Observations of Grass Community Dynamics in Short Duration Grazing Systems in West Texas

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ABSTRACT

Short duration grazing (SDG) has played a major role in grazing management practices in North America over the past 2 decades. Among other things, implementation of SDG (i.e., cell grazing) reportedly improves livestock distribution within the grazing unit and improves range condition. The objective of this study was to evaluate density and frequency of the herbaceous vegetation as affected by distance from cell center, as well as changes in density and frequency over a 9-year period. Vegetation of the study area is considered a semidesert grass-shrub complex dominated by black grama (*Bouteloua eriopoda* Torr., Torr.) and multiple-stemmed honey mesquite (*Prosopis glandulosa* Torr.). Following implementation of SDG, density and frequency of herbaceous vegetation differed at various distances from the cell center. The spatial variability in plant response suggests that implementation of SDG did not result in uniform forage utilization. Secondly, there was an increase in density and frequency of perennial grasses over the 9 years of the study. The increase in plant density and frequency may be related to SDG but it is likely that a principal cause of the positive response was favorable precipitation levels received during the study period.

KEYWORDS: SDG, cell grazing, black grama, *Bouteloua eriopoda*, density, frequency

In the early development of short duration grazing (SDG) and similar grazing systems, proponents suggested that uniform utilization of grazing land could be achieved by proper implementation of SDG (Savory and Parsons, 1980). Although Savory (1983) has since refuted claims that uniform utilization can be achieved under SDG, he still states that distribution of grazing can be improved through properly managed SDG methods (Savory, 1988). Recent research questions the idea that SDG improves or results in uniform livestock distribution and utilization (Kirby et al., 1986; Pitts and Bryant, 1987; Nelson et al., 1989; Walker et al., 1989a; Walker et al., 1989b; McKown et al., 1991). Nevertheless, numerous producers and land managers still believe that uniform distribution and forage utilization will be

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achieved with the implementation of SDG or other grazing strategies that rely on high stock densities (Stan Reinke, Natur. Res. Conserv. Service, pers. comm.).

We believe that existing paradigms held by land managers and producers concerning livestock distribution and utilization warrant evaluation of SDG on a long-term basis, especially in semiarid and arid ecosystems where soil water and nutrients are limited. Thus, the objective of our study was to determine spatial and temporal dynamics of herbaceous vegetation in terms of density and frequency in two SDG systems over a 9-year period. Development and evaluation of the objective is based on the assumption that similar utilization by livestock of plants at various distances from the cell center should result in a similar pattern of plant response (i.e., density and frequency) within cell pastures.

STUDY AREA

The study was conducted on two sites of the Anderson Ranch in Winkler and Ward counties of the Trans Pecos Region of Texas. The sites were owned by the University of Texas Lands/Surface Interests and leased for grazing by Mike Harrison. The area was classified as a semidesert grass-shrub complex (Nelson, 1934; Paulsen and Ares, 1962). Average annual precipitation was 11 inches with 80% of the precipitation occurring from May to October. Temperatures ranged from a daily minimum of 13°F in January to an average maximum of 95°F in July. The frost-free period averaged 233 days. The area was dominated by shallow sandy loam to deep noncalcareous sandy soils which had good infiltration rates and were well drained.

The major native grasses on the Anderson Ranch were perennials including black grama (*Bouteloua eriopoda* Torr. Torr.), dropseeds (*Sporobolus contractus* Hitchc., *Sporobolus flexuosus* Thurb. Rydb.), plains bristlegrass (*Setaria leucopila* Scribn. & Merr., K., Schum.), bush muhly (*Muhlenbergia porteri* Scribn.), fluffgrass (*Erioneuron pulchellum* H. B. K.), and threeawns (*Aristida* spp. L.). The primary woody plant was multiple-stemmed honey mesquite (*Prosopis glandulosa* Torr.); however, creosotebush (*Larrea tridentata* DC., Cov.), catclaw (*Acacia greggii* Gray), threadleaf groundsel (*Senecio douglasii* DC.), and broom snakeweed (*Gutierrezia sarothrae* Pursh, Britt. & Shinners) were also common. Short-lived perennial and annual forbs were abundant during intermittent wet periods, but generally made up a minor portion of the plant cover.

Sandwell Cell

Nine pastures were arranged in a wagon-wheel design in the Sandwell Cell, which covered 7,606 acres. Each pasture was about 840 acres and 2 miles long. Sandwell Cell was dominated by shallow soils classified as Sharvana sandy loam (thermic Petrocalcic Ustalfic Paleargids). The Sandwell Cell was native rangeland dominated by black grama and multiple-stemmed honey mesquite. The cell was stocked with a cow/calf herd at 49 acres per animal unit year (AUY) throughout the study. The grazing cycle was 90 days with 10- to 12-day grazing periods.

Harrison Cell

The Harrison Cell encompassed 8,006 acres with eight pastures of nearly equal size arranged in a wagon-wheel design. Each pasture was about 1,000 acres and 2 miles long. Harrison was dominated by a shallow, gravelly loam soil in the Simona series (thermic Typic Paleorthids). In 1977-78, the Harrison site was rootplowed and seeded to a mixture of 75% Lehmann lovegrass (*Eragrostis lehmanniana* Nees) and 25% plains bristlegrass, dropseeds, and sideoats grama (*Bouteloua curtipendula* Michx., Torr.). Although a good stand of Lehmann lovegrass established, substantial re-establishment of native plant species like black grama and fluffgrass had occurred by 1983. The Harrison Cell was stocked with a cow/calf herd at 40 acres per AUY throughout the study. The overall grazing cycle was similar to that of Sandwell with a 90-day grazing cycle and 10- to 12-day grazing periods.

METHODS

In January 1983, three pastures within each cell were selected for measurement of spatial and temporal changes in vegetation under SDG. Selected pastures were generally equal in size and were considered to represent the respective cells in terms of dominant soils and vegetation. Beginning near the cell center and extending toward the periphery of each pasture, eight permanent transects were located systematically at 1322-ft intervals. Each transect line was 164 ft long and situated perpendicular at 105 ft from a paddock fence radiating out from the cell center.

Beginning with the establishment of the cells in 1983, vegetation was sampled annually. A modified belt transect system (Schmutz et al., 1982) was used to estimate density and frequency. The methodology involved systematic placement of a 0.33 ft^2-quadrat at 3.28-ft intervals along a tape measure stretched between opposite ends of the transect. At each quadrat placement, the number of individual plants of each species was recorded for plant density (plants ft^{-2}) and frequency (%) determination. Before observations were recorded each year, procedures for identifying individual plants were standardized among observers and years. Individual grass plants are often difficult to distinguish, especially if they reproduce vegetatively (Bonham, 1989). Consequently, we adopted a procedure of identifying an individual plant as vegetation growing from an individual tussock.

Both cells were analyzed separately because initial botanical composition and stocking rates differed. Repeated measures analysis of variance was used to determine differences in density and frequency among the eight distances (treatments) across the three pastures (replicates) within each cell averaged over time (Hicks, 1993). Test of sphericity determined that multivariate analysis rather that univariate should be utilized (SAS, 1985). Least squares analysis was performed on treatment and interaction effects when $P \leq 0.10$. Significant year differences were identified using multivariate analysis procedure for a paired contrast between years (SAS, 1985), which limits year comparisons to contrasts between two consecutive years (e.g., 1983 vs. 1984, not 1983 vs. 1985).

RESULTS

Distance from Cell Center

Analyses of the first year data (1983), collected prior to implementation of SDG, indicated that density and frequency of the major perennial grass species were similar among the treatments (i.e., distance from cell center) for both cells. Hence, there did not appear to be existing patterns in plant density or frequency at the onset of the study.

Sandwell Cell

Black grama was the dominant perennial grass species as it composed more than 77% of the total perennial grass density in the Sandwell Cell. Other prevalent grasses were threeawns at a low relative density of 4.7%. Density and frequency for black grama differed among lines in the Sandwell Cell (Table 1). Black grama density was higher near the cell center (line 1 = 2.89 plants ft^{-2}) than for the remaining lines, while black grama density for lines midway through the pasture (4 and 5 = 0.90 plants ft^{-2}) was lower than all other lines except for line 3. Black grama frequency for line 1 (78.0%) was higher than lines 2 through 6.

There was a year by line interaction for density of total grasses and threeawns. For the first 5 years of the study, density of total grasses was generally similar in the front and back part of the paddocks but higher than total grass density for the middle lines. During the last 4 years of the study, however, density for line 1 was generally higher than all other lines, including those in the back part of the paddocks. As for density of threeawns, all lines had similar densities from 1983 through 1986, whereas density varied among lines from 1987 through 1991.

Frequency for threeawns and total grasses differed among lines in the Sandwell Cell (Table 1). Frequency of total grasses was similar for the lines at the front and back parts of the paddocks while the lowest frequencies were recorded for lines 4 and 5 (61.1 and 62.9%, respectively). Frequency of black grama followed the same pattern as total grasses, whereas threeawn frequency by line was considerably different. Frequency of threeawns peaked in the middle lines at 14.8% and reached its lowest point towards the front part of the paddock at 1.4%.

Harrison Cell

Lehmann lovegrass was the dominant perennial grass in the Harrison Cell as it composed about 26.1% of the total perennial grass density. The secondary grass species were black grama and threeawns with relative densities of about 15.5% and 15.2%, respectively. Density and frequency of black grama, threeawns, and total grasses were similar for all lines. Lehmann lovegrass, however, tended to decrease in density as distance from cell center increased (Table 2). There was a year by line interaction for Lehmann lovegrass frequency which was related to the inconsistency of significant differences among lines over time. Frequency was generally higher for lines 1 through 5 than for lines 6 through 8 (Table 2). During the majority of the study (1983 through 1988), lines 1 and 2 tended to have the highest frequency. Frequency for 1990, was highest for lines 4 and 5.

Table 1. Density (plants ft^{-2}) and frequency (%) for the major perennial grass species by line in the Sandwell Cell. Means are averaged over years.

Species	Line†							
	1	2	3	4	5	6	7	8
Density								
Black grama	2.9 a‡	1.6 b	1.5 bc	0.9 c	0.9 c	1.7 b	2.1 b	2.0 b
Frequency								
Black grama	78 a	50 bcd	49 bcd	31 d	35 cd	54 bc	71 ab	68 ab
Threeawns	4 cd	1 d	10 ab	15 a	11 ab	6 bcd	9 bc	9 bc
Total grass	83 ab	68 bc	71 bc	61 c	63 c	69 bc	82 ab	98 a

†Density and frequency were estimated along lines at intervals of 1,322 ft from the cell center.
‡Within a row, means followed by different letters are different ($P<0.1$).

Table 2. Density (plants ft^{-2}) and frequency (%) for the major perennial grass species by line in Harrison Cell. Means are averaged over years.

Species	Line†							
	1	2	3	4	5	6	7	8
Density								
Leh. lovegrass	1.0 a‡	0.8 ab	0.5 bcd	0.7 abc	0.6 abcd	0.2 d	0.3 cd	0.4 bcd
Frequency								
Leh. lovegrass	41	40	26	33	31	8	12	24

†Density and frequency were estimated along lines at intervals of 1,322 ft from cell center.
‡Within a row, means followed by different letters are different ($P<0.1$).

Sandwell Cell

Density and frequency of black grama differed over time in the Sandwell Cell (Table 3). Black grama density and frequency peaked in 1989 and then declined to lower levels in 1990 and 1991 levels. Density and frequency of threeawns also changed over the course of the study. Frequency increased over time peaking in1991 at 16.8% (Table 3). Analysis of density of threeawns, however, indicated a year by line interaction. Line 2 did not change over time while density for the remaining lines increased. There was a year by line interaction for total grass density. The interaction reflected the small change in density that occurred in lines 6, 7, and 8 over the course of the study while density increased for lines 1 through 5 over the study period.

Table 3. Density (plants ft^{-2}) and frequency (%) for the major perennial grass species from 1983 to 1991 in the Sandwell Cell. Means are averaged over lines.

Species	Year								
	83	84	85	86	87	88	89	90	91
Density									
B. grama	1.5*	1.0*	1.3*	1.8*	1.8	1.7*	2.3*	1.8	1.9
Frequency									
B. grama	48*	37*	42*	57	59*	64*	66*	59	57
Threeawns	4	3*	5*	6	9*	12*	8	8*	17

*Within a row, a mean with an asterisk is different ($P<0.1$) than the mean of the following year.

Harrison Cell

Density of black grama, Lehmann lovegrass, threeawns, and total grasses increased over time in the Harrison Cell (Table 4). Density for the major grasses peaked in the period from 1989 to 1991. Density of total grasses reached its highest level in 1988 before declining in 1989. Lehmann lovegrass increased from 0.20 plants ft^{-2} in 1983 to 0.73 plants ft^{-2} in 1991, while total grasses increased from 1.23 to 2.52 plants ft^{-2} over the same period. Frequency of black grama and total grasses did not change throughout this study. Frequency of threeawns did increase, reaching its highest level in 1991 (Table 4). The year by line interaction which occurred for frequency of Lehmann lovegrass was significant. Frequency of Lehmann lovegrass for lines 1 and 2 peaked between 1987 and 1988, while lines 3 through 7 peaked between 1990 and 1991. Lines 1 and 2 declined to the level reported in 1991.

Table 4. Density (plants ft^{-2}) and frequency (%) for the major perennial grass species from 1983 to 1991 in the Harrison Cell. Means are averaged over lines.

Species	Year								
	83	84	85	86	87	88	89	90	91
Density									
B. grama	0.3*	0.2	0.2*	0.3	0.2*	0.4	0.5	0.4	0.4
L. lovegrass	0.2*	0.1*	0.4*	0.5*	0.6*	0.7	0.7*	1.0*	0.7
Threeawns	0.2	0.2	0.2*	0.3*	0.4	0.3	0.3	0.5*	0.6
Total grass	1.2	1.4	1.4*	2.2*	2.3*	2.9*	2.4	2.5	2.5
Frequency									
Threeawns	11	10	10*	19*	25	21*	18*	21*	30

*Within a row, a mean with an asterisk is different ($P<0.1$) than the mean of the following year.

DISCUSSION

Distance from Cell Center

If SDG results in uniform utilization within pastures, then one might expect uniformity of plant response at various distances from cell center, assuming climate and soils are similar. Results of our study indicate that changes in density and frequency of some of the major perennial grass species varied spatially within the experimental pastures (Tables 1 and 2). Our findings are consistent with others which suggest uniform utilization by grazing livestock is not achieved under SDG (Kirby et al., 1986; Pitts and Bryant, 1987; Soltero et al., 1989).

Density of grasses was relatively high near both cell centers. Heavy grazing pressure often causes bunchgrasses to break, and results in increased density and lower basal cover (Nelson, 1934; Hickey, 1961; Butler and Briske, 1988). Vigor of these smaller plants is generally lower and the plants are more susceptible to grazing (Briske, 1991). As measured in 1990 and 1991, basal area of individual grass plants in the front portions of the pastures was less than that of grass plants of the same species further from the cell center (Scott and Schacht, unpublished data). Visual observations also indicated that although plant density was higher in the front portions of the pastures, individual plants were considerably smaller. Collectively, these results suggest that heavy use was occurring in the front of pastures, probably because of proximity of water.

The apparent low utilization of plants in the back of pastures was probably due to distance from water. Stuth (1991) indicated that forage utilization decreases dramatically after 0.5 miles from water with the outer limit of cattle and sheep grazing at approximately 1 mile. Pastures in both Sandwell and Harrison cells were approximately 2 miles long, and consequently, the back of the pastures may have exceeded the area available for grazing. Nevertheless, Squires (1981) described some groups of cows that travelled as far as 5.5 miles from water to forage. Livestock often forage in disparate locations because of preferences for particular areas (e.g., habitats) within the environment (Scott et al., 1995), which may explain the observations of Squires (1981). Livestock may also learn the schedule of movements in a SDG system. Managers report that livestock are usually "waiting at the gate" when its time to move into a new cell pasture. In the Sandwell and Harrison cells cattle were moved on a regular basis from one pasture to the next through gates near the cell centers; therefore, livestock grazing distribution was probably also affected by movement procedures employed in the two cells.

Pasture configuration may have influenced livestock distribution and utilization patterns. Pastures in the two cells were triangular-shaped and arranged in a wagon-wheel design, with watering facilities at the cell centers. It is possible that higher levels of utilization in the front portion of pastures were the result of pasture design rather than factors relating to SDG. Nevertheless, most SDG units utilize a wagon-wheel design with triangular-shaped pastures. Our findings regarding plant responses at varying distances should be applicable to the majority of SDG units.

Change Over Time

The increase in density and frequency of the major perennial grass species could be interpreted as a result of implementation of SDG. The cells were established during relatively dry years when annual precipitation was below the annual long-term average of 11 inches. During the study period, annual precipitation was relatively high especially from 1984 through 1987. Following 1987, annual precipitation declined to below-average levels in 1989 before increasing again in 1990. Nelson (1934) reported years of above-average rainfall preceded increases in herbaceous plant density by 1 to 2 years in the semidesert region of western Texas and southern New Mexico. In our study increases in density and frequency of major perennial grass species generally occurred 1 to 2 years after above-average annual precipitation (Figures 1 and 2). Therefore, increases in density and frequency over time may be attributed to above-average annual precipitation rather than SDG, or possibly a combination of both factors.

Finally, average stocking rate for the two cells (45 acre per AUY) was about 32% higher than the long-term stocking rate previously used on the Anderson Ranch under continuous grazing (Gary Loftin, Manager, Anderson Ranch, pers. comm.). Control of intensity and frequency of defoliation of key forage species is a basic principle of intensively-managed grazing systems such as SDG (Vallentine, 1990). When properly managed, intensively-managed grazing systems reportedly allow for higher levels of utilization and stocking rates because length of grazing and recovery periods match the needs of the key species (Waller et al., 1986). Perennial grasses in our study responded favorably to relatively high stocking rates and SDG as they increased in density and frequency over the study period. Other studies in Texas and Oklahoma, however, report varying results concerning vegetation response to SDG at higher stocking rates (Ralphs et al. 1990; Gillen et al. 1991). Moreover, our study did not provide the resolution to separate the effect of above-average precipitation

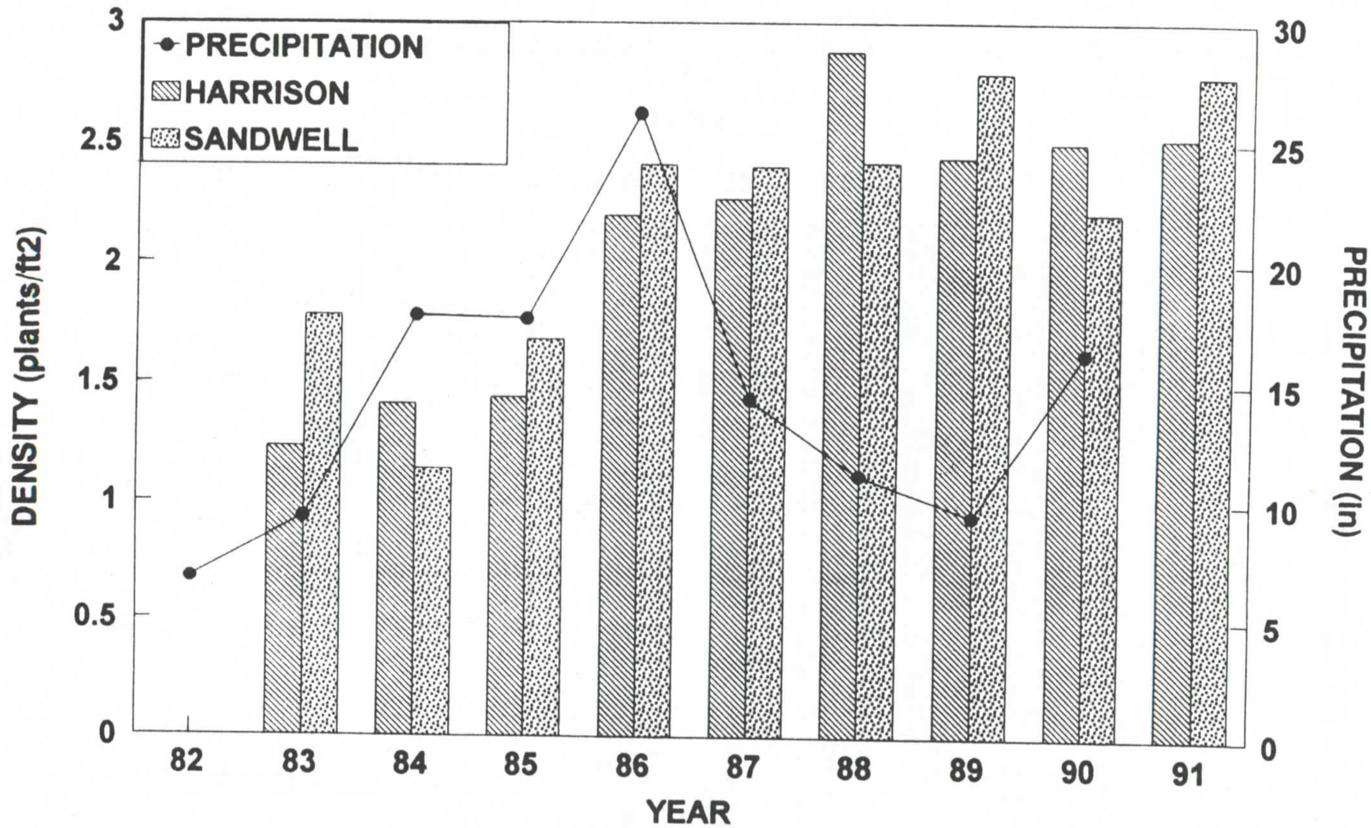

Figure 1. Total grass density for the two cells compared to annual precipitation received during the study period.

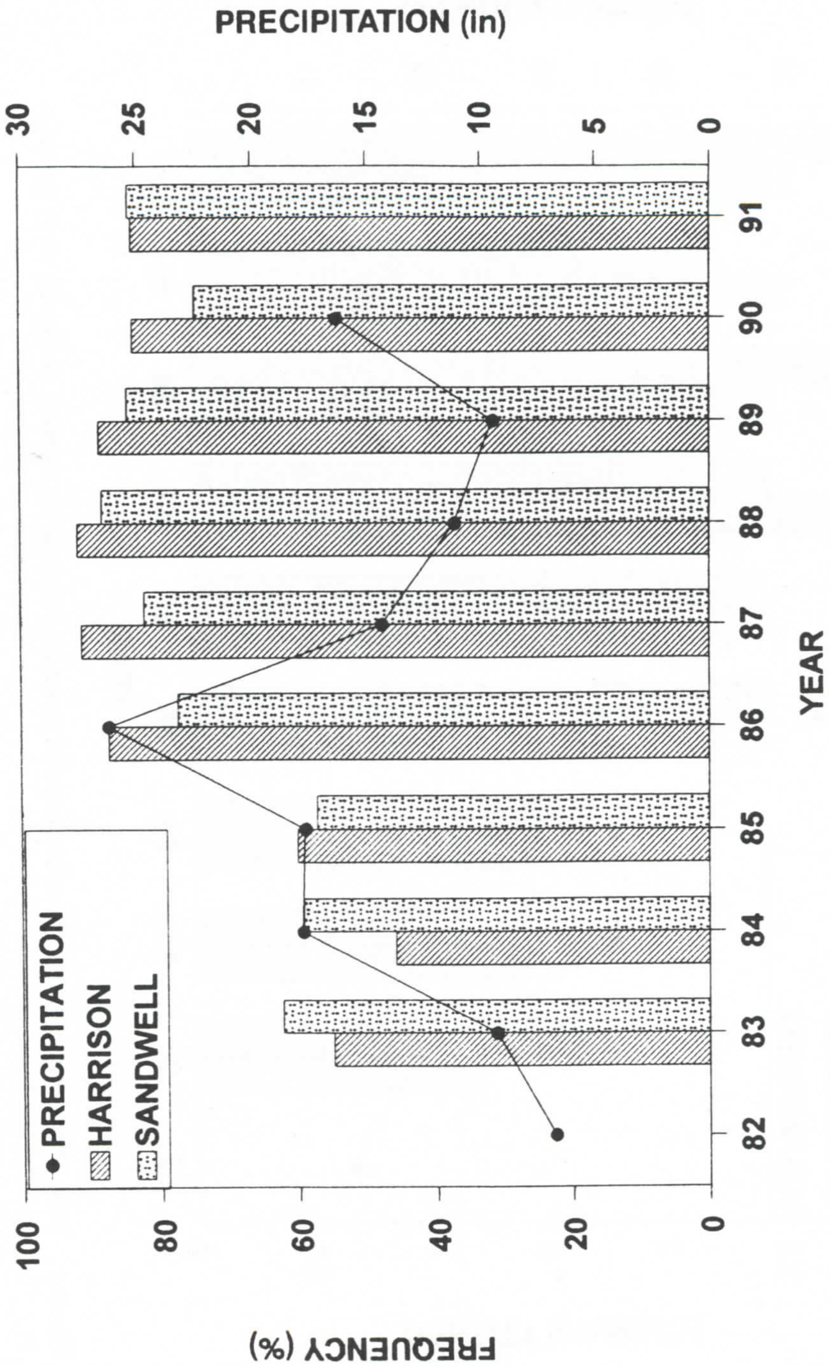

Figure 2. Total grass frequency for the two cells compared to annual precipitation received during the study period.

from SDG. Consequently, further research is needed to determine if relatively high stocking rates can be maintained with SDG over an extended period of time without causing range degradation, especially during periods of below-average precipitation.

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