High-performance short-duration and repeated-seasonal grazing systems: Effect on diets and performance of calves and lambs

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Abstract

Diet composition, performance, and production of calves and lambs grazing in combination were contrasted between a repeated-seasonal (RSG) (May-Sep.) and a 16-subunit, 1-herd high-performance short-duration grazing (HPSDG) system during 1983 and 1984. Animal numbers were adjusted with put-and-take sets of livestock to attain planned forage use levels for each cycle in HPSDG and comparable end-of-season use levels in both treatments. Diet quality, as estimated from fecal nitrogen (N), was better (*P*<0.05) for the RSG livestock especially during the first 2 grazing periods. Similarity indices of lamb and calf diet composition indicated compatibility of the lamb and calf mix in both grazing systems treatments. Calves primarily selected western wheatgrass (*Agropyron smithii* Rydb.) and annual grasses and lambs selected buffalograss (*Buchloe dactyloides* [Nutt.] Engelm.) and blue grama (*Bouteloua gracilis* [H.B.K.] Lag. ex Griffiths). Average daily gain (ADG) of RSG calves was greater in both 1983 and 1984 (0.52 and 0.68 kg/d) compared to HPSDG calves (0.39 and 0.62 kg/d, *P*<0.05). RSG lamb ADG (72.6 g/d) was greater in 1983 compared to HPSDG (45.4 g/d, *P*<0.05). Attained stocking rates were 35 and 25% higher in HPSDG during 1983 and 1984, respectively. Gain/ha, however, was greater for the HPSDG calves and combined livestock (calves + lambs) only during 1984 (*P*<0.05).

Key Words: grazing management, mixed-species grazing, diet similarity, diet selection

Grazing systems are an integral part of grazing management. Repeated-seasonal grazing (RSG), in which the animals graze the same area at the same season each year, is one of the simplest and most common grazing systems (Lewis 1983). In recent years, much attention has been directed towards the use of intensively managed systems referred to as "short-duration", "time-controlled", "controlled", or "rapid rotation", all operated under similar principles. Of particular interest to ranchers and range managers has been the claim that proper implementation of a short-duration system will result in a two-fold or greater increase in livestock carrying capacity (Savory 1978).

Several researchers (Pitts and Bryant 1987; Jung et al. 1985; Heitschmidt et al. 1982, 1987a; Olson and Malechek 1988; among others) have evaluated animal performance, production, and/or diet composition and quality in short-duration grazing (SDG) systems. However, variations in the system (size and number of subunits or paddocks), management of the system (stocking rates, occupation, and nonuse periods), geographical location, vegetation type, or year-to-year variations in precipitation are complicating factors that often prevent the extension of results to other locations and situations.

In many grazing system comparisons, fixed stocking rates were used where the number of animals per unit area was constant during the entire grazing period. Animal numbers per unit area were either: (1) equal in both systems, (2) greater in one than the other, or (3) some percentage greater or less than the general recommended stocking rate for that area. Consequently, animal performance and production were a function of stocking rate or grazing pressure rather than grazing system. Mott (1960) emphasized the need to adjust stocking rates to provide equal grazing pressure on all treatments and replications, since failure to do so may bias performance per animal and per area.

Our objectives were to compare diet composition, quality, and performance per animal and per unit area between high-performance short-duration grazing (HPSDG) and RSG systems. A HPSDG system is one in which occupation periods, nonuse periods and utilization levels are planned with flexibility to promote high performance per animal and per area (Lewis 1983).

Study Area and Methods

Data were collected during 1983 and 1984 at the Cottonwood Range and Livestock Research Station in west-central South Dakota. Vegetation is mixed grass prairie with mid and short grasses co-dominant. Major species are western wheatgrass (*Agropyron smithii* Rydb.), buffalograss (*Buchloe dactyloides* [Nutt.] Engelm.), and blue grama (*Bouteloua gracilis* [H.B.K.] Lag. ex Griffiths.). Lesser abundant perennial grasses include green needlegrass (*Stipa viridula* Trin.) and needle-and-thread (*Stipa comata* Trin. and Rupr.). Japanese brome (*Bromus japonicus* [Thunb.] ex Murr.) and six-weeks fescue (*Festuca octoflora* Walt.) are common annual grasses. Needleleaf sedge (*Carex eleocharis* Bailey) and threadleaf sedge (*Carex filifolia* Nutt.), as well as numerous forb species, are also present but account for a relatively small percentage of the total biomass.

Range sites were about 70% clayey, 19% silty, and the remainder in other related upland sites. Kyle and Pierre clays (very-fine, montmorillonitic, mesic Ustertic Camborthids) and Nunn loams (fine, montmorillonitic, mesic Aridic Argiustolls) were the major soil series.

Precipitation at the Research Station averaged 39.6 cm from 1910–1984 with 78% falling during the April through September growing season. Annual precipitation was 38.1 and 41.6 cm during 1983 and 1984, respectively. During 1983, precipitation was 81 and 67% of the long-term mean for the growing and warm (Jun.–Aug.) seasons, respectively. Cool-season precipitation (previous Sep.–May), however, was 137% of the mean. During 1984, precipitation was 121, 137, and 110% of the mean for the growing, warm, and cool seasons, respectively.

The experimental design was a randomized complete block with 2 treatments and 6 replications. The 2 treatments were the grazing systems (HPSDG and RSG). HPSDG pastures were 2.2 ha and divided into 16 subunits (paddocks) arranged in a wagon-wheel configuration. Initial stocking was 0.65 AU/ha with stocking den-

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sity in a single subunit at 10.4 AU/ha or 32 times that of RSG. RSG pastures (4.4 ha) were not subdivided, allowing livestock access to the entire unit for the duration of the grazing period. RSG initial stocking was 0.33 AU/ha. The HPSDG system was planned to have 4 cycles of rotation and subunit occupation periods of 1, 2, 2, and 3 days with corresponding nonuse periods of 15, 30, 30, and 45 days for cycles 1 through 4, respectively. The progressive increase in length of occupation and nonuse periods corresponds to declining vegetation growth rate as suggested by Voisin (1962). Grazing began on 29 May 1983 and 15 May 1984.

Lambs (ewes and wethers, 28 kg) and heifer calves (165 kg) were used as experimental animals. The lambs and calves were grouped in sets with a set consisting of 1 calf and 3 lambs. At the start of the grazing season, 2 sets of record animals were randomly allotted to each pasture. Later in the grazing period, adjustments were made with put-and-take sets of animals (Burns et al. 1970). Primary criteria for adjustments of numbers of sets of animals were to attain a similar end-of-season standing crop or an ocularly estimated forage use level of 40 to 50% in both treatments. Additionally in HPSDG, planned use levels of approximately 10, 20, and 30% for a 1-, 2-, and 3-day occupation were used as criteria for animal number adjustment.

Botanical composition of the diet of both lambs and calves was estimated during 1984 by microhistological examination of fecal material[1]. Percent relative density of discerned fragments for a species was calculated. McInnis et al. (1983) concluded diets may be described using fecal material; however, more digestible species or plant parts may be under-estimated. Fecal samples were collected from each animal on: 23 May, 17 June, 20 July, and 24 August (HPSDG cycle midpoints). Fecal samples were later dried (48 h at 60° C) and then ground through a 1-mm screen. Individual calf and lamb samples were composited into treatment by replication by date samples. The species or genera were grouped into the following 6 categories for analysis and discussion: (1) western wheatgrass; (2) shortgrasses (blue grama and buffalograss); (3) annual grasses; (4) sedges; (5) forbs; and (6) other grasses. Kulcyznski's similarity indices (Oosting 1956) were calculated to estimate the amount of dietary overlap between the calves and lambs within each grazing system treatment. Selection (preference) indices were also calculated as the ratio of the percentage of a species in the diet to the percentage of the species in the current-year standing crop (Van Dyne et al. 1978).

Kjeldahl nitrogen (N) and ash were measured in duplicate on the composited fecal samples (AOAC 1980). Wofford et al. (1985) observed a high correlation (r=.83) between percent diet N and percent fecal N. Similar results were also reported by Clarke et al. (1966) and Fels et al. (1959). This relationship has greater validity with low and moderate N forage diets than with high N diets due to a greater degree of confounding with endogenous metabolic N in high N diets.

Double sampling was used for estimation of current-year standing crop by species or species group. Five 0.25-m² circular plots were randomly located in each of the second, sixth, tenth, and fourteenth subunit of each HPSDG pasture. In RSG, 25 plots per pasture were sampled. For calibration, 1 of every 7 estimated plots was also clipped, oven-dried, separated by species, and weighed. R^2 values ranged from 0.52 to 0.01 for the different species and groups. Standing crop estimations were made at the end of the grazing season both years. In 1984, estimations were also made each cycle immediately before and immediately after livestock left the 4 designated HPSDG subunits. In RSG, estimations were made at the midpoints of the 4 HPSDG cycles.

Livestock were weighed at the start of the first and at the end of each HPSDG cycle. Put-and-take livestock were not included in average daily gain (ADG) calculations. Livestock were penned without feed or water overnight and weighed the following morning. Gain/ha was calculated by multiplication of ADG by grazing days of both record and put-and-take livestock and then divided by pasture hectareage. Lamb and calf animal unit equivalents were derived from daily dry matter intake (DMI) requirements with 12 kg equaling 1 AU. A 28-kg lamb was considered 0.12 AU based on its NRC (1985) DMI requirement of 1.4 kg. A 165-kg calf was considered 0.39 AU based on intake estimated using the equation: $Y=0.297X^{0.54}$, where Y is intake and X is body weight (Colburn and Evans 1968). AU values were recalculated each weigh day.

Statistical analyses were conducted by using the appropriate Statistical Analysis System procedures (SAS Institute Inc. 1985). Production per area was subjected to analysis of variance procedures. All other data sets were evaluated with repeated measures analysis of variance (SAS Institute Inc. 1985) and a multivariate approach (Cole and Grizzle 1966) was used. Model components were treatments, replications, cycles (or sampling dates) and treatment by cycle interaction. Where needed, protected LSD was used for mean separation (Steel and Torrie 1980). Years were analyzed separately due to differences in livestock breeds and trial starting dates.

Results and Discussion

Botanical Composition of Diets

Twenty-two different species or genera (8 perennial grasses, 2 annual grasses, 11 forbs and sedges) were identified in the fecal samples from the lambs and calves in the 2 grazing systems. Annual grasses and western wheatgrass were major components in calf diets and shortgrasses were the major component in lamb diets in both treatments (Table 1). RSG calf samples contained a greater percentage of western wheatgrass and forbs and less annual grasses than HPSDG samples ($P<0.05$). RSG lamb samples also contained a greater percentage of forbs as well as less sedges than HPSDG samples ($P<0.05$). RSG lamb samples also contained a greater percentage of forbs as well as less sedges than HPSDG samples ($P<0.05$).

Date effects for both calves and lambs included a greater percentage of western wheatgrass on 23 May and 24 August than on the middle 2 dates and percentage of shortgrasses was least on 23 May compared to the other 3 dates ($P<0.05$). For the calves only, percentage of annual grasses was greater on 17 June and 20 July than on the first and last dates ($P<0.05$). For the lambs, percentage of annual grasses was greater on 23 May than on the other 3 dates and percentages of sedges and forbs were greater on the first 2 dates than on the last 2 ($P<0.05$).

RSG lamb and calf diets contained a greater variety of forb species (11 vs. 3 in HPSDG) as might be expected with the greater opportunity for selection in RSG. Additionally, the relatively small area of an HPSDG subunit would limit supply of forbs, which would be diminished rapidly during an occupation period. Depending on new growth, the supply could be further limited during later cycles. Forbs were not detected in HPSDG calf samples from the cycle 2, 3, and 4 sampling dates (Table 1).

Calves in both treatments showed a high degree of selection for annual grasses (Table 2). Rodgers (1972) also reported this with yearling steers in an earlier study on similar pastures. Calf selection indices in both treatments were least for shortgrass and forb groups. Lambs in both treatments showed stronger selection for the shortgrasses, annual and other grasses groups and the least selection of western wheatgrass.

For all species groups, similarity index means were never excessively high (Table 2). Similarity indices for the annual and other grasses groups were among the highest as those two groups were

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Table 1. Percent relative density of species observed in microhistologically examined fecal samples of calves and lambs in RSG and HPSDG systems at 4 dates, 1984[1].

Calves	23 May		17 June		20 July		24 August		Mean	
Species/Group	HPSDG	RSG	HPSDG	RSG	HPSDG	RSG	HPSDG	RSG	HPSDG	RSG
Western wheatgrass	29	47	13	22	10	25	26	34	19[A]	32[B]
Shortgrasses	2	3	10	10	10	13	13	9	9	9
Annual grasses	54	34	74	57	74	57	56	50	65[A]	49[B]
Sedges	10	9	0	4	<1	<1	1	1	3	4
Forbs	1	3	0	2	0	<1	0	0	<1[A]	1[B]
Other grasses	4	4	3	5	5	4	4	6	4	5
Lambs										
Western wheatgrass	10	13	5	4	2	3	7	7	5	7
Shortgrasses	19	21	35	51	61	73	62	56	44	50
Annual grasses	24	33	19	18	25	7	11	3	20	15
Sedges	31	12	24	14	8	11	4	9	17[A]	12[B]
Forbs	3	12	2	8	1	3	1	<1	2[A]	6[B]
Other grasses	13	9	15	5	3	3	15	24	12	10

[1]Dates correspond to the midpoints of the 4 HPSDG cycles.
[AB]Within species or group, means with unlike letters significantly differ, ($P<0.05$).

Table 2. Selection indices and similarity indices of diets of calves and lambs in RSG and HPSDG systems, 1984[1].

	Species (Group)					
	Western wheatgrass	Short-grasses	Annual grasses	Forbs	Sedges	Other grasses
RSG						
% of total standing crop[2]	48.9	31.7	9.0	5.7	3.6	1.2
Selection index (calf)[3]	0.7	0.3	5.5	0.2	1.0	4.2
Selection index (lamb)[3]	0.1	1.6	1.7	1.0	3.3	8.5
Similarity index[4]	35.4	29.0	46.5	38.5	46.7	64.2
HPSDG						
% of total standing crop[2]	41.9	30.4	17.1	5.4	4.4	0.7
Selection index (calf)[3]	0.5	0.3	3.8	0.1	0.7	5.4
Selection index (lamb)[3]	0.1	1.5	1.2	0.3	3.8	16.5
Similarity index[4]	44.1	32.8	47.0	30.5	29.1	49.4

[1]Mean of the 4 sampling dates.
[2]Current-year standing crop estimated at the midpoints of the 4 HPSDG cycles.
[3]Percent in diet/Percent of total standing crop.
[4]Calves vs. lambs; $2W/(a+b) \times 100$ where W is the lesser percentage of the species group in the 2 diets being compared and a+b is the sum of the percentages of the species group in the 2 diets.

Table 3. Sets of livestock and cycle and cumulative stocking rates (AUM/ha) in HSPDG and RSG systems, 1983 and 1984.

		HPSDG			RSG		
Period	Cycle	Sets[1]	Stocking rate	Cumulative stocking rate	Sets[1]	Stocking rate	Cumulative stocking rate
1983							
5/29–6/13	1	2	0.35	0.35	2	0.17	0.17
6/15–7/16	2	2	0.73	1.08	2	0.36	0.54
7/18–8/18	3	3/2[A]	0.96	2.03	3	0.57	1.11
8/20–9/28	4	1	0.52	2.55	3	0.78	1.89
1984							
5/15–5/30	1	2	0.35	0.35	2	0.17	0.17
6/1–7/2	2	2	0.71	1.06	2	0.35	0.53
7/4–8/4	3	1	0.38	1.44	3	0.57	1.10
8/6–9/14	4	1	0.51	1.95	3/1[B]	0.46	1.56

[1]One set = 1 calf and 3 lambs.
[A]Three sets started cycle 3 in HPSDG, but 1 set was removed after 16 days (8 subunits).
[B]Two sets in RSG were removed after 16 days into this cycle.

Table 4. Average daily gain (kg) of calves in repeated-seasonal (RSG) and high-performance short-duration (HPSDG) grazing systems, 1983 and 1984.

	1983				1984			
Cycle	RSG	HPSDG	Mean	±SE	RSG	HPSDG	Mean	±SE
1	0.27	0.15	0.21[a]	±0.09	0.58	0.48	0.53[a]	±0.05
2	0.98	0.68	0.83[b]	±0.06	1.00	0.76	0.88[b]	±0.04
3	0.58	0.50	0.54[c]	±0.04	0.78	0.79	0.78[b]	±0.06
4	0.25	0.22	0.24[a]	±0.05	0.39	0.43	0.41[a]	±0.03
Season mean	0.52[A]	0.39[B]			0.68[A]	0.62[B]		
±SE	±0.04	±0.04			±0.03	±0.02		

[abc]Within years, cycle means with unlike superscripts differ ($P<0.01$ in 1983 and $P<0.05$ in 1984).
[AB]Within years, season treatment means with unlike superscripts differ ($P<0.05$).

selected by both calves and lambs. Similarity indices were generally highest for all species groups in both treatments on 23 May as would be expected since the warm-season species had not yet begun rapid growth and consequently, the least amount of live forage was available. Probably the most important similarity and selection indices to consider are those for the 2 dominant forages, western wheatgrass and shortgrasses. Here the compatibility of the calf and lamb combination in both grazing systems can be seen with the low or moderate similarity indices. However, the similarity index for western wheatgrass was 25% higher in HPSDG compared to RSG, reflecting the greater stocking density and grazing pressure of HPSDG.

Stocking Rates and Standing Crop

Attained stocking rates resultant from the put-and-take approach were 35 and 25% greater in HPSDG than in RSG for 1983 and 1984, respectively (Table 3). In 1983, end-of-season standing crop was significantly less in HPSDG (661 kg/ha) compared to RSG (809 kg/ha) ($P<0.05$). This indicates that our put-and-take adjustments of livestock were incorrect as we did not meet our end-of-season criterion of similar standing crop. In 1984, end-of-season standing crop was not different between HPSDG (1,222 kg/ha) and RSG (1,178 kg/ha) ($P>0.05$). Stocking rates for both treatments averaged 27% higher in 1983 than in 1984 and this was reflected in the lesser end-of-season standing crop in 1983.

In order to prevent excessive forage use during cycle 4, it was necessary to reduce the occupation days (d) from 3 to 2 for the final 8 subunits. This reduced cycle 4 length to 40 d rather than the planned 48 d. These 8 subunits were last grazed in late July and early August of cycle 3. Mature forage and typically dry conditions at this time minimized regrowth potential in those subunits. This difference in regrowth or recovery potential between early and late grazed subunits can be a problem in any SDG system in which there is rapid forage maturity or drought effects appear mid-cycle.

Livestock Performance and Production

Significant treatment and cycle effects were detected in average daily gain (ADG) of calves during both years (Table 4). RSG calf ADG was greater during both years ($P<0.05$). ADG during cycles 2 and 3 was significantly greater than cycles 1 and 4 during both years ($P<0.05$). With the exception of the lower cycle 1 ADG, this parallels vegetative growth dynamics in the area.

Lamb ADG exhibited a sigificant treatment × cycle interaction in both years in addition to significant treatment and cycle effects in 1983 and a cycle effect in 1984 (Table 5). RSG lamb ADG was greater during cycles 1 and 4 in 1983 and cycle 2 in 1984 ($P<0.05$). ADG for the entire season was greater for the RSG lambs in 1983 ($P<0.01$), but there was no difference in 1984. As with the calves, lamb ADG was highest during cycles 2 and 3 each year ($P<0.01$).

Our animal performance data tend to conform to an ADG and stocking rate or grazing pressure relationship. In studies by Hart et al. (1988), about two-thirds of the variation in ADG could be accounted for by grazing pressure. This was especially true between HPSDG and RSG calves both years, for lambs in 1983, as well as an overall comparison between years.

During 1984, gain/ha under HPSDG for calves (47.3 kg/ha) and total livestock (calf + lamb, 63.9 kg/ha) were greater than for RSG calves (40.8 kg/ha) and total gain (56.3 kg/ha) ($P<0.05$, Fig. 1). In essence, the lower ADG or HPSDG was offset by the higher stocking rates that were attained resulting in greater gain/ha. Similarly, across treatments, gain/ha was somewhat higher in 1984 because of higher ADG than in 1983, even though stocking rates were less in 1984.

Diet Quality

Analysis of percent fecal N revealed a significant treatment × date interaction in addition to significant treatment and date effects (Table 6). RSG calf and lamb samples had a greater percent fecal N on 23 May and 17 June and the RSG treatment mean was higher than HPSDG ($P<0.05$).

One reason, then, for the greater ADG of livestock in RSG was their opportunity for greater selection of species and plant parts, resulting in a diet higher in N. In a SDG system with 3-day

Table 5. Average daily gain (g) of lambs in repeated-seasonal (RSG) and high-performance short-duration (HPSDG) grazing systems, 1983 and 1984.

	1983				1984			
Cycle	RSG	HPSDG	Mean	±SE	RSG	HPSDG	Mean	±SE
1	47.8[a]	−37.8[b]	5.0[A]	±11.3	−9.4[a]	−12.4[a]	−10.9[A]	±10.6
2	157.5[a]	157.5[a]	157.5[B]	±6.5	196.1[a]	133.8[b]	164.9[B]	±6.1
3	66.4[a]	55.9[a]	61.2[C]	±7.5	135.4[a]	144.4[a]	139.9[B]	±8.4
4	23.2[a]	6.8[b]	15.0[A]	±6.3	19.5[a]	18.4[a]	18.9[A]	±7.0
Season mean	72.6[A]	45.4[B]			86.2[A]	72.6[A]		
±SE	±3.8	±5.3			±5.1	±5.7		

[ab]Within years and cycles, treatment means with unlike superscripts differ ($P<0.05$).
[ABC]Within years, cycle or season means with unlike superscripts differ ($P<0.01$).

Table 6. Percent nitrogen (organic matter basis) of fecal samples of lambs and calves in RSG and HPSDG systems, 1984[1].

	Treatment	Date: 23 May		17 June		20 July		24 August	Treatment Mean±SE	
Calves	RSG	3.42^{a}		2.91^{a}		2.31^{a}		1.95^{a}	2.65^{A}	±0.12
	HPSDG	3.03^{b}		2.63^{b}		2.27^{a}		1.90^{a}	2.46^{B}	±0.09
Date Mean ± SE		3.23^{A}	±0.08	2.77^{B}	±0.06	2.29^{C}	±0.04	1.93^{D}	±0.03	
Lambs	RSG	3.90^{a}		2.97^{a}		2.40^{a}		1.97^{a}	2.81^{A}	±0.10
	HPSDG	3.34^{b}		2.66^{b}		2.37^{a}		2.11^{a}	2.62^{B}	±0.07
Date Mean±SE		3.62^{A}	±0.11	2.82^{B}	±0.07	2.39^{C}	±0.04	2.04^{D}	±0.04	

[1]Dates correspond to the midpoints of the 4 HPSDG cycles.
[ABCD]Within livestock class, treatment or date means with unlike superscripts differ ($P<0.05$).
[ab]Within livestock class and date, treatment means with unlike superscripts differ ($P<0.05$).

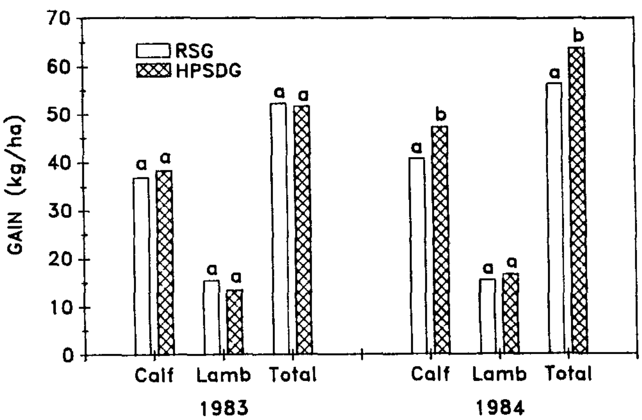

Fig. 1. Calculated gain (kg/ha) of calves and lambs in RSG and HPSDG systems, 1983 and 1984.

[ab]Within years for the calf, lamb and total (calf + lamb) comparisons, means with unlike letters differ.

occupation periods, Olson et al. (1989) reported heifer diets to decline in crude protein and organic matter digestibility from entry to day 3. It is possible that this may have occurred in our HPSDG system and contributed to lower animal performance.

Fecal N decreased over the season for both calves and lambs, corresponding to increasing forage maturity ($P<0.05$) (Table 6). Hand-plucked forage samples contained 2.41, 1.78, 1.34 and 0.98% N (organic matter basis) on 23 May, 17 June, 20 July, and 24 August, respectively. With the exception of cycle 1, declines in fecal N were consistent with declines in ADG.

Conclusions

Data from these trials show that properly managed HPSDG systems may allow only modest increases in stocking rate and result in a slight increase in livestock production per area; however, individual animal performance may be reduced. The plant-animal-climate association within a HPSDG system lends itself to a need for very intensive management and flexibility of the system. Increases in stocking rate under SDG systems are thought to be resultant from better livestock distribution (Heitschmidt et al. 1987b). Management must be observant of forage use and residue levels, particularly during dry periods, and then be flexible, providing supplemental feed, reducing animal numbers, or having reserve pastures in order to prevent serious overuse.

Long-term testing of SDG systems is needed to provide data for a variety of weather conditions and to detect possible cumulative effects of the system on grassland ecosystems. The number of subunits, length of periods of occupation and nonuse and their variation by site, season, and year, as well as degree of use and amount of residue following each occupation, are variables that require further study in order to be optimized.

Cattle and sheep grazing in combination appears to have excellent potential for improving livestock production on the range types used in these trials. Unplanned comparisons suggest the hypothesis that mixing kinds of livestock in RSG may permit stocking rate increases as large as those due to HPSDG. Additionally, there is a need for research designed to evaluate interactions of mixed-species grazing and grazing systems.

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Associate Editor Nominations
Journal of Range Management

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