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Use of Clover-Potassium vs. Ryegrass-Nitrogen for Sustained Production from Coastal Bermudagrass Pastures

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Summary

'Coastal' bermudagrass pastures fertilized annually with 200-100-100 lb nitrogen-phosphorus-potassium (N-P_2O_5-K_2O)/A for a 15-year period and grazed at one of three stocking rates were divided into equal-sized paddocks. Within each stocking rate treatment, one pasture was overseeded with 'Yuchi' arrowleaf clover and received a single application of approximately 100 lb K_2O/A during each fall of a 5-year period. The other paddock in each of the three stocking rate pastures was overseeded with 'Marshall' ryegrass and fertilized with N in split applications. A total annual rate of approximately 400 lb/A was applied to ryegrass and bermudagrass. Cows and calves were observed to monitor animal and unit land area production. High-stocked clover-bermudagrass pastures supported 2.82 animal units (AU)/A and produced 709 lb calf gain/A, whereas similarly grazed ryegrass-bermudagrass pastures supported 3.21 AU/A and produced an average of 1,011 lb calf gain/A annually for each of the 5 years. Stocking rates for the medium and lightly grazed clover pastures were 1.50 and 0.92 AU/A, respectively, and 1.98 and 1.19 AU/A, respectively, for the ryegrass pastures. The ryegrass-N pasture produced from 1,185 to 300 more lb/A calf gain than did the clover-K_2O pastures. Ryegrass was available for grazing 3 to 4 weeks before clover. Calf average daily gains were similar for both systems in the medium- and low-stocked pastures.

An economic assessment indicates that pasture costs attributable only to fertilizer were about 2.5¢ to 4¢/lb of calf gain on the clover-K_2O treatments and 10¢ to 16¢/lb of calf gain on the ryegrass-N treatments. There was no indication of major production decline on the bermudagrass pastures during this 5-year period in which no N was applied.

Introduction

Fertilizer applied to exclusively hay meadows is largely removed from the system by hay production. Under grazing systems, forage consumed by the animal undergoes microbial degradation in the rumen, and the undigested portion is deposited as dung or urine to be reused to maintain some level of production. Various factors affect the magnitude 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 Coastal bermudagrass pastures overseeded and fertilized with either clover plus K_2O or ryegrass plus N.

Procedure

Coastal bermudagrass pastures used in this 5-year nutrient-recycling study had previously been fertilized with 200-100-100 lb N-P_2O_5-K_2O/A 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 pasture, 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 K_2O/A 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. Brah-

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Table 1. Fertilizer rates applied to Coastal 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

man x Hereford (F-1) cows and their Simmental-sired calves were used to monitor individual 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 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 level. 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-calf performance, calf gains per acre, and stocking rates of Coastal bermudagrass overseeded with clover-K_2O or ryegrass-N for each of three stocking rates are shown in Tables 2 to 4. A 5-year summary indicates that ryegrass pastures were available for grazing 3 to 4 weeks earlier than the clover pastures. Under the cow-rebreeding schedule of this program, cow-calf pairs were not available for grazing until mid-February of each year. From other research data at the Overton Center, ryegrass could be available for grazing earlier than late February if planting date, seeding rate, and date of first application of N are adjusted.

The high-stocked bermudagrass pastures overseeded with clover-K_2O supported 2.82 AU/A, whereas overseeded ryegrass-N supported 3.21 AU/A on an annual basis. Medium-stocked bermudagrass pastures equated to 1.50 AU/A for clover-K_2O and 1.98 AU/A for ryegrass-N, whereas low-stocked pastures had a 5-year average of 0.92 and 1.19 AU/A, respectively, on clover and ryegrass pastures. Table 5 also shows some of the relative advantages of the ryegrass-N pastures in terms of calf performance. On the high-stocked pastures, the ryegrass-N treatment resulted in 0.34 lb more gain per day

Table 2. Animal performance on high-stocked Coastal 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‡	187	1.56	-1.11	293	-207	767	2.79
1	RYG	209	1.99	-1.08	416	-226	1169	3.09
2	ARL	178	1.14	-1.76	203	-313	568	3.07
2	RYG	211	1.52	-.26	320	-53	974	3.18
3	ARL	219	1.48	-1.61	325	-298	825	2.61
3	RYG	219	1.43	-1.34	314	-294	825	2.85
4	ARL	168	1.76	-1.21	297	-203	734	2.68
4	RYG	189	1.91	-.54	362	-103	1009	3.18
5	ARL	170	1.34	-.67	229	-254	652	3.01
5	RYG	204	1.50	-.83	307	-169	1077	3.80
			5-year average					
	ARL	184	1.32	-1.29	269	-255	709	2.82
	RYG	206	1.66	-.82	344	-169	1011	3.21

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

(1.66 vs. 1.32) and 302 lb more gain per acre (1,011 vs. 709) compared with the clover-K_2O treatment.

On the medium- and low-stocked pastures, where forage available for consumption was more abundant, calf daily gains were relatively similar. However, because of earlier grazing and higher stocking rates, the ryegrass-N-treated pastures produced from 185 to 245 more pounds gain per acre than did the clover-K_2O pastures. There was no apparent declining trend in carrying capacity of the non-N-fertilized bermudagrass pastures during the 5-year study. This would indicate that the process of recycling plant food nutrients through excreta may be functioning in accord with the availability of a previously applied pool of nutrients in the bermudagrass root zone.

Table 6 presents a subdivision of the grazing period into spring and summer. Of particular

Table 3. Animal performance on medium-stocked Coastal 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‡	187	2.21	.47	414	88	630	1.53
1	RYG	209	2.14	.69	449	143	885	2.05
2	ARL	178	2.36	-.51	420	-92	695	1.66
2	RYG	211	2.26	.31	477	70	1035	2.19
3	ARL	205	2.66	-.20	547	-41	798	1.45
3	RYG	206	2.51	-.18	517	-38	922	1.83
4	ARL	168	2.95	.91	496	153	716	1.45
4	RYG	189	2.58	1.15	488	217	846	1.77
5	ARL	151	2.06	.33	311	50	428	1.37
5	RYG	204	2.09	.71	427	145	796	2.05
		5-year average						
	ARL	178	2.46	.18	438	32	653	1.50
	RYG	204	2.31	.52	472	107	897	1.98

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

Table 4. Animal performance on low-stocked Coastal 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‡	187	2.52	.44	472	82	500	1.07
1	RYG	209	2.59	1.15	542	241	625	1.22
2	ARL	178	2.65	.56	641	181	497	1.05
2	RYG	211	2.69	.92	567	195	781	1.39
3	ARL	219	2.39	.67	523	147	437	.83
3	RYG	219	2.65	.78	581	172	627	1.08
4	ARL	168	3.36	1.91	565	321	454	.80
4	RYG	174	2.98	1.86	519	323	553	1.12
5	ARL	154	2.67	1.38	412	213	344	.83
5	RYG	204	2.49	1.05	509	214	570	1.15
		5-year average						
	ARL	181	2.70	.95	523	189	446	.92
	RYG	203	2.67	1.12	544	229	631	1.19

†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 ADG	Calf Gain/animal	Calf Gain/acre	Stocking rate†
					AU/A	
High	ARL‡	184	1.32	269	709	2.82
High	RYG	206	1.66	344	1011	3.21
Ryegrass + nitrogen advantage		+22	+.34	+75	+302	+.39
Medium	ARL	178	2.46	438	653	1.50
Medium	RYG	204	2.31	472	897	1.98
Ryegrass + nitrogen advantage		+26	-.15	+34	+244	+.48
Low	ARL	181	2.70	523	446	.92
Low	RYG	203	2.67	544	631	1.19
Ryegrass + nitrogen advantage		+22	-.03	+21	+185	+.27

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

Table 6. Five-year average of calf daily gains during the spring and summer periods from overseeded Coastal 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
2.25	2.09	3.25	.97	2.42	2.21	4.05	1.12
1.50	2.69	1.49	2.25	1.59	2.74	2.36	1.91
.87	3.05	.95	2.48	.96	3.05	1.41	2.32

†Pastures consist exclusively of bermudagrass.

interest are the differences in calf daily gains between spring and summer pastures and the similarities in calf gains between the clover and ryegrass phase at each stocking rate. During the exclusive bermudagrass phase, the 5-year average stocking rate on non-N-fertilized pastures was 3.25 AU/A, whereas the N-fertilized pastures accommodated 4.05 AU/A. Calf daily gains on the high-stocked pastures during the spring were double that of the calf gains during the summer (2.00 vs. 1.00 lb). This was due primarily to quality differences between the winter-annual forage (clover and ryegrass) and the warm-season perennial bermudagrass. Another contributing factor was that the stocking rate during the spring was necessarily lower than that during the summer because the annual forages are not as resistant to defoliation compared with bermudagrass.

The magnitude of calf gain differences between the clover vs. ryegrass pastures are shown by summing calf gain per acre during the 5-year period (Table 7). Figure 1 illustrates the relationship between calf gain per acre and stocking rate. By using data from each of the three stocking rate treatments for each of the 5 years, a typical response ($r = 0.85$) was evident from bermudagrass overseeded with clover and K_2O. The curvilinear relationship ($r = 0.89$) produced with the ryegrass-N treatment shows the disparity between the two treatments at the higher stocking rates. This figure

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

Stocking rate	Clover + K_2O bermudagrass	Ryegrass + N bermudagrass
	..... lb/A	..... lb/A .....
High	3546	5054
Medium	3267	4484
Low	2232	3156

indicates that the impact of N fertilizer on the system elevated the total gain per acre at the higher stocking rates. The data also suggest that an additional level of grazing pressure may have been needed to depress calf gain per acre.

Figure 2, however, which depicts both cows and daily gains with stocking rate, suggests that a higher level of stocking (grazing pressure) may have caused severe body condition losses in lactating cows. These data also indicate that grazing pressures were higher on the bermudagrass-clover-K_2O pastures at similar stocking rates as those on the ryegrass-N treatments. Additional summarization of the forage availability data will likely confirm this. The primary emphasis of Figure 2, however, is to illustrate the animal response to stocking rate as well as the "buffer system" in which milk serves to support "acceptable" calf gains.

Fertilizer costs per acre and per pound of calf gain are presented in Table 8 for both the clover-K_2O and ryegrass-N treatments. This simple economic comparison makes no attempt to present cash-flow opportunities but rather shows the fertilizer K_2O or N costs per pound of calf gain. The calf gain on clover-K_2O-treated bermudagrass pastures costs less than 5¢/lb at all stocking rates. The calf

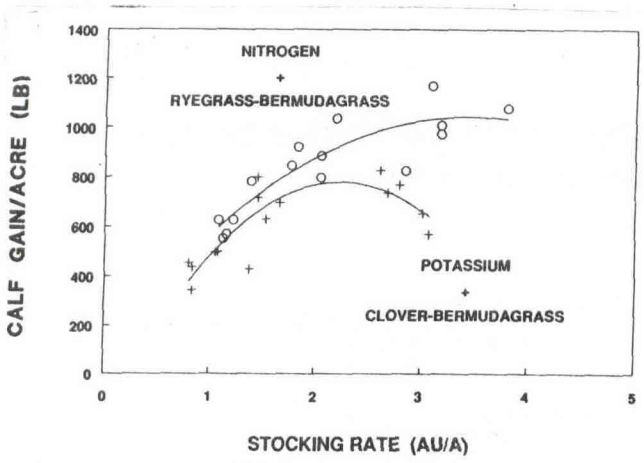

Figure 1. Relationship of calf gain per acre with stocking rate on Coastal bermudagrass pastures in combination with either nitrogen plus ryegrass or potassium plus clover.

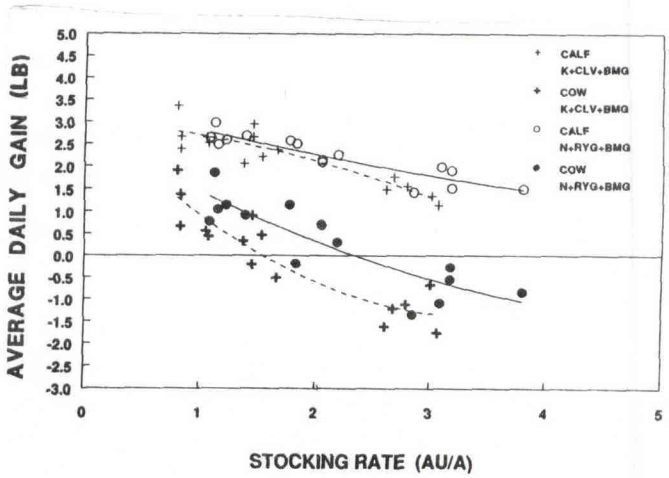

Figure 2. Relationship of daily gain of cows and calves at different stocking rates on Coastal bermudagrass (BMG) pastures in combination with either potassium (K) plus clover (CLV) or nitrogen (N) plus ryegrass (RYG).

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

Item	Stocking rates		
	High	Medium	Low
Clover + K_2O			
Animal units/A (1,500 lb)	2.82	1.50	.92
Calf gain/A (lb)	709	653	446
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	$ .0241	$ .0262	$ .0383
Ryegrass + N			
Animal units/A (1,500 lb)	3.21	1.98	1.19
Calf gain/A (lb)	1011	897	631
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	$ .1009	$ .1137	$ .1616

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

gain on ryegrass-N-treated bermudagrass pastures costs from 10¢ to 16¢/lb and varied with stocking rate. This example clearly shows that either K_2O or N fertilizer accounts for a minor portion of the total costs attributed to calf gain. In addition, this economic example indicates that under-utilized pastures have dramatic increases in fertilizer costs per pound of gain. In both the K_2O- and N-fertilized treatments, fertilizer cost per pound of gain increased about 60% in the low-stocked pastures compared with the high-stocked, maximum-utilized pastures.

Naturally, additional considerations are necessary before selecting the level of stocking rate to use on a seasonal or yearlong basis. Perhaps some of the more noteworthy points from this 5-year study are the apparent extent of recycling of plant food nutrients, the relatively stable stocking rate and carrying capacity of the non-N-fertilized pastures over time, and the relatively low cost of fertilizer when expressed on a basis of per pound of calf gain. Additional information concerning bermudagrass stand and soil fertility status to various depths is forthcoming.