PASTURE-BEEF CATTLE MANAGEMENT OPTIONS WITH INCREASED COSTS OF FERTILIZER, FEED GRAINS, AND FUEL: STOCKING STRATEGIES AND NUTRIENT CYCLING

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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. Regardless of current oil and gas production, 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 to deal with appraisal districts and increased taxes. Management strategies and implementation options for pastures and beef production have been drastically altered by the more than doubling of nitrogen (N) fertilizer prices from 2003 to 2008. With the current world-wide energy demands, escalating prices of feed grains, and captive 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.

Grass production is nitrogen dependent. The basic forage for pastures in Texas, as well as in most of the grazing lands of the world, 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 of forage for pasture and/or hay will be dependent upon numerous factors including: 1) price of cattle; 2) forage requirements for soil nitrogen-phosphorous-potassium (N-P-K) and lime to meet pasture and/or hay needs; 3) economic stocking rate that is sustainable with moderate, minimum, or no fertilization; and 4) alternative land-use 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 or perennial forages?" "If I make only one application of nitrogen when is the best time of the year to fertilizer?" "Should I consider stocker cattle in my operation?" "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, and cull animals.

Pasture-Beef Cattle Management Options

Cow-calf and/or stocker operations on 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. And, 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 times of 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; 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 scenarios that follow:

Eliminate All Fertilizer

1. Obtain a soil test analyses. 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 nutrient 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 ecotypes of common bermudagrass will initially invade and eventually dominate these pastures with an extended absence of N-fertilizer. Subsequent invasion by other annual and perennial weeds may become more predominant with time.

Reduce Fertilizer to a Minimum Amount

1. Obtain a soil test analyses
2. Fertilizer strategies based on soil analyses 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 application (50 lbs N/ac) to stimulate ryegrass and/or one or two spring-summer N application (50 lbs N/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 to purchase 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 analyses 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 weaned dates for increased weaning percent and weaning weight.
7. Apply herbicides to eliminate competition for nutrients, water, and space.

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 AgriLife Research at Overton. 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 and stocker operations.

Recycled Nutrients and Cow-Calf Stocking Rates

Background. (Taken from Rouquette et al RCTR 2006-1) During the spring of 1968, common and Coastal bermudagrass pastures were established at the Texas 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 tons/ac lime (ECCE 65), and split-applications of fertilizer at a rate of 120-65-65 lbs/ac N-P_2O_5-K_2O (Table 1). 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 lbs/ac N-P_2O_5-K_2O. Nitrogen was split applied at 50-65 lbs/ac at each 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 2008. The original fertilization strategy was to apply N-P_2O_5-K_2O at an approximate ratio of 2:1:1. Although fertilizer rates were reduced by half during 1974 and 1975, the average annual fertilizer applications approximated 200-100-100 lbs/ac N-P_2O_5-K_2 from 1969 through 1984 (Table 1).

Table 1. Annual fertilization rates for all bermudagrass pastures.[1]

Year	Lime	N	P_2O_5	K_2O
	tons/ac	------------------lbs/ac------------------------		
1968	2 (all pastures)	120	65	65
1969 thru 1973		200	100	100
1974 and 1975		110	50	50
1976		175	50	50
1977		220	100	100
1978		200	70	70
1979		175	100	100
1980	2 (all pastures)	225	100	100
1981	1 (all pastures)	225	100	100
1982		195	100	100
1983		250	100	100
1984	1 (all pastures)	200	100	100

[1] Rouquette et al. Research Center Tech. Report 2006-1.

In the fall of 1984, a nutrient recycling 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. 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 initiated in 1985 through 1997 (Table 2). The N rates varied from an average of 408 lbs/ac from 1985-1989, 238 lbs/ac from 1990-1994, 290 lbs/ac for 1995-1996, and 221 lbs/ac for 1997. The annual K_2O rates averaged about 112 lbs/ac. During this 13 year period, 1985-1997, no fertilizer P was applied. Beginning with the 1998 grazing season and continuing through 2005, all pastures received phosphorus, potassium, sulfur, magnesium, and boron; however, only the N + ryegrass pastures received nitrogen fertilizer (Table 2). The annual application rates of N have ranged from 213 lbs/ac to 360 lbs/ac, and P_2O_5 and K_2O rates ranged from 100 to 135 lbs/ac from 1998 through 2004 and were reduced to about 50 lbs/ac each in 2005. Fertility ratios were altered in 2007 to reduce applications of S, Mg, and B.

Stocking rates have varied by bermudagrass and fertility regimens. Long term averages for stocking from mid-February to late September have approximated 0.75, 1.3, and 2.0 cow-calf pair (1500 lbs BW/acre) for common bermudagrass and about 1.0, 1.7, and 3.0 cow-calf pair/ac for Coastal bermudagrass.

Table 2. Annual fertilization rates for bermudagrass pastures receiving Nitrogen plus ryegrass and no-Nitrogen plus clover.[1]

Year	Lime tons/ac	N +Ryegrass	no –N +Clover
		N-P_2O_5-K_2O-B (lbs/ac)	
1985	2 (all pastures)	408-0-0	0-0-114
1986		400-0-0	0-0-100
1987	1 (all pastures)	400-0-0	0-0-100 +2
1988		450-0-0	0-0-150 +1.5
1989		400-0-0	0-0-120 +1.5
1990		250-0-0	0-0-112 +1.5
1991	2.25 (N only)	250-0-0	0-0-100 +1.5
1992 thru 1993		250-0-0	0-0-125 +1.5
1994	1 (N-only)	190-0-0	0-0-114 +2
1995 and 1996		290-0-0	0-0-108
1997	0.5 (N only)	221-0-0	0-0-120
		N-P_2O_5-K_2O-S-Mg-B (lbs/ac)	
1998		255-100-100-44-22-1	0-100-100-44-22-1
1999		360-114-114-50-27-1.2	0-114-114-50-27-1.2
2000		255-135-133-60-32-1.4	0-135-135-60-32-1.4
2001		306-100-100-44-24-1.1	0-100-0100-44-24-1.1
2002	1 (all pastures)	365-120-120-53-29-1.2	0-120-120-53-29-1.2
2003		365-120-120-53-29-1.2	0-120-120-53-29-1.2
2004		213-116-116-52-27-1.2	0-116-116-52-27-1.2
2005		306-48-48-42-22-1	0-48-48-42-22-1
2006		203-41-41-86-19-1	0-41-41-36-19-1
2007		272-50-50	0-50-50

[1] Rouquette et al. Research Center Tech. Report 2006-1.

Soil P Concentrations (Taken from Silveira et al RCTR 2006-1) Initial soil P concentrations in 1969 were very low (< 3 ppm). This was consistent with non-fertilized, P-deficient sandy Coastal Plain soils. Soil P concentrations in the 0-6 inch depth significantly increased (up to 10-fold) from 1975 to 1985 as result of P fertilizer application (~100 lbs P_2O_5/ac year) (Fig 1). Sixteen years (1969-1985) of P application (total P load of 1,500 lbs P_2O_5/ac) shifted soil P status from very low (0-5 pm) to high (21-40 ppm). This increased soil P level enhanced forage growth, especially ryegrass and clover. During 1985 to 1997, bermudagrass pastures received no inorganic P fertilizer; thus, the major P contributions to the soil occurred via nutrient recycling as animal excreta. Average soil P concentrations in 1985 were approximately 33 ppm for common and 27 ppm for Coastal bermudagrass. In 1996, soil P concentrations were comparable to those in 1985 (31 ppm for common and 24 for Coastal), suggesting that P was not depleted during 11 years of continuous stocking with no P-fertilizer applied. Nutrient cycling through animal residues and prior history of P application sustained relatively constant P concentrations in the 0-6 inch depth of soils.

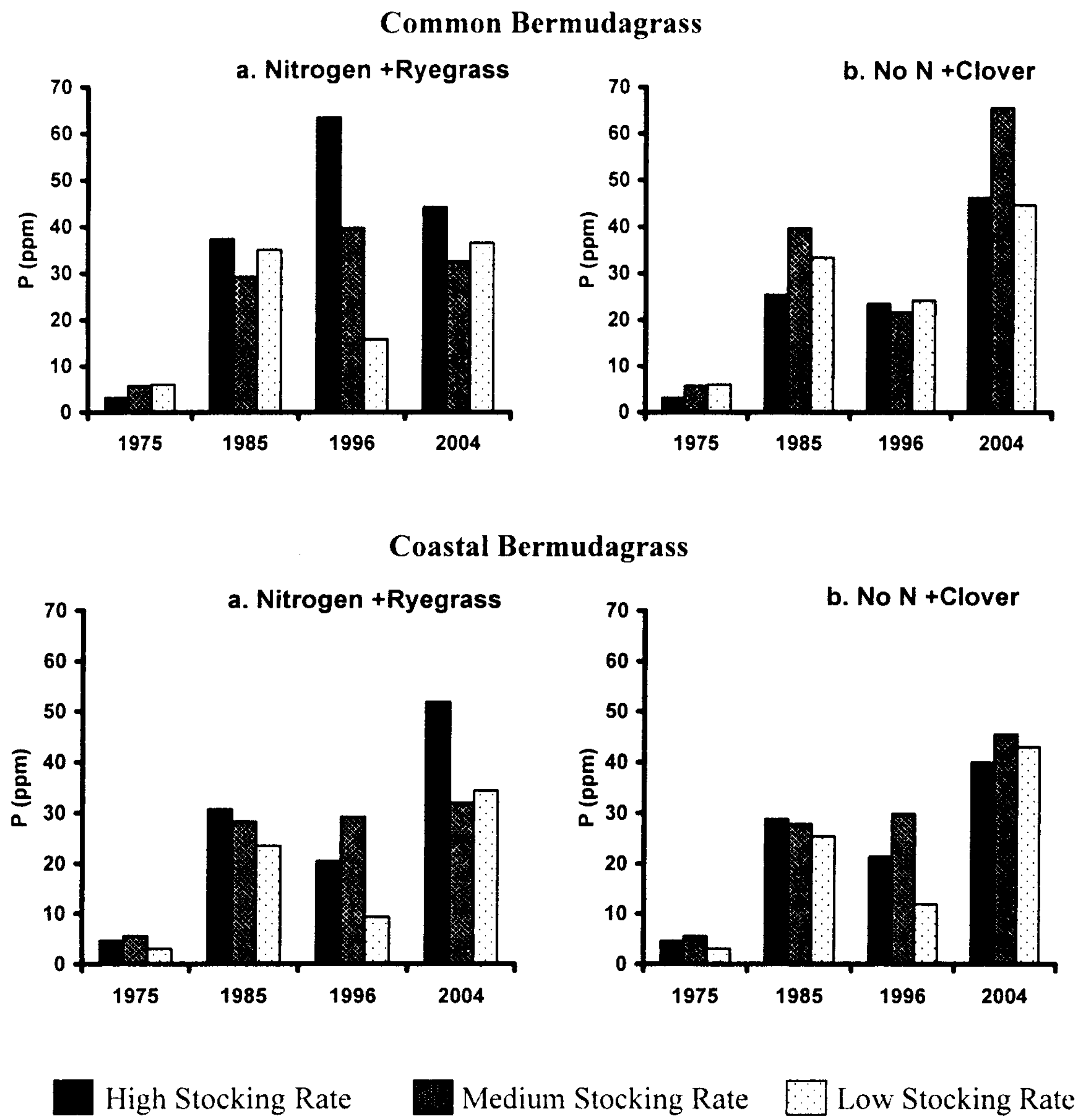


Figure 1. Changes in soil P concentrations (0-6" soil depth) in common and Coastal bermudagrass pastures after 29 years of continuous grazing at different stocking rates and fertility regimens. (Silveira et al Research Center Tech. Report 2006-1).

In general, soil P concentrations were similar in common and Coastal bermudagrass pastures with different fertility regimens (Fig 1). From 1985 to 1996 there was a slight decrease in soil P concentrations at low stocking rates (1 pair/ac) for both common and Coastal bermudagrass pastures. This suggested that animal excreta was playing an important role in P recycling. Relatively small increases in soil P concentrations were observed in common bermudagrass fertilized with N under high stocking rates (2 to 3 cow-calf pair/ac) from 1985 to 1996; however, this difference was not statistically significant. From 1999 to 2004, P fertilizer was applied at 100 lbs/ac P_2O_5. Soil P concentrations in the 0-6" depth increased across all treatments, except for common bermudagrass pastures under high and medium stocking rates. Increases in soil P due to fertilization during this 5-year period were more evident in pastures under low and medium stocking rates.

With continuous stocking of Coastal bermudagrass, soil P concentrations were nearly two times greater at high stocking rates (2-3 cow-calf/ac) than at the low stocking rates (1 cow-calf/ac) (Fig 2). Differences in soil P concentrations due to stocking rates were mainly observed in the top 48-in soil depth. In contrast, deeper soil depths showed no evidence of stocking rates affecting P concentrations. Across all treatments, P concentrations decreased significantly with soil depth. This trend was expected, since P has slow mobility in the soil profile and tends to preferentially accumulate in the surface horizons in grazed pastures due to above ground contributions from fertilizer, animal wastes, and nutrient recycling.

Nutrient cycling through animal excreta can sustain adequate soil P concentrations for optimum bermudagrass production. Overseeded ryegrass and clover growth are especially favored by adequate soil P levels. Coastal plain soils previously fertilized with P sustained relatively constant soil P concentrations during 11 years of no-P fertilizer. Phosphorus fertilization, however, can considerably affect soil P concentrations, and, thus, adequate fertilization rates and intervals of application should be carefully managed to minimize potential environmental concerns associated with accumulation of P in soils and subsequent edge-of-field P losses. Coastal bermudagrass pastures with prior history of P fertilization can maintain adequate soil P concentrations for several years under continuous stocking. Under low stocking rates, soil P will deplete faster than at high stocking rates. Animal manure can recycle substantial amounts of P and sustain adequate bermudagrass growth in Coastal Plain soils. During more than 35 years of grazing, there was no evidence that P was accumulating in soils at levels that may potentially become an environmental hazard.

Soil Nitrate-Nitrogen Concentrations (Taken from Silveira et al RCTR 2006-1) Soil NO_3-N concentrations significantly increased from 1985 to 1989 in bermudagrass pastures overseeded with ryegrass and fertilized with about 408 lbs N/ac annually (Fig 3). Excess N (not used for plant uptake) was contributing to NO_3 accumulation in the 0-6" soil depth. However, compared to the annual N load, increases in soil NO_3-N were negligible after four years of relatively high N application rates. During this 5-year period, bermudagrass pastures overseeded with ryegrass received approximately 2,000 lbs N/ac, while soil NO_3-N status increased less than 10 ppm (~ 20 lbs N/ac). This suggested that plant uptake was recovering a significant fraction of the applied and recycled N Coastal bermudagrass produces more total dry matter than common bermudagrass. Thus, soil N was likely more efficiently used for plant uptake by Coastal bermudagrass.

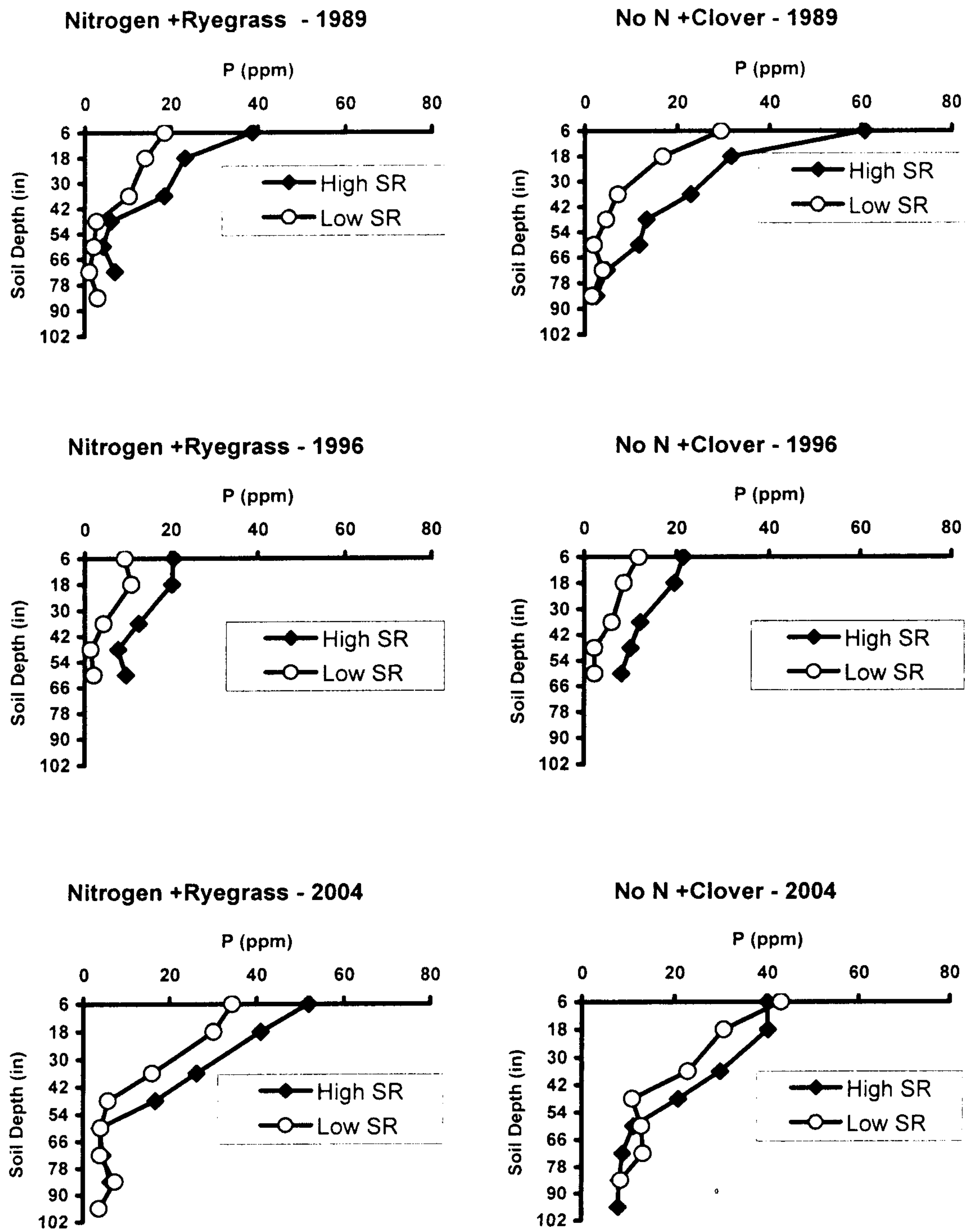
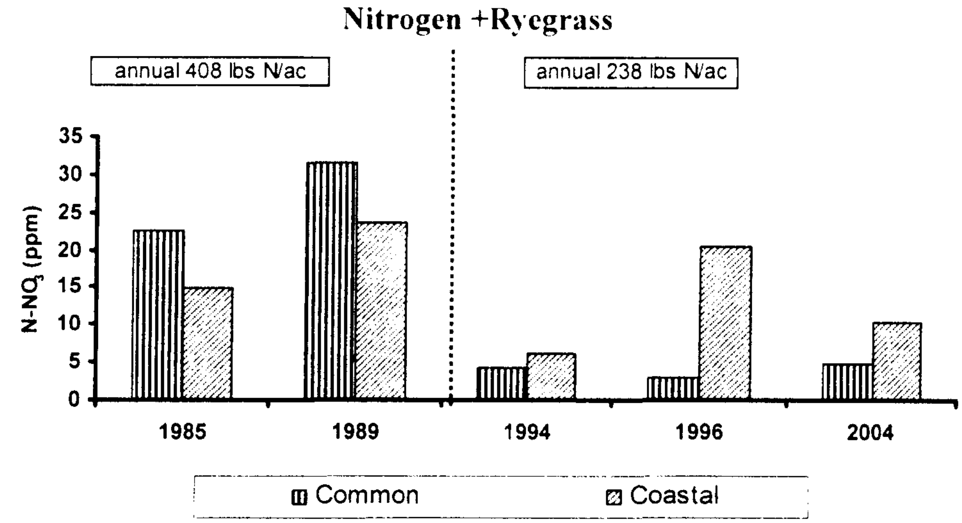


Figure 2. Phosphorus distribution in the Coastal bermudagrass soil profile as a function of different stocking rates (SR) and nitrogen fertilization. (Silveira et al Research Center Tech. Report 2006-1).



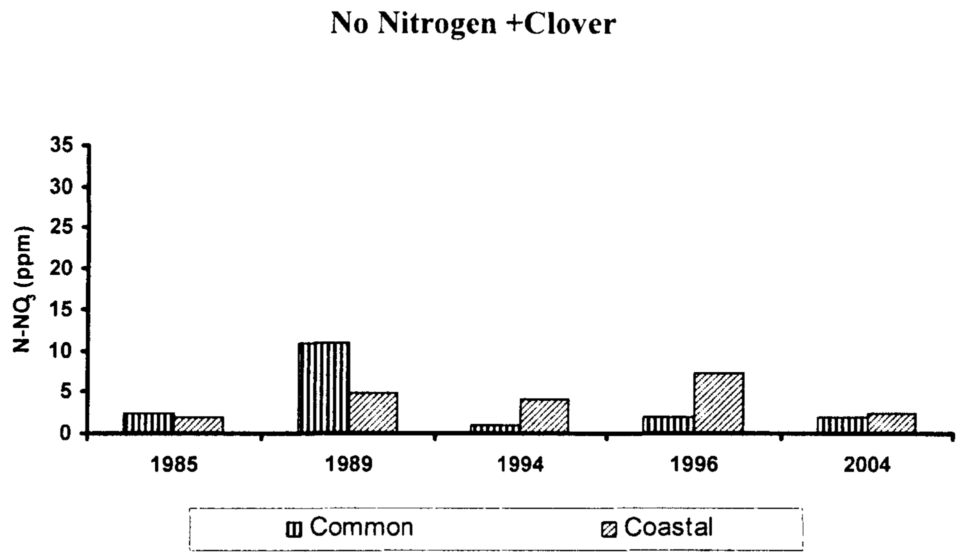


Figure 3. Changes in soil NO_3-N concentrations in the 0-6" soil depth of bermudagrass pastures with different fertility regimens. (Silveira et al Research Center Tech. Report 2006-1).

From 1989 to 2004, annual N fertilization rates were reduced to ~ 200 lbs N/ac, and there was a dramatic decrease in soil NO_3-N concentrations, especially in common bermudagrass pastures. Pastures overseeded with clover and not fertilized with N had much lower soil NO_3-N levels than N-fertilized ryegrass pastures. Although no N had been applied to the clover pastures since 1984, soil NO_3-N concentrations were relatively constant over 35-years of continuous stocking. Fixation of atmospheric N_2 by clovers and subsequent recycling via animal excreta maintained adequate levels of available N for modest forage production. Stocking rates varying from 1 to 2-3 cow-calf pair/ac showed no effect on soil NO_3-N concentrations. From 1994 to 2004, soil NO_3-N concentrations were greater for Coastal bermudagrass (average = 8.5 ppm) compared to common bermudagrass (average= 2.8 ppm). Both common and Coastal pastures at the high stocking rates had substantial changes in forage species composition. On Coastal bermudagrass pastures, there was a dramatic shift to multiple ecotypes of common bermudagrass to the extent that only about 30% of this pasture was Coastal and about 70% was mixed common types in 2008. On the non-N fertilized, high stocked common bermudagrass pastures, bahiagrass occupied about 45% of the area in 2008.

Soil NO_3-N concentrations on Coastal Plain, sandy soils, are strongly related to the fertilizer management. Large N application rates (greater than plant uptake) may result in NO_3 accumulation in soils and rapidly increase soil acidity. Environmental risks associated with N losses may occur. Excessive soil drainage associated with the warm and humid climate of east Texas may favor N losses via leaching and denitrification in heavily N fertilized sandy soils. Bermudagrass pastures overseeded with clover, with no N-fertilization for the previous 20-years, sustained moderate production of bermudagrass with significant species changes at the high stocking rate. Despite the inherent seasonal and spatial variability associated with NO_3 in soils, relatively constant NO_3 concentrations with time is an indication that N has been efficiently recycled via animal excreta in bermudagrass pastures overseeded with clover. Clover is an environmental and economic alternative to N fertilization, and can be integrated into fertility strategies for forage production for pastures and hay.

Soil Potassium Concentration (Taken from Silveira et al RCTR 2006-1) Extractable soil K concentrations in the 0-6" soil depth were consistently low, and ranged from ~ 7 to 150 ppm (Fig 4). On average, soil K concentrations were rated as either very low (0-90 ppm) or low (91-130 ppm). The only exception occurred in 1994, when extractable soil K increased on high stocking rate common bermudagrass pastures overseeded with clover + K_2O and no applied N. Potassium is utilized by forages in relatively large quantities, usually as great as N; therefore, soil levels can be considerably depleted due to plant uptake. Because K is mobile in soils, residual K (not used by plants) can be leached to deeper soil depths. Although larger K concentrations were usually observed in pastures that received no N, overseeded with clover and average annual application rates of ~100 lbs K_2O/ac for 35 years (Tables 1 and 2), K concentrations in the top 0-6-in soil depth were variable but not significantly greater than that in the bermudagrass pastures receiving only N and overseeded with ryegrass (Fig 4). Pastures fertilized with N and overseeded with ryegrass received no K for 13 years (1985-1997), and soil concentrations were relatively constant with time. From 1998-2004, all pastures received about 100lbs/ac K_2O (Table 2). Plant and animal wastes recycled K to maintain low soil levels. There was no clear effect of different stocking rates on soil K concentrations. The surface horizon (0-6") of Coastal Plain soils may not

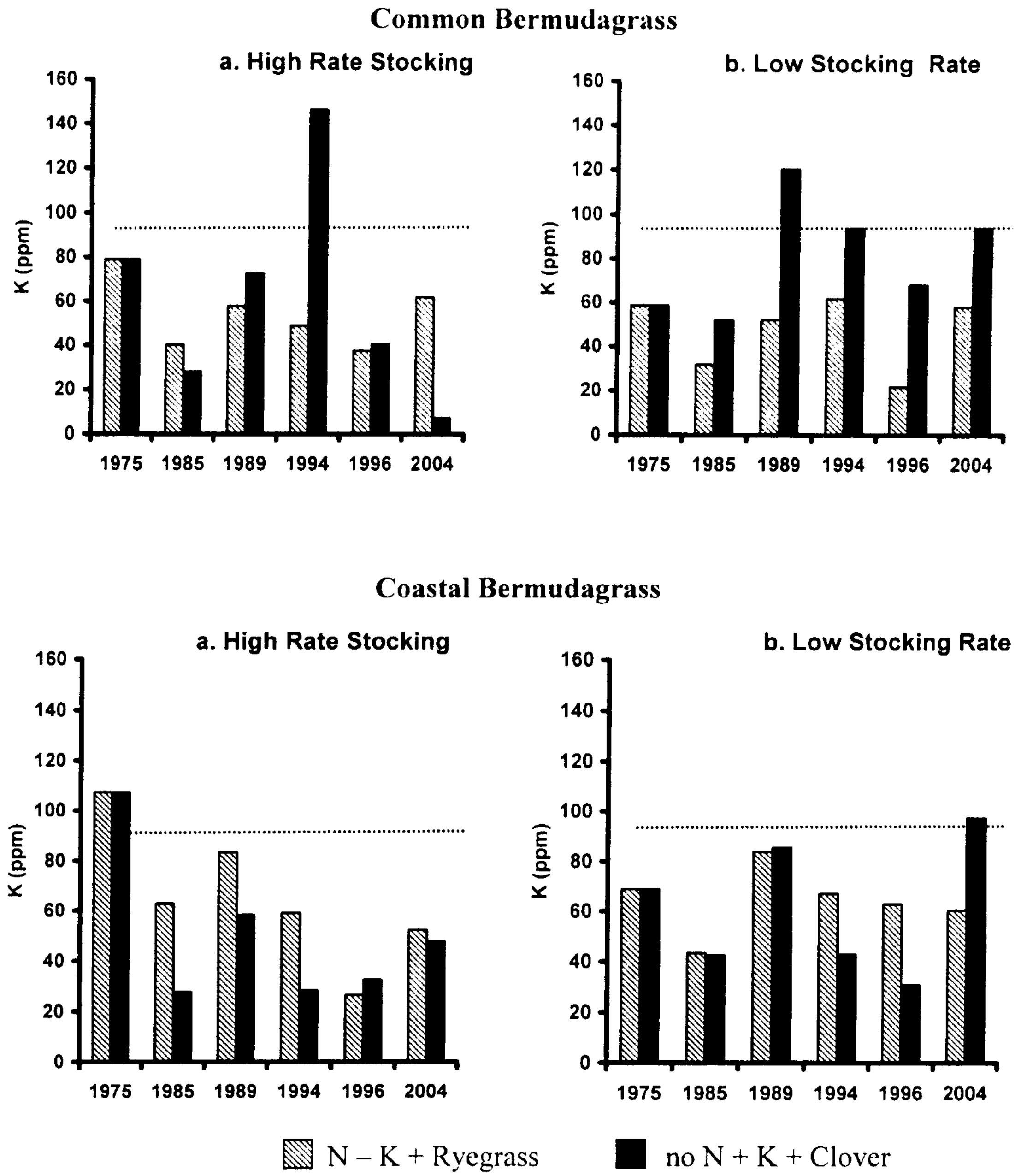


Figure 4. Changes in soil K concentrations (0-6") in bermudagrass pastures under different stocking rates and fertility regimens. Dashed lines represent limit between very low and low K concentrations in soils. (Silveira et al Research Center Tech. Report 2006-1).

supply adequate amounts of K for optimal forage growth. The large K requirements of forages rapidly depletes soil K concentrations in the surface soil depths. Because of the coarse texture and poor sorbing capacity of these soils, residual K eventually leaches to deeper soil depths. Nutrient recycling via plant and animal wastes in grazed pastures contribute to maintain low levels of K in soils, but K fertilization must be included in soil fertility management strategies in order to maintain sustainable bermudagrass production on Coastal Plain soils. Relatively low K fertilizer inputs may be feasible for bermudagrass under grazing conditions. However bermudagrass used exclusively for hay production removes significant amounts of K exported with forage; thus, larger K fertilization rates are required to maintain adequate forage growth and sustained stands on hay meadows compared to grazed areas.

As previously discussed, both common and Coastal bermudagrass pastures at Texas AgriLife Research - Overton were initially stocked in 1968 with an average of 200-100-100 lbs/ac N-P_2O_5-K_2O through 1984 (Table 1). The currently active, long-term fertility regimen x stocking rate, nutrient cycling experimentation was initiated in 1985. For the next five years (1985-1989), N rates averaged 408 lbs/ac applied in 8 applications at 50 lbs N/ac, and with about half of the N applied during the ryegrass growing period and half of the N applied during the exclusive bermudagrass growth phase. The K_2O (0-0-100) was applied in a single application in the fall at or near clover planting. The five-year average suckling calf performance at three stocking rates on common bermudagrass (Table 3) and on Coastal bermudagrass (Table 4) are presented for both the N + ryegrass vs no N + K_2O + clover pastures. It is important to recall that this nutrient cycling experimentation was initiated after more than 15 years of fertilization and continuous stocking from February through September of each year.

Table 3. Five-year comparison of calf performance on common bermudagrass pastures overseeded with either arrowleaf clover or ryegrass and stocked at each of three levels (1985-1989).[4]

Fertilizer + Annual Forage	STK Rate[1]	Grazing Days	Calf ADG	Calf Gain/animal	Calf Gain/acre
	(au/ac)		(lb/d)	(lb)	(lb/ac)
No N + K_2O + CLV[2]	1.92	174	.84	147	279
N + RYG[3]	2.15	199	1.48	294	624
No N + K_2O + CLV	1.40	178	2.27	405	568
N + RYG	1.45	200	2.29	460	664
No N + K_2O + CLV	0.83	178	2.52	450	371
N + RYG	0.88	202	2.69	544	482

[1] One Au = 1,500-lb body weight.
[2] CLV = arrowleaf; 0-0-100 applied in one application during fall planting.
[3] RYG = ryegrass; Annual N rate of 408 lbs/ac applied in 8 applications of 50 lbs N/ac each.
[4] Rouquette et al. 1992. Forage Research in Texas. CPR-5039.

Table 4. Five-year comparison of calf performance on Coastal bermudagrass pastures overseeded with either arrowleaf clover or ryegrass and stocked at each of three levels (1985-1989).[4]

Fertilizer + Annual Forage	STK Rate[1]	Grazing Days	Calf ADG	Calf Gain/Animal	Calf Gain/Acre
	(au/ac)		(lb/d)	(lb)	(lb/ac)
No N + K_2O + CLV[2]	2.82	184	1.32	269	709
N + RYG[3]	3.21	206	1.66	344	1011
No N + K_2O + CLV	1.50	178	2.46	438	653
N + RYG	1.98	204	2.31	472	897
No N + K_2O + CLV	0.92	181	2.70	523	446
N + RYG	1.19	203	2.67	544	631

[1] One Au = 1,500-lb body weight.
[2] CLV = arrowleaf; 0-0-100 applied in one application during fall planting.
[3] RYG = ryegrass; Annual N rate of 408 lbs/ac applied in 8 applications of 50 lbs N/ac each.
[4] Rouquette et al. 1992. Forage Research in Texas. CPR-5040.

Nutrient Cycling on Pastures Plant food nutrients, primarily N, P, and K may be absorbed from the soil and then returned to the soil for use once again. This return-process has been labeled as nutrient cycling. In general, plant nutrients are recycled from root decay, leaf-stem loss and accumulated as litter, and excreta deposition by the grazing animal. Recycling of plant food nutrients is most effectively accomplished via excreta of dung and urine, and the excreta nutrient-base is primarily a function of diet (forage). In general, fecal excretion of N has been reported to be relatively constant per unit dry matter intake; whereas N in the urine fluctuates with N content of the diet. Phosphorus is recycled in both dung and urine with both organic and inorganic P excreted in the urine. However, K is primarily recycled in the urine with only 10% to 30% excreted in the feces. With respect to the extent of nutrients returned to the pasture (recycling) vs the amount of nutrients removed from the pasture, grazing animals remove only a small part of the forage N, P, and K. Estimates of removal will vary according to an array of factors; however, the percent composition of N, P, and K in the animals body has been estimated at about 2.6% N, 1% P, and less than 0.5% K per pound of weight gain (Rouquette et al 1973). The greatest losses of plant food nutrients from pastures occurs via runoff, leaching through the soil profile, volatilization, etc. with forage, soil type, and climatic conditions governing the extent of nutrient loss. And, the effectiveness of these plant nutrients recycled via excreta is stocking rate and stocking method dependent. In general, with lower stocking rates, excreta is not well-distributed on the entire pasture area and tends to accumulate in resting-loafing areas as well as in near proximity to water, mineral and/or supplementation areas. Rotational stocking tends to enhance distribution effectiveness compared to continuous stocking; however, the overall effectiveness is based on stocking rate, duration of stocking, and extent of forage utilization in specific pasture areas.

During the first five years of fertility regimen x stocking rate, nutrient cycling (1985-1989), higher stocking rates and hence calf gain per acre were greater from N + ryegrass compared to no N + K_2O + clover. In addition, Coastal bermudagrass pastures had more production of calf gain compared to common bermudagrass (Tables 3 and 4). Following this initial 5-year period of stocking, a 7-year period followed in which the annual N fertilization rate was reduced to about 250 lbs/ac N. These N fertilizations of about 50 lbs/ac N per application were all applied during the ryegrass growing period with the exception of one application made on exclusive bermudagrass. Thus, the nitrogen cycling from fertilization of ryegrass was intended to provide N for the subsequent bermudagrass pastures (Tables 5 and 6). The 7-year average pasture-animal production (1990-1996) indicated some reductions in stocking rate and calf gain per acre primarily from the Coastal bermudagrass pastures. Thus, with continued reduction of N application, forage production from common bermudagrass and Coastal become more similar. Perhaps the most noteworthy response were those from non N-fertilized pastures during this 12-year period in that calf gain per acre were at 300 to 400 lbs/ac. In addition, moderate to low risk stocking rates ranged from about 1.3 acres to 1 acre per cow-calf pair during the active grazing period of February through September. Note that these stocking rates are not for the 12-month period; hence other pastures and/or hay must be provided to estimate year long stocking rate requirements and cow costs.

Table 5. Seven-year cow-calf performance from common bermudagrass pastures stocked at three levels and receiving Nitrogen fertilizer + ryegrass or no Nitrogen + K_2O + clover (1990-1996).[4]

			Calf	
Grazing Pressure	**Fertilizer + Annual Forage**	**STK Rate[1]**	**ADG**	**Gain/Ac**
		(au/ac)	(lb/d)	(lb/ac)
High	No N + K_2O + CLV[2]	1.97	0.71	229
High	N + RYG[3]	2.18	1.41	563
Medium	No N + K_2O + CLV	1.23	2.04	446
Medium	N + RYG	1.32	2.25	564
Low	No N + K_2O + CLV	0.70	2.53	304
Low	N + RYG	0.80	2.56	390

[1] One-Au = 1500-lb body weight.
[2] CLV = included crimson, arrowleaf, Subterranean, and ball clover.
[3] RYG = ryegrass; Approximately 250 lbs N/ac applied at 50 lbs N/ac per application with only one application on exclusive bermudagrass (late May).
[4] Rouquette et al. Research Center Tech. Report -1998-1.

Table 6. Seven-year cow-calf performance from Coastal bermudagrass pastures stocked at three levels and receiving Nitrogen fertilizer + ryegrass or no N + K_2O + clover (1990-1996).[4]

Grazing Pressure	Fertilizer + Annual Forage	STK Rate[1]	Calf ADG	Calf Gain/ac
		(ac/ac)	(lb/d)	(lb/ac)
High	No N + K_2O + CLV[2]	2.35	1.31	514
High	N + RYG[3]	2.76	1.36	645
Medium	No N + K_2O + CLV	1.23	2.21	490
Medium	N + RYG	1.61	2.39	716
Low	No N + K_2O + CLV	0.79	2.74	390
Low	N + RYG	0.98	2.73	494

[1] One-Au = 1500-lb body weight.
[2] CLV = included crimson, arrowleaf, Subterranean, and ball clover.
[3] RYG = ryegrass; Approximately 250 lbs N/ac applied at 50 lbs N/ac per application with only one application on exclusive bermudagrass (late May.
[4] Rouquette et al. Research Center Tech. Report 1998-1.

Pasture Costs Table 7 presents pasture costs for the first 5-year and follow-up 7-year experiments. Costs used were based on early April 2008 and these are subject to change. Assessing costs only seed and fertilizer, the N-fertilized + ryegrass pastures would cost $332/ac for 408 lbs/ac N and $222/ac at the 253 lb/ac N rates. In contrast the K_2O + clover pastures plus lime would cost $145/ac and $118/ac, respectively. Differences in cost were for lime additions during the first 5 years; however no lime was required on the no N fertilized pasture during the following 7-year period due primarily to an absence of N fertilization. Using these cost assessments for each fertility regimen, estimated pasture costs per pound of calf gain are shown in Table 8. Certainly, there are numerous other expenditures in estimating a year-long cow budget; however, these seed and fertilizer expenditures represent the major pasture costs. Other costs associated with wintering, land costs, labor, interest, etc. have to be included for accurate yearlong expenses. Evaluating these costs, it becomes readily apparent that the moderate stocked pastures may offer opportunities for least costs per pound of calf gain. However, from the perspective of reducing risk plus the opportunity to harvest hay off the pastures, a lower stocking rate of about 1.25 to 1.5 acres per cow-calf unit during the February to October period may be a best management strategy. Before one decides to eliminate ALL N from the pasture system, the pasture costs per pound of calf gain from N fertilization are greater than no N-fertilization; however, these N + ryegrass pasture costs remain within practical consideration for forage production.

Table 7. Annual seed and fertilizer costs for bermudagrass pastures overseeded with either clover + K or Ryegrass + N based on April 2008 costs.[1]

Item	Appl. Rate (lbs/ac)	Nutrient	Cost/Unit ($)	1984-89 $/ac	1990-96 $/ac
Ryegrass	25		.48/lb	12	12
34-0-0		408	.71/lb N	290	
34-0-0		253	.71/lb N		180
Lime	1300		45/ton	30	30
Total Ryegrass + N				**332**	**222**
Clover	20		100/cwt	20	20
0-0-60	190	114	.50/lb K_2O	95	
0-0-60	195	117	.50/lb K_2O		98
Lime	1300		45/ton	30	0
Total Clover + K				**145**	**118**

[1] Rouquette et al. Research Center Tech. Report 1998-1.

<u>**Stocker Calves and Winter Pastures**</u> As production costs rise, numerous pasture assessments of forage utilization, hay, overseeding, fertilization, etc. must be made. However, concurrent, critical decisions must also be made for the class of beef cattle used, their efficiency of production, and returns based on occupancy weight of the animal(s). Replacement Angus x Brahman (F-1) heifers were grazed on these same fertility regimen, nutrient cycling pastures during a 2-year period (Table 9). Stocking pastures with 535-lb heifers in early February resulted in heifer weights of more than 800 pounds by mid-June from low and moderate stocked pastures. And, although there were slight ADG advantages on N + ryegrass pastures, heifers made final weight expectations on both fertility regimens. With the low stocking rates of 1.5 535-lb heifers per acre at grazing initiation, the ADG approached 3 lbs/da. The same fertility regimens and fertilizer-seed costs (based on April 2008) as those in Table 7 for the 1990-1996 period of N + ryegrass at $222/ac and K_2O + clover at $118/ac were in place for this heifer study. Thus, these pasture costs per pound of calf gain on N + ryegrass ranged from $0.44/lb gain at 500 lbs/ac gain to $0.28/lb gain at 800 lbs/ac gain. Pasture costs for the K_2O + clover pasture costs ranged from $0.24/lb gain at 500 lbs/ac gain to $0.16/lb gain at the 750 lbs/ac gain. Thus, with adapted animal genotypes and adequate nutritious forage available, either N + ryegrass or K_2O + clover systems may be acceptable for developing replacement heifers or stockers steers.

Table 8. Bermudagrass (BG) pasture (PAS) costs/lb gain for suckling calves when grazed by cow-calf pair at three stocking rates (SR) based on April 2008 costs.[1]

			1984 through 1989			
CLV + K_2O Costs/Ac = $145; RYG + N = $332						
Item	**LOW SR**		**MED SR**		**HIGH SR**	
Common BG	CLV+K	RYG+N	CLV+K	RYG+N	CLV+K	RYG+N
SR (1500 lbs)	0.83	0.88	1.40	1.45	1.92	2.15
Calf gain/ac (lbs)	371	482	568	664	279	624
PAS Cost/lb gain ($)	0.39	0.68	0.26	0.50	0.52	0.53
Coastal BG	CLV+K	RYG+N	CLV+K	RYG+N	CLV+K	RYG+N
SR (1500 lbs)	0.92	1.19	1.50	1.98	2.82	3.21
Calf gain/ac (lbs)	446	631	653	897	709	1011
PAS Cost/lb gain ($)	0.33	0.52	0.22	0.37	0.20	0.33
			1990 through 1996			
CLV + K Costs/Ac = $118; RYG + N = $222						
Common BG	CLV+K	RYG+N	CLV+K	RYG+N	CLV+K	RYG+N
SR (1500 lbs)	0.70	0.80	1.23	1.32	1.97	2.18
Calf gain/ac (lbs)	304	390	446	564	229	563
PAS Cost/lb gain ($)	0.38	0.56	0.26	0.39	0.50	0.39
Coastal BG	CLV+K	RYG+N	CLV+K	RYG+N	CLV+K	RYG+N
SR (1500 lbs)	0.79	0.98	1.23	1.61	2.35	2.76
Calf gain/ac (lbs)	390	494	490	716	514	645
PAS Cost/lb gain ($)	0.29	0.45	0.23	0.31	0.22	0.34

[1] Rouquette et al 2000 RCTR.

Research on small grain (Maton rye) plus ryegrass sod-seeded on bermudagrass pastures were pioneered at the Texas AgriLife Research-Overton location during the late 1960's-early 1970's. In addition to ADG that may exceed 2.5 lbs/da, there are opportunities to exceed ADG of 3 lbs/da with supplementation. The ADG for a rye + ryegrass pasture experiment with 3 stocking rates and 3 levels of supplementation are shown in Tables 10 and 11. Using only the moderate stocking rate of 2.1 hd/ac (550 lbs at initiation), a budget assessment is presented in Table 12 that includes all cash expenses plus interest, but does not include charges for land, labor, and planting. Pasture expenses included 450 lbs/ac 34-0-0 split applied; Maton rye at $38/wt; and TAM 90 ryegrass at $48/wt. All animal expenditures for implant, de-wormer, vaccinations, mineral, etc. were included. Interest charges at 10% were made on all expenditures. Using these assumptions, N costs at $0.71/lb and corn at $240/ton ($6.70/bu) showed returns of more than $180 per acre for all supplement levels. This $180 per acre return must be used for land, labor, planting, etc. expenses before any net return may be realized. However, given the magnitude of these returns, a net profit should be expected from this management strategy along with budget estimates that include 148 days grazing with high performance animals on high nutritive value forage.

Table 9. Two-year performance from F-1) (Angus x Brahman) heifers stocked at 3 levels on common or Coastal bermudagrass and overseeded with TAM 90 annual ryegrass + Nitrogen vs Tibbe crimson clover + K_2O and without N fertilizer.[4]

Grazing Pressure	Fertilizer + Forage[2, 3]	STK Rate[1]	ADG	Final Live Wt	Gain/Ac
		(hd/ac)	(lb/d)	(lbs)	(lb/ac)
High	CM-CL	3.8	1.30	685	589
High	CM-RG	4.1	1.40	713	671
Medium	CM-CL	2.6	2.28	812	685
Medium	CM-RG	2.6	2.46	835	739
Low	CM-CL	1.5	2.94	882	519
Low	CM-RG	1.5	2.60	844	459
High	CS-CL	3.8	1.56	724	699
High	CS-RG	4.2	1.77	736	864
Medium	CS-CL	2.6	2.51	840	754
Medium	CS-RG	2.6	2.75	864	828
Low	CS-CL	1.5	2.93	889	518
Low	CS-RG	1.5	2.93	886	518

[1] Stocking rate based on 535 lbs per heifer; pastures stocked from early February to mid-June.
[2] CM = common bermudagrass; CS = coastal bermudagrass; CL = Tibbe crimson clover; RG = TAM 90 annual ryegrass.
[3] Fertilizer for CL = 0-100-100-22-44-1 (N-P_2O_5-K_2O-Mg-S-B) and for RG = 175 lbs N/ac split applied.
[4] Rouquette et al. Research Center Tech. Report 2000-1.

Table 10. Effect of stocking rate on average daily gain (ADG) on rye-ryegrass pastures.[3]

Stocking Rate[1] hd/ac	Supplementation (% BW) 0	0.4%	0.8%
	ADG (lbs/da)[2]		
1.5	2.80 a[2]	3.13 a	3.24 a
2.1	2.21 b	2.86 a	3.11 a
3.0	1.13 c	1.94 b	2.10 b

[1] Stocking rates based on 550 lbs = one stocker at initiation of grazing on 12-20-04.
[2] ADG followed by a different letter within a **supplement** column, differ at P<.05.
[3] Rouquette et al. Research Center Tech Report 2006-1.

Table 11. Effect of supplement level on average daily gain (ADG) on rye-ryegrass pastures.[3]

Supplement	Stocking Rates[1] (hd/ac)		
	1.50	2.1	3.0
	ADG (lbs/da)[2]		
Pasture Only	2.80 a[2]	2.21 b	1.13 b
0.4% BW	3.13 a	2.86 ab	1.94 a
0.8% BW	3.24 a	3.11 a	2.10 a

[1] Stocking rates on 550lbs = one stocker at initiation of grazing on 12-20-04.
[2] ADG followed by a different letter in a **stocking rate** column, differ at P<.05.
[3] Rouquette et al. Research Center Tech Report 2006-1.

Stocker ventures have always been associated with moderate to high levels of uncertainty related to climatic conditions and the margin of purchase price – selling price of the animals. In many cases the careful attention to details of pastures and animal management can be radically offset by the extent of negative margin between purchase-sales prices. Using the budget presented in Table 12 for non-supplemented cattle, the average purchase price for steers and heifers was about $1.07/lb and the average sales price was about $0.92/lb. This approximate $15/cwt negative margin showed estimated returns/ac at about $183. Various purchase-sales margin scenarios are shown in Table 13 for these previously used databases for stocking rate and ADG information. As has been shown by several others in previous assessments, as the absolute price of stockers declines, (i.e. say from $1.10/lb to $0.80/lb), there is less negative margin that can be absorbed and continue to return net income to the operation. In contrast, this performance data illustration shows that stockers purchased at $1.10/lb and sold for a $0.20/lb negative margin of $0.90/lb continues to have profit potential. Although positive margins are often rarely experienced in the stocker business, the old adage of...."if you can't make money with stockers with a positive margin, you don't need to be in the cattle business is probably correct."

From 2003 to 2008, the price per lb of N has doubled to costs of about $0.70/lb N for ammonium nitrate (early April 2008). The primary management concerns with any pasture system, but particularly with the relatively expensive small grain plus ryegrass pastures, are how the continued cost per pound of N effects returns. Table 14 uses stocking rate data from Table 10 and budget estimates used for Table 12 to make assumptions on returns/ac for two stocking rate pastures with increasing prices of N ranging from $0.71 to $1.00 per pound. Although increased fertilizer N costs reduce net returns, there are potential "significant" returns/ac from either the low stocked pastures at 1.5 hd/ac or the moderate stocked rye + ryegrass at 2.1 hd/ac. In contrast, however, are those costs associated with increased supplementation of stockers grazing small grain + ryegrass pastures. Using the previous performance data and economic return estimates from pastures stocked at 2.1 hd/ac and receiving either 0, 0.4%, or 0.8% BW corn supplement, there is an abrupt, negative return with both increased price of supplement and with increased level of supplement (Table 15). Thus, assessing management strategies using these accelerating input costs, one can more easily contend with increased cost of N rather than increased costs associated with supplementation. Budget templates for use with estimating cost-returns for cow-calf or stockers may be found on the web site of Extension Economist, Dr. Greg Clary, at http://ruralbusiness.tamu.edu/.

Table 12. Performance, costs, and returns from stocker steers and heifers grazing rye + ryegrass at three levels of supplement and stocked at 2.1 hd per acre.[4]

SR (hd/ac)	**2.1**	**2.1**	**2.1**
SUP (% BW)	**0**	**0.4**	**0.8**
Days on Pasture	148	148	148
Avg. Initial Wt (lbs/hd)	565	587	582
Avg. Final Wt (lbs/hd)	893	1009	1042
ADG	2.21	2.85	3.11
Daily SUP (lb/hd/da)	0	2.8	5.9
Daily Hay (lb/hd/da)	4	3	3
Revenue per Hd ($)	829	912	944
Revenue per Acre ($)	1740	1914	2078
Value of Gain ($/lb)	0.67	0.67	0.69
Costs/Hd[1]	741	807	860
Costs/Ac	1557	1694	1892
Cost/lb Gain	**0.41**	**0.42**	**0.51**
Return/Hd[2]	87	105	85
Return/Ac[2]	**183**	**220**	**186**
Break-even ADG (lb/da)	1.6	2.1	2.48
Break-even Wt (lb/hd)	800	890	949
Break-even Price ($/lb)	**0.83**	**0.80**	**0.83**

[1] N @ $.71/lb N; SUP (corn @ $240/ton ($6.70/bu); Hay valued at $80/ton.
[2] Returns to off set cash expenses and intent. Not included are land, labor, and planting costs.
[3] Purchase price of $1.10/lb for steers and $1.05/lb for heifers with $0.15 negative margin sides for each.
[4] Rouquette et al. Research Center Tech. Report 2006-1.

Table 13. Returns per acre for stockers on rye-ryegrass pasture with varying margins of purchase prices vs sale prices.

Sale Price ($/lb)	Purchase Price ($/lb) 0.80	0.85	0.90	0.95	1.00	1.05	1.10
	Returns/ac ($/ac)						
0.60	-90	-151	-213	-275	-336	-398	-460
0.65	4	-57	-119	-181	-242	-304	-366
0.70	98	37	-25	-87	-149	-210	-272
0.75	192	130	69	7	-55	-116	-178
0.80	286	224	163	101	39	-23	-84
0.85	380	318	256	195	133	71	10
0.90	474	412	350	289	227	165	103
0.95	568	506	444	382	321	259	197
1.00	661	600	538	476	415	353	291

[1] Animal weights for non-supplemental stockers at 2.1 hd/ac, budget, and expense items included in Table 12.

Table 14. Projected returns per acre for steers and heifers stocked on rye + ryegrass pasture at two stocking rates with variable ammonium nitrate costs.

Ammonium Nitrate Costs		**Stocking Rate**[1] **1.5 hd/ac**	**2.1 hd/ac**
Cost/ton	Cost/lb N	Returns/ac ($/ac)	
480	0.71	192	183
510	0.75	183	174
544	0.80	173	165
612	0.90	159	151
680	1.00	145	137

[1] Stocking rates and ADG from Table 10 and expense items from Table 12 format.

Stocker Calves and Bermudagrass Stockers grazing on bermudagrass pastures have wide arrays of average daily gain (ADG) responses based on breedtype, weight, age, sex, condition, and stocking rate. Thus, reported stocker ADG on summer-long stocking may range from less than 0.5 lb/da to more than 2 lbs/da. Grazing data from Texas AgriLife Research-Overton and other locations in Texas and the southeastern US have shown stocker gains of about 1 lb/da on Coastal bermudagrass. And, more recently, stocker gains on Tifton 85 bermudagrass have been about 1.5 lbs/da without supplementation. Table 16 provides a spreadsheet scenario for stocking rate x ADG and was intended to most closely relate to performance from bermudagrass pastures. Stocker-grazing experimentation at Overton has shown average stocking rates on Coastal bermudagrass at about 3 to 3.5 550-lb calves per acre, and about 3.5 to 4.5 550-lb calves per acre for Tifton 85 bermudagrass. Thus, using the previous database for estimate purposes, one may expect about 400 lbs/ac gain from Coastal bermudagrass and about 725 lbs/ac from Tifton 85 bermudagrass. Using those stocking rate x ADG scenarios and fertilizer costs of $130/ac per year, fertilizer costs per pound of gain may be estimated. Thus, from Table 17 fertilizer costs per lb gain may range from less than $0.20/lb gain for Tifton 85 to nearly $0.35/lb gain for Coastal bermudagrass. Both of these examples provide support for consideration of some form of stocker operation on bermudagrass. These examples have used only 150 lbs/ac N and 50 lbs/ac K_2O; however, additional forage may be possible with higher rates of N fertilizer. However, once the decision is made to harvest hay rather than exclusive grazing, then alternative fertility strategies involving P, K, and lime may be appropriate.

Table 15. Projected returns per acre for steers and heifers stocked on rye + ryegrass at 2.1 hd per acre and receiving three levels of daily supplement corn ration.

Supplement Cost		**Daily Supplement (lb/hd/da)**[1]		
Cost/ton ($)	**Cost/lb ($)**	**0**	**2.8**	**5.9**
		Returns/ac ($/ac)[2]		
240	0.12	183	220	186
300	0.15	183	193	126
360	0.18	183	166	65
400	0.20	183	148	25
460	0.23	183	121	-36
500	0.25	183	102	-
600	0.30	183	57	-
700	0.36	183	3	-

[1] Stocking rate and ADG from Table 11 for the 2.1 hd/ac performance.
[2] Budget and expense items taken from Table 12.

Table 16. Gain per acre assuming various stocking rates and ADG on bermudagrass.

Stocking Rate[1]	**ADG (lb/da)**				
	0.75	**1.0**	**1.25**	**1.50**	**1.75**
			Gain/acre (lbs/ac)[2]		
1.5	135	180	275	270	315
2.0	180	240	300	360	420
2.5	275	300	375	450	575
3.0	270	360	450	540	630
3.5	315	420	575	630	735
4.0	360	480	600	720	840
4.5	405	540	675	810	945
5.0	450	600	750	900	1050

[1] Stocking rate based on 550-lb = one steer at initiation of grazing.
[2] 120 day grazing (May 15 – Sept 15).

Table 17. Fertilizer cost per pound of gain on bermudagrass pastures.[2]

Stocking Rate[1]	ADG (lbs/da)				
	0.75	**1.00**	**1.25**	**1.50**	**1.75**
	Fertilizer Cost/lb Gain ($/lb)				
1.5	0.97	0.72	0.58	0.48	0.41
2.0	0.72	0.54	0.43	0.36	0.31
2.5	0.58	0.43	0.35	0.29	0.25
3.0	0.48	0.36	0.29	0.24	0.21
3.5	0.41	0.31	0.25	0.21	0.18
4.0	0.36	0.27	0.22	0.18	0.15
4.5	0.32	0.24	0.19	0.16	0.14
5.0	0.29	0.22	0.17	0.14	0.12

[1] Stocking rate based on 550-lb = one steer at initiation of grazing.
[2] Fertilization of 150 lbs/ac N applied at 50 lbs N/ac 3each time with N cost at $0.70/lb N; K_2O applied at 0-0-50 in single application cost of $0.50/lb K_2O. Total estimated fertilization cost of $130/ac per year.

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 AgriLife Research-Overton as a model for management strategies, the following alternatives should be scrutinized for specific site economic benefits:

1. Pastures at Overton had a 15-year history of N-P-K applications, and once compromises were implemented, soil P was deemed to be at moderate to high levels. The soil nutrient "base" determines the fate of reduced fertilization of pastures. A soil test analysis provides this information.
2. By eliminating all N fertilizer, but continuing with annual applications of K_2O plus overseeding bermudagrass with an adapted clover, pastures continue 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 climatic conditions. However, at high stocking rates, bahiagrass and various bermudagrass ecotypes are likely to invade the pastures. Perhaps more importantly 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.
3. 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 lbs/ac N for ryegrass period and one to two applications of 50 lbs/ac N for the bermudagrass growing phase.

4. Small grain + ryegrass overseeded on pastures with N fertilization of 150 lbs/ac N continues to be a viable option for winter-spring grazing as well as an excellent source of recycled nutrients. Due to the input costs for forage production, grazing may be limited to stocker cattle, including replacement heifers, and/or restricted-access grazing by cows and calves. This restricted grazing may consist of 2 to 3 hours grazing per day with one acre allocated to 2 to 3 pair to supply protein requirements but reduce costs per animal. During the other 20 to 22 hours, cows and calves are relegated to standing forage and/or hay.

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 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) of 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 lbs N/ac per application.
4. Add legumes to the pasture system.
5. Use broiler litter as a nutrient source.
6. Increase efficiency of forage utilization.
7. Make hay from pastures and at any time practical, and eliminate exclusive hay meadows.
8. Purchase hay based on nutrient analyses and weight of package.
9. Make strategic, timely herbicide applications.
10. Maintain accurate, up-to-date cattle records for culling options.
11. Reduce stocking rate.
12. Enhance weaning percent, weaning weight and/or eight at time of sales.
13. Alter weaning schedule; retain ownership options.

14. Critically assess supplementation strategies, product cost, and supplement:extra gain conversion.

15. Market cattle proactively.

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.