Sustained Production from Common Bermudagrass Pastures Using Clover-Potassium or Ryegrass-Nitrogen

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Summary

Common bermudagrass pastures that had been fertilized annually with 200-100-100 lb nitrogen-phosphorus-potassium (N-P_2O_5-K_2O)/A for 15 years and grazed at one of three stocking rates were divided into equal-sized pastures. Within each stocking rate treatment, one pasture was overseeded with 'Yuchi' arrowleaf clover and fertilized with a single application of approximately 100 lb K_2O/A during each fall of the 5-year study. The other paddock in each stocking rate treatment was overseeded with 'Marshall' ryegrass and received split applications of N. A total annual rate of approximately 400 lb/A was applied to the ryegrass and bermudagrass. Observations of cows and calves were used to measure animal performance and gains per unit area. Stocking rates were similar for both the clover-K_2O and ryegrass-N systems and averaged about 2.0, 1.4, and 0.85 animal-units (AU)/A, respectively, for high, medium, and low stocking rates. Both calf and cow daily gains were suppressed at the high stocking rates; however, the gains from the ryegrass-N pasture were substantially greater than those from the clover-K_2O pasture. Animal performance in the medium- and low-stocked pastures was similar for the clover-K_2O and ryegrass-N systems. Stocking rates during the spring period (February - May) were similar to stocking rates during the summer (June - September). This indicated that nutrient recycling through excreta was relatively effective on the non-N-fertilized pastures. Annual fertilizer costs per pound of calf gain were optimized at the medium stocking rates for both K_2O and N-treatments. Actual fertilizer costs ranged from less than 5¢/lb of calf gain on the K_2O-fertilized pastures to more than 15¢/lb of calf gain on the N-fertilized pastures.

Keywords: bermudagrass / nutrient recycling / nitrogen / clover / ryegrass / stocking rate.

Introduction

Fertilizer applied to exclusively hay meadows is largely removed from the system by hay production. Grazing systems, however, provide an oppor-

The F-1 (Brahman x Hereford) cow continued to lactate even though the weight losses were appreciable. This sometimes small quantity of milk, however, caused the positive calf gains obtained at the high stocking rates. Thus, the importance of milk as a "buffer system" for suboptimal nutritional regimens of quantity or quality is clearly evident.

The annual cost of fertilizer and the fertilizer costs per pound of calf gain are presented in Table 8. From these economic assessments, the K_2O costs were optimized at about 3¢/lb of calf gain at the medium stocking rate. The other two stocking rates projected a fertilizer cost of about 5¢/lb of calf gain. The medium stocking rate was also the optimum rate for fertilizer costs associated with applying 408 lb N/A/year. Again, in pasture systems in which utilization efficiency was low, such as the low-stocked pastures, percentage of fertilizer cost per pound of gain increased dramatically. In this study, fertilizer N costs increased from 15¢ to 21¢ on medium- (1.40) and low- (0.83) stocked pastures, respectively.

Additional input data would be necessary to construct a detailed cash-flow analyses, but the data presented here may provide some baseline information on fertilizer and stocking rate management strategies. Except in the high-stocked clover-K_2O pastures in which some stand thinning occurred as well as some invasion of bahiagrass, common bermudagrass pastures exhibited no forage-animal production losses by the absence of fertilizer N. Thus, nutrient recycling appears to be a biological and economic asset in sustaining common bermudagrass grazing systems. Additional data on stand loss and soil fertility are currently being assessed, and summaries of this information will be forthcoming.

Table 8. Annual fertilizer cost per pound of calf gain on common bermudagrass pastures overseeded with either arrowleaf clover and K_2O or ryegrass and N.

	Stocking rates		
Item	High	Medium	Low
Clover + K_2O			
Animal units/A (1,500 lb)	1.92	1.40	.83
Calf gain/A (lb)	279	568	371
Fertilizer			
1. Annual K_2O/A (lb)	114	114	114
2. Cost†/ton	$180	$180	$180
3. Cost/A	$ 17.10	$ 17.10	$ 17.10
4. Cost/lb calf gain	$ .0613	$ .0301	$ .0461
Ryegrass + N			
Animal units/A (1,500 lb)	2.15	1.45	.88
Calf gain/A (lb)	624	664	482
Fertilizer			
1. Annual N/A (lb)	408	408	408
2. Cost‡/ton	$170	$170	$170
3. Cost/A	$102	$102	$102
4. Cost/lb calf gain	$ .1634	$ .1536	$ .2118

†Cost includes addition and spreading of boron.
‡Cost includes spreading.

Literature Cited

Rouquette, F. M., Jr., M. J. Florence, V. A. Haby, and G. R. Smith. 1992. Use of clover-potassium vs. ryegrass-nitrogen for sustained production from Coastal bermudagrass pastures. *In* Forage Research in Texas, 1992. This publication.

tunity for plant food nutrients to be recycled through excreta and used to maintain some level of production. Forage consumed by the grazing animal undergoes microbial degradation in the rumen, and the undigested portion is deposited as dung or urine. Various factors affect the extent of recycled plant food nutrients, but two primary components are quality of the diet and stocking density. The primary objective of this trial was to determine the influence of previous stocking rate and fertilizer regimens on common bermudagrass pastures overseeded and fertilized with either clover plus K_2O or ryegrass plus N.

Procedure

Common bermudagrass pastures used in this 5-year nutrient-recycling study had previously received annual fertilizer rates of 200-100-100 lb N-P_2O_5-K_2O/A during each year of a 15-year period. In addition, specific pastures had been grazed at a low, medium, or high stocking rate for the same 15-year period. Thus, for each stocking rate paddock, a total of at least 3,000-1,500-1,500 lb N-P_2O_5-K_2O/A had been applied in split applications. The 1,500 lb of P_2O_5/A combined with nutrient recycling from bovine fecal material had elevated soil test phosphorus to 30 ppm—very high. Phosphorus fertilizer could be withheld for a few years. Limestone was applied to maintain soil acidity at a level favorable for optimum ryegrass and clover production.

In the fall of 1984, each of the stocking rate pastures was subdivided into two equal-sized areas. Through random selection, one area was designated to receive only K_2O and the other area was to receive only N. The pasture that received approximately 100 lb/A K_2O in a single, fall application was overseeded each October with 10 lb 'Yuchi' arrowleaf clover/A. During the last 3 years of this study, boron was also applied at the rate of 1.5 to 2 lb/A. The pasture that received split applications of a total of approximately 400 lb N/A was overseeded each October with 30 lb 'Marshall' ryegrass/A. The annual and total fertilizer-lime quantities are shown in Table 1.

Forage in each pasture was sampled every 2 weeks for nutritive value and at monthly intervals for forage availability. Within any one grazing pressure treatment (high, medium, or low), forage availability was regulated as closely as possible between clover-K_2O and ryegrass-N pastures. Brahman x Hereford (F-1) cows and their Simmental-sired calves were observed for animal performance and total gains per unit land area. Fall-calving cow-calf pairs were grazed from February to early June, and winter-calving cow-calf pairs were grazed from early June to late September. A variable stocking rate was used

Table 1. Fertilizer rates applied to common bermudagrass pastures during a 5-year period.

Year	Date (mo.-day-year)	Clover + K_2O	Ryegrass + nitrogen
		....lb/A....	
1	11-29-84	0-0-100	
	2-20-85 to 9-17-85		390-0-0
	9-26-85	....2 tons lime/A....	
2	11-22-85	0-0-100	
	11-26-85 to 9-8-86		400-0-0
3	11-20-86	0-0-100 + 2B	
	1-27-87 to 8-25-87		400-0-0
	9-15-87	....1 ton lime/A....	
4	11-18-87	0-0-150 + 1.5B	
	12-1-87 to 8-30-88		450-0-0
5	11-9-88	0-0-120 + 1.7B	
	12-14-88 to 7-5-89		400-0-0
5-year total		0-0-570 + 5.2B	2040-0-0
Yearly avg.		0-0-114 + 1B	408-0-0

through the put-and-take technique to maintain as closely as possible equivalent grazing pressures among the clover- and ryegrass-overseeded pastures at each stocking rate. Because of differences in body weight of cows and calves, stocking rates were calculated according to total body weight per acre, 1 AU being equivalent to 1,500 lb. Animals were weighed at 28-day intervals throughout the 180- to 200-day grazing period.

Results and Discussion

Individual cow and calf performance, calf gain per acre, and stocking rate for each of the 5 years are presented in Tables 2 to 4 for high-, medium-, and low-stocked pastures, respectively. Table 5 presents a summary of the advantage of the ryegrass-N pastures. Daily calf gains on the high-stocked (2.15 AU/A) ryegrass-N pastures were 0.64 lb/day greater than the daily calf gains on the clover-N pastures (1.48 vs. 0.84). This difference in daily gains was due primarily to diversity in stand density and grazing pressure or forage availability rather than to nutritive value. Thus, the impact of calf gain multiplied by differences in overall stocking rate resulted in calf gains per acre on the ryegrass-N paddocks that were about 2.5 times greater than those on clover-K_2O (624 vs. 279). During the entire 174-day, 5-year-average grazing period, cows on the high-stocked bermudagrass-clover pastures lost 354 lb (-2.33 lb/day) compared with a loss of 230 lb (-1.16 lb/day) from the lactating cows grazing the bermudagrass-ryegrass-N pastures.

At the medium stocking rate of approximately 1.4 AU/A, cow weights remained at about the same

Table 6. Five-year average of calf daily gains during the spring and summer periods from overseeded common bermudagrass pastures.

Clover + K_2O				Ryegrass + N			
Spring		Summer†		Spring		Summer†	
SR	ADG	SR	ADG	SR	ADG	SR	ADG
AU/A	lb/day	AU/A	lb/day	AU/A	lb/day	AU/A	lb/day
1.93	.96	1.97	.72	2.10	1.71	2.20	1.28
1.42	2.75	1.39	1.87	1.48	2.65	1.42	1.94
.80	2.99	.85	2.15	.92	3.07	.85	2.32

†Pastures consist exclusively of bermudagrass.

fertilizer-forage system appears to be very effective in the non-N-fertilized pastures of common bermudagrass. A companion paper dealing with 'Coastal' bermudagrass does not make apparent this degree of similarity between N and non-N-fertilized pastures. Thus, with the inherently lower forage-producing common bermudagrass pastures, the higher rates of N fertilizer had little production impact compared with the clover-K_2O treatment.

With the exception of the previously mentioned high-stocking rate, the total 5-year calf gain per acre was also similar (Table 7). Figure 1 shows a classical example of the relationship between gain per acre and stocking rate for both the clover-K_2O and the ryegrass-N systems. Gain per acre declines dramatically on the bermudagrass-clover-K_2O pastures with increasing stocking rate. An optimum relationship was apparently achieved between 1.0 AU/A and 1.5 AU/A. The ryegrass-N-treated bermudagrass pastures, however, allowed optimum calf gains per acre at approximately 2 AU/A. The ryegrass-N-treated bermudagrass pastures maintained higher levels of animal production at all levels of stocking, but this was even more dramatic at the higher levels of stocking. The relationships of daily gains of both cows and calves with changes in stocking rate also shows the disparity between clover-K_2O- and ryegrass-N-treated pastures (Fig. 2). Calf response to the clover-K_2O pastures appears to be negatively curvilinear as expected; however, calf response was negatively linear to the ryegrass-N pastures. Certainly forage availability or forage density at these similar stocking rates may explain these differences.

Table 7. Total calf gain per acre during a 5-year period of grazing common bermudagrass pastures.

Stocking rate	Clover + K_2O bermudagrass	Ryegrass + N bermudagrass
	........lb/A........	........lb/A........
High	1394	3122
Medium	2842	3320
Low	1856	2409

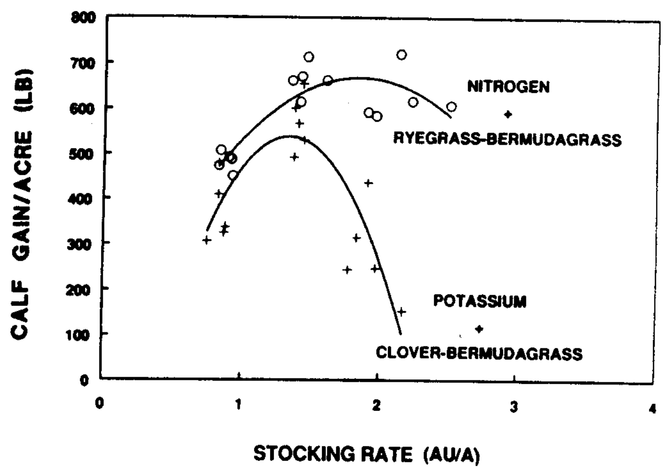

Figure 1. Relationship of calf gain per acre with stocking rate on common bermudagrass pastures in combination with either nitrogen plus ryegrass or potassium plus clover.

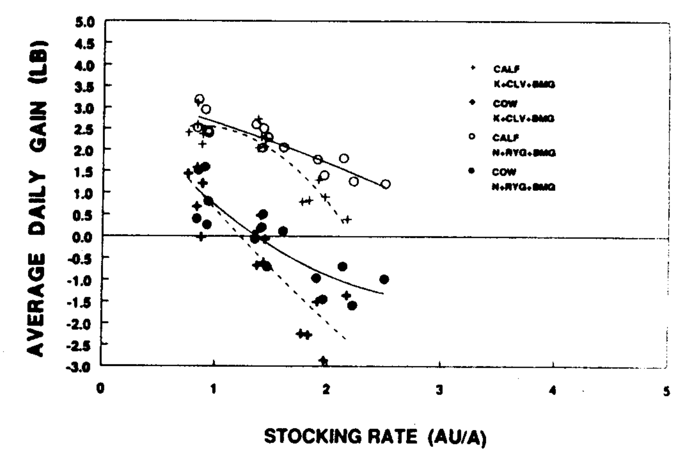

Figure 2. Relationship of daily gain of cows and calves at different stocking rates on common bermudagrass (BMG) pastures in combination with either potassium (K) plus clover (CLV) or nitrogen plus ryegrass (RYC).

level throughout the grazing period. Daily calf gains were essentially identical at 2.27 lb on clover-bermudagrass and 2.29 lb on ryegrass-bermudagrass. The 22 days earlier grazing that ryegrass-N pastures produced caused nearly an extra 100 lb of calf gain/A. These two treatments produced approximately identical individual animal gains and similar stocking rates of 1.40 and 1.45 AU/A. Thus, ample evidence indicates that nutrient recycling from an existing nutrient pool through excreta had nearly maintained the productivity of common bermudagrass pastures that received no additional fertilizer N during a 5-year period.

Cattle performance on the low-stocked pastures of clover or ryegrass was also similar with respect to daily calf and cow gains as well as stocking rate (0.83 vs. 0.88). The additional 24 days of grazing on the ryegrass-N pastures resulted in an extra 100 lb of calf gain/A. The

Table 2. Animal performance on high-stocked common bermudagrass pastures overseeded with either arrowleaf clover or ryegrass.

Year	Annual forage	Grazing days	Average daily gain		Gain/animal		Gain/acre	Stocking
			Calf	Cow	Calf	Cow	Calf	rate†
			.... lb/day	....	.... lb	....	...... lb	AU/A
1	ARL‡	175	1.30	-1.51	228	-265	436	1.91
1	RYG	187	1.81	- .69	340	-128	721	2.13
2	ARL	176	.79	-2.24	139	-395	244	1.77
2	RYG	211	1.41	-1.45	298	-306	584	1.96
3	ARL	208	.83	-2.27	172	-474	314	1.83
3	RYG	219	1.27	-1.59	279	-349	617	2.22
4	ARL	142	.90	-2.86	129	-407	247	1.97
4	RYG	173	1.78	-.96	308	-166	592	1.90
5	ARL	170	.40	-1.36	68	-231	153	2.17
5	RYG	204	1.21	-.98	247	-201	608	2.50
				5-year average				
	ARL	174	.84	-2.33	147	-354	279	1.92
	RYG	199	1.48	-1.16	294	-230	624	2.15

†1 AU = 1,500-lb body weight.
‡ARL = arrowleaf; RYG = ryegrass.

Table 3. Animal performance on medium-stocked common bermudagrass pastures overseeded with either arrowleaf clover or ryegrass.

Year	Annual forage	Grazing days	Average daily gain		Gain/animal		Gain/acre	Stocking
			Calf	Cow	Calf	Cow	Calf	rate†
			.... lb/day	....	.... lb	....	...... lb	AU/A
1	ARL‡	175	2.30	.48	403	85	566	1.40
1	RYG	187	2.51	.51	471	95	670	1.42
2	ARL	176	2.05	-.67	360	-118	492	1.37
2	RYG	211	2.05	.21	433	- 45	614	1.41
3	ARL	219	2.08	-.60	456	-132	654	1.43
3	RYG	211	2.30	-.70	487	-148	713	1.46
4	ARL	160	2.73	.11	438	- 17	600	1.37
4	RYG	189	2.60	-.06	492	- 12	661	1.35
5	ARL	162	2.27	.40	369	66	530	1.44
5	RYG	204	2.06	.12	419	26	662	1.60
				5-year average				
	ARL	178	2.27	-.06	405	- 23	568	1.40
	RYG	200	2.29	.02	460	- 17	664	1.45

†1 AU = 1,500-lb body weight.
‡ARL = arrowleaf; RYG = ryegrass.

Table 4. Animal performance on low-stocked common bermudagrass pastures overseeded with either arrowleaf clover or ryegrass.

Year	Annual forage	Grazing days	Average daily gain		Gain/animal		Gain/acre	Stocking rate†
			Calf	Cow	Calf	Cow	Calf	
			..........lb/day..........		............lb.............		......lb......	AU/A
1	ARL‡	175	2.41	1.44	423	253	306	.75
1	RYG	187	2.95	1.60	553	299	492	.90
2	ARL	176	2.13	-.02	376	-4	324	.87
2	RYG	211	2.45	.26	519	55	487	.92
3	ARL	219	2.60	.68	571	149	480	.83
3	RYG	219	2.52	.40	553	89	473	.83
4	ARL	160	3.11	1.59	498	254	409	.83
4	RYG	189	3.19	1.52	604	287	507	.84
5	ARL	162	2.37	1.21	383	195	337	.88
5	RYG	204	2.40	.80	490	164	450	.93
		............5-year average............						
	ARL	178	2.52	.95	450	169	371	.83
	RYG	202	2.69	.88	544	179	482	.88

†1 AU = 1,500-lb body weight.
‡ARL = arrowleaf; RYG = ryegrass.

Table 5. Five-year comparison of calf performance on common bermudagrass pastures overseeded with either arrowleaf clover or ryegrass and stocked at each of three levels.

Grazing pressure	Annual forage	Grazing days	Calf			Stocking rate†
			ADG	Gain/ animal	Gain/ acre	
						AU/A
High	ARL‡	174	.84	147	279	1.92
High	RYG	199	1.48	294	624	2.15
Ryegrass + nitrogen advantage		+25	+.64	+147	+345	+.23
Medium	ARL	178	2.27	405	568	1.40
Medium	RYG	200	2.29	460	664	1.45
Ryegrass + nitrogen advantage		+22	+.02	+ 55	+ 96	+.05
Low	ARL	178	2.52	450	371	.83
Low	RYG	202	2.69	544	482	.88
Ryegrass + nitrogen advantage		+24	+.17	+ 94	+111	+.05

†1 AU = 1,500-lb body weight.
‡ARL = arrowleaf; RYG = ryegrass.

relatively small decrease in stocking rate from 1.4 AU/A on medium-stocked pastures to 0.85 AU/A on low-stocked pastures was responsible for sufficiently more forage available to provide for cow daily gains of nearly 1 lb/day and total grazing period cow gains of approximately 175 lb.

Five-year average daily calf gains at each of three stocking rates during the spring and summer periods are presented in Table 6. Within a stocking rate treatment, animal-units per acre were similar during the spring and summer periods. In addition, stocking rates were similar between the clover-K_2O and ryegrass-N treatments. Obviously the depressed calf gains on the clover-K_2O pastures compared with the ryegrass-N pastures indicate that grazing pressures were inadvertently heavier on the clover pastures. Thus, the extent of nutrient cycling and the resultant impact on the