for overseeded ryegrass on bermudagrass was $268.50/ac. This reduced cost of N resulted in fertilizer costs/lb calf gain from $0.30 to $0.51/lb (Table 1). With increased costs of N fertilizer, Coastal bermudagrass would be the preferred pasture to fertilize with nitrogen and with a medium to high stocking rate depending upon management strategies for calf sales and body condition of cows at weaning. From the perspective of reducing risk plus the opportunity to harvest hay off the pastures, a lower stocking rate of about 1 to 1.5 acres per cow-calf unit during the February to October period may be a best management strategy.

Table 1. 29-year average stocking rate, suckling calf gain per acre, and fertilizer costs per pound of gain on Coastal (COS) and common (COM) bermudagrass pastures using 2022 fertilizer prices.

	Clover			Ryegrass			
						Cost of N	
						$0.75/lb	$1.10/lb
Bermudagrass	Stocking rate, pair/ac[1]	Calf gain, lb/ac	Fertilizer costs, $/lb gain[2,4]	Stocking rate, pair/ac[1]	Calf gain, lb/ac	Fertilizer costs, $/lb gain[3,4]	Fertilizer costs, $/lb gain[3,4]
COS – Low	0.99	470	$0.17	1.22	612	$0.44	$0.58
COS – Med	1.50	560	$0.14	1.88	796	$0.34	$0.45
COS – High	2.55	610	$0.13	3.07	894	$0.30	$0.40
COM – Low	0.93	446	$0.18	0.98	522	$0.51	$0.68
COM – Med	1.47	537	$0.15	1.55	727	$0.37	$0.49
COM – High	2.06	454	$0.18	2.38	779	$0.35	$0.46

[1]One cow-calf pair = 1500 lb body weight

[2]Clover fertilizer: 0-60-60 = $81/ac

[3]Ryegrass fertilizer: 250-60-60; with N @ $1.10/lb = $356/ac; with N @ $0.75/lb = $269/ac

[4]Fertilizer component costs: P_2O_5 = $0.65/lb; K_2O = $0.70/lb; N varies between $0.75/lb to $1.10/lb

Pasture-Beef Cattle Fertilizer Management Options

The basic fact for all pasture-livestock producers to remember is that grass production is nitrogen dependent. The basic forages for pastures in Texas, as well as in most of the Southwest and Southeastern US, are warm-season perennial grasses. This category of forages includes bermudagrass, bahiagrass, dallisgrass, and numerous other introduced and native species. In many areas of Texas, nitrogen-containing fertilizers have been a regular part of hay and pasture production for livestock. The immediate and perhaps long-term extended changes in fertilization use on forages for pasture and/or hay will be dependent upon numerous factors including: 1) price of fertilizer; 2) price of cattle; 3) forage requirements for soil N-P-K and lime to meet pasture and/or hay needs; 4) economic stocking rate that is sustainable with moderate, minimum, or no fertilization; and 5) alternative land-use, leasing, and with or without livestock. Thus, some of the management questions may include…"How many cattle can my pastures accommodate with reduced or eliminated fertilizer input?" "How sustainable are my perennial grass pastures without nitrogen fertilizer?" "How long can I "mine" these pastures?" "Should I produce or purchase hay?" "Can I afford to use winter annual forages?" "If I make only one application of nitrogen, what is the best rate and when is the best time of the year to fertilize?" "Should I consider stocker cattle in my operation?" "Should I substitute supplementation for fertilizer?" "Should I lease more land…or lease my own land to someone else?" The primary management concerns remain focused on how to offset cow costs associated with fertilizer, hay, supplemental feed, fuel, etc. with projected percent calf crop weaned, sale weight of calves, retained ownership, and culling of cattle.

Cow-calf and/or stocker operations from pastures require on-going management decisions to adjust for seasonal and total forage production-availability, animal performance expectations, wintering costs, and other operating expenses. In general, rainfall and temperature fluctuations and soil nutrient status control forage production. Thus, stocking rate adjustments dictate requirements for fertilizer, hay, and/or supplemental feed to meet animal performance expectations. For cow-calf producers, wintering costs associated with hay and supplement to maintain cow condition for calving and rebreeding are responsible for a substantial part of the 12-month cow costs. Thus, fertilizer management during the summer months, hay production or purchase, and inclusion of winter annual pastures requires primary consideration during escalating input prices. In response to increased fertilizer prices, management may choose an array of options; however, these strategies will likely include one of the following: 1) eliminate all fertilizer; 2) reduce fertilizer to minimum applications; or 3) continue with moderate fertilization applications. With any strategy, there is an action followed by reaction or adjustment due to those decisions. Some of the action-reaction scenarios for fertilizer management may include some of the checklist items that follow:

Eliminate All Fertilizer

1. Obtain a soil test analysis. If soil status of pH, P, etc are acceptable, then clovers may be overseeded for late winter-early spring grazing. These grazed clovers provide a source of nitrogen fixation via excreta and these nutrients are available for use by bermudagrass or other warm-season forage. This recycling of nutrients stimulates forage production and reduces the “soil mining” effects.
2. Reduce stocking rate and/or lease additional pastureland to account for reduced forage production.
3. Hay requirements may be met by purchasing hay based on nutritive value and weight. However, if clovers are components of the pasture system, then allowing them to set seed with hay harvest after seed maturation will provide some of the hay requirements. In addition, these clover seed-abundant hay bales can act as a method of reseeding pasture areas, and this process is enhanced by “unrolling” the round bales onto new seeding areas during the autumn.
4. Supplementation may be required during the wintering period depending upon nutritive value of hay and/or deferred pasture for “standing hay.”
5. Time of calving may have to be adjusted to fit the seasonal availability of forage nutrients and dry matter from pasture and/or hay. In general, if winter annual forages are not components of this system, then a late spring calving may best fit pasture conditions without prolonged supplementation of the cow herd.
6. Herbicide applications and/or mowing of pastures will be required to control annual weeds and perennial woody species that will invade pastures.
7. Bahiagrass and common bermudagrass will initially dominate these pastures with an extended absence of N-fertilizer. Subsequent invasion by other annual and perennial grasses may become more predominant with time.

Reduce Fertilizer to a Minimum Amount

1. Obtain a soil test analysis.

2. Fertilizer strategies based on soil analysis may include non-Nitrogen fertilizer plus overseeded clovers with required lime and/or Phosphorus fertilizer.
3. Other fertilizer strategies may include overseeding with annual ryegrass with one or two winter N applications (50 lb/ac) to stimulate ryegrass and/or one or two spring-summer N applications (50 lb/ac) to stimulate bermudagrass, bahiagrass, etc.
4. Strategic, timely application of N is imperative to match climatic conditions and best utilize the optimum effectiveness of N rate and forage production.
5. Hay requirements may be met with harvest of clover and/or ryegrass at seed maturation, or by purchasing hay based on nutritive value and weight.
6. Evaluate forage conditions for proper stocking rate and incorporate a regimented cow culling procedure based on performance.
7. Herbicide applications and/or mowing may be required to control annual weeds and perennial woody species.
8. Some forage species composition changes will likely occur on non N-fertilized pastures with increases in bahiagrass and assorted ecotypes of common bermudagrass.

Continue With Moderate Fertilization

1. Obtain a soil test analysis for use with overseeded winter annual clovers, ryegrass, and/or small grains.
2. Apply lime (ECCE-100) as appropriate primarily for cool-season annual forages.
3. Consider rates of 50 to 60 lb N/ac for each application with the potential of 3± applications on small grain + ryegrass, 2± applications on ryegrass, and/or 2 to 3 applications during the exclusive bermudagrass phase.
4. Increase forage production-utilization efficiencies by harvesting hay and/or utilization of stocker calves (retained and/or purchased).
5. Consider selling excess hay.
6. Adjust calving and weaning dates for increased weaning percent and weaning weight.
7. Apply herbicides to eliminate competition for nutrients, water, and space.

Stocking Strategies and Nutrient Cycling

Stocking strategies and nutrient cycling have inseparable relationships, and in the course of stable or diminishing cattle prices and unstable and increasing costs of fertilizer, fuel, and feed grains, there is an increased dependency on recycled nutrients for forage production. Management strategies are personal and “zip code specific.” Using the long-term fertility regimen x stocking rate nutrient cycling database from Texas A&M AgriLife Research-Overton as a model for management strategies, the following options should be considered for production and costs for specific sites:

- Pastures in the Pineywoods Vegetational region at Overton had a 15-year history of N-P-K applications from 1969 through 1984. Once fertilization strategies were changed and implemented, soil P was deemed to be at moderate to high levels. However, from 1998 to 2022, P_2O_5 had been applied. The soil nutrient "base" determines the fate of reduced fertilization of pastures. A soil test analysis provides this information on suggested rates of fertilizer and limestone.

- By eliminating all N fertilizer and overseeding bermudagrass with an adapted clover, pastures continued to be stocked from about March 1 through September. And, at low stocking rates of 1.5 to 2.0 acres per cow-calf pair, forage will likely be sufficiently abundant to minimize risks due to climate. However, at high stocking rates, bahiagrass and various bermudagrass ecotypes are likely to invade the pastures. Perhaps more important is that the absence of N fertilization on bermudagrass pastures allows for increased opportunities for weed invasion, which in turn, requires herbicide applications or mowing.

- When applying only N fertilizer and eliminating P_2O_5 and K_2O, overseeded ryegrass on bermudagrass has provided a more reliable winter-spring forage supply to initiate grazing by mid- to late February. Ryegrass is more tolerant of dry conditions and frequent defoliation compared to clovers. With the N + ryegrass strategy, nutrient cycling is active and suggested N fertilization may include one to two applications of 50 lb/ac N for ryegrass period and one to two applications of 50 lb/ac N for the bermudagrass growing phase. Annual ryegrass, however, is not tolerant to low soil pH of less than 5.0 to 5.5; thus, soil tests and limestone recommendations are required management strategies.

As forage-cattlemen move into the next paradigm of input costs, the "secrets for success" are closely tied to "using forages that produce and animals that perform." This mandates that every aspect for the forage-cattle operation must be critically evaluated. For many operators who choose to eliminate most if not all fertilizers, the long-term experimentation at Texas A&M AgriLife Research-Overton suggests nutrient cycling is a valuable asset for forage production. And, some species composition changes will occur once N fertilizer is removed for prolonged durations. Some of the checklist management strategies that may be implemented to counter increased fertilizer, fuel, and feed prices include the following:

1. Create a pasture management plan of action that is firm but flexible.
2. Implement a fertilization strategy via soils test and reason(s) for need.
3. In many situations, the most cost-effective fertilizer strategy is to apply one or two applications of only Nitrogen at 50 to 60 lb/ac per application.
4. Hybrid bermudagrasses such as Coastal or Tifton 85, for example, produce more forage per unit of N fertilizer compared to common bermudagrass.
5. Add legumes to the pasture system after assessing soil analysis and pH.

6. Use broiler litter as a nutrient source.
7. Increase efficiency of forage utilization for specific classes of cattle.
8. Make hay from pastures and eliminate exclusive hay meadows.
9. Purchase hay based on nutrient analysis and weight of package.
10. Make strategic, timely herbicide applications as warranted.
11. Maintain accurate, up-to-date cattle records for culling options.
12. Reduce stocking rate.
13. Enhance weaning percent, weaning weight, and/or weight at time of sales.
14. Alter weaning schedule and consider retained ownership options for stockers with or without supplementation.
15. Critically assess supplementation strategies, product cost, and supplement to extra gain conversion.
16. Market cattle proactively through special sales, etc.

The “rules” for management have changed with increasing fertilizer and fuel costs for operating pastures-livestock systems. Although the “game” does not “look like” the more familiar one of a few years ago, the “game plan” remains the same. And, that is to set production targets, manage to manipulate forage utilization systems to enhance economic returns, and sustain the soil – plant resources.

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