Observations on vegetation responses to improved grazing systems in Somalia

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Abstract

Vegetation community response is an important factor determining the potential for improvement of rangeland dormant season forage availability through implementation of grazing systems. Heavy continuous grazing (HCG) (5 ha AU^{-1}) of communal rangelands in coastal southern Somalia has resulted in a herbaceous vegetation community dominated by short-lived annual forbs of low palatability that provide little forage during the dormant season. Changes in the plant community resulting from implementation of 2 grazing systems were compared: complete livestock deferral (LEX) and moderately stocked short-duration grazing (MSDG) (10-1; 3:30 day, stocked at 10 ha AU^{-1}). After 2 years, the LEX pasture was dominated by palatable forbs (primarily *Commelina forskalaei* and *Ipomoea garckeana*), which formed a vine mat that overtopped other herbaceous species. These vines died and decomposed soon after the rainy season ended and thus were not a useful source of dry season forage. The periodic grazing in the MSDG opened the vine mat and enabled grasses to establish, thus grass cover became significantly greater on the MSDG pasture compared to either the LEX or HCG pastures and provided forage for livestock in the dry season.

Key Words: standing phytomass, species composition, short-duration grazing, communal grazing, deferred grazing, Somalia vegetation.

Little is known of successional dynamics and community structure of grasslands in Somalia. Heavy livestock grazing on communally used rangeland has eliminated communities that where in advanced successional stages. No information is available on rate of recovery and type of response that could be expected if there was a reduction or deferral of livestock grazing. Several studies have recently been conducted on species composition shifts along livestock use intensity gradients radiating from isolated water points (Herlocker and Ahmed 1986; Herlocker et al. 1987, 1988). Such studies provide information on retrogression of the vegetation community as grazing intensity increases and gives an indication of the plant composition that could be expected for a particular grazing intensity. However, such studies do not provide insight into the rate and pattern of plant succession when there is a reduction in grazing intensity.

The research objective was to document the vegetation recovery of a heavily grazed site when there was a reduction or complete deferral of livestock density. The resultant rate and magnitude of change in species composition and standing crop would give managers an indication of the type of results that could be obtained with these treatments. Increasing dry season forage availability is a primary objective of range management programs in Somalia. Prior general observation indicated that, where rainy seasons are brief but intense, short-lived annual forbs quickly dominate grazing deferred sites of fair or poor condition. The vine growth form of several of the dominant forbs rapidly overtop and outcompete other vegetation. Such forbs are of little use for dry season forage since they die and decompose soon after the rain stops. We sought to test the hypothesis that moderately stocked short-duration use of the site during the growing season would facilitate more rapid grass establishment than would complete livestock deferral. This hypothesis was based on the supposition that moderately stocked short-duration use would graze back the initial surge of vines, enabling grasses to establish more effectively.

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Study Area

The study site was located 8 km south of Afgoi, Somalia (2° 10'N, 45° 05'E) on slightly undulating rangeland with deep (<1.5 m) soil of sand texture. Annual precipitation at the study site was highly variable (annual median precipitation, 1981 to 1987 = 446 mm; range = 214 to 670 mm). Most precipitation occurred during the April to May and November rainy seasons. Monthly temperature averaged 25 to 30° C. Annual precipitation was 3 to 20% of evaporative demand (UNSO 1984). Shrub canopy cover, dominated by *Acacia horrida,* (L.) Willd. and *Acacia tortillis,* (Forsk) Hayne was maintained at about 20% by fuelwood harvest pressure. The rangeland was unfenced and communally used by seminomadic pastoralists for grazing livestock.

Methods

In October 1985 a portion of the heavily grazed (5 ha AU^{-1}) communal rangeland (HCG) was fenced to create a 2-ha livestock exclosure (LEX) and a 1-ha pasture that was moderately stocked (10 ha AU^{-1}) using a short-duration system (MSDG) to simulate a 10 pasture rotation grazing strategy (10-1; 3:30 day). The MSDG pasture was stocked with an standard stock unit (SSU) ratio of 65% cattle and 35% goats. The SSU was based on estimates for pastoral Africa (Brown 1971) (i.e., 1 SSU equals 1 camel, 2 cattle or 10 sheep or goats). The HCG rangelands were stocked with a livestock animal unit ratio of 67% cattle, 24% goats, 5% camels, and 4% sheep. The size of the treatment pastures was restricted by pastoralist opposition to fencing and the need to keep the pastures small enough to maintain continuous surveillance against trespass. Opposition turned to support once benefits of the study became apparent, illustrating the utility of demonstration studies, particularly where foreign concepts of range management are viewed with skeptism.

Cover, standing phytomass, and litter accumulation were sampled monthly from October 1985 through February 1988. During each sample period, 10, 0.25-m^2 plots were randomly placed in each pasture. Standing (live and dead) grass and forbs were clipped and litter was collected on each plot. This material was dried at 60° C, weighed, and reported as kg ha^{-1}. In addition, 10 permanent 0.25-m^2 vegetation plots were established in each pasture. A 10-point frame (Brown 1954) was used to measure cover on these plots each month. In November 1985 and 1987, 10 randomly located 30-m line transects were placed in each pasture. Species composition of foliar cover was determined at 100 points spaced at 30-cm intervals

along each of the transects.

Differences among vegetation communities and grazing strategies were not replicated; the error term in the analysis of variance consisted of the nested variation of the randomized sites within the grazing strategies (Dunn and Clark 1974). Treatment means were separated by Duncan's new multiple-range test (Duncan 1955) at the <0.05% level. The Shannon-Weiner diversity index (Shannon 1948) was used to provide an indices of species diversity for the pastures. Palatability interpretation was based on the ratings of Herlocker and Kuchar (1986).

Results

The seasonal rainfall pattern (Fig. 1) strongly influenced the amount of cover and above-ground phytomass. Most forbs were annuals which rapidly increased standing phytomass during the growing season but died soon after the rains ceased, resulting in great seasonal fluctuations. There was generally no difference in amount of forb standing phytomass among pastures (Fig. 2). Grass standing phytomass followed the same seasonal cycle as the forbs. In contrast, however, the amount of grass standing phytomass was greatest in the MSDG pasture (Fig. 3) and lowest in the HCG pasture. Litter phytomass also followed a seasonal cycle, lagging approximately 2 months behind the peak of standing phytomass. Litter phytomass was greatest in the LEX pasture and lowest in the HCG pasture (Fig. 4). Bare ground reflected these seasonal patterns in above ground phytomass, being greatest at the end of the dry seasons and lowest at the end of the rainy seasons (Fig. 5). Percentage of bare ground during the dry season was greatest in the HCG pasture and lowest in the LEX pasture. During the main growing season (April to June) there was nearly complete aerial cover in all pastures.

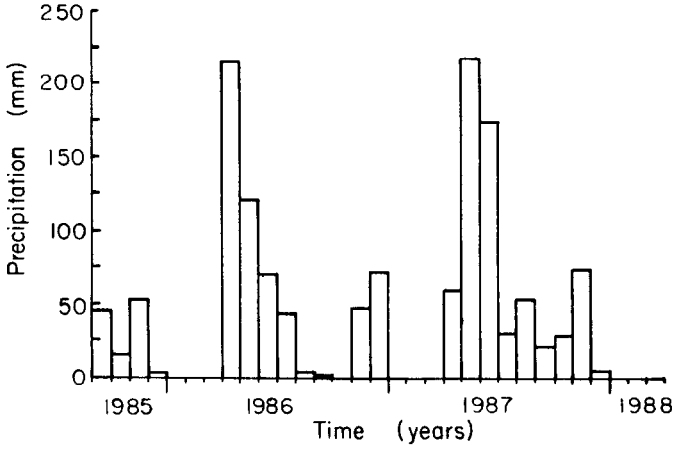

Fig. 1. *Distribution of precipitation throughout the study period.*

There was a marked difference in species composition between the 3 pastures after 2 years (Table 1). The relative cover of forbs was greatest in the HCG pasture and least in the MSDG pasture. Species of low palatability such as the woody forb *Indigofera tinctoria* L., and the hard, sharp-seeded *Oxygonum sagittatum* R. Grah. were dominant in the HCG pasture. Highly palatable vines such as *Ipomoea garckeana* Vatke, and *Commelina forskalaei* Vahl., were dominant in the LEX and MSDG pastures. The MSDG pasture had significantly greater cover of grasses; the dominants being of moderate palatability such as *Cenchrus ciliaris* L., and *Eragrostis ciliaris* (L.) R. Br. The cover of highly palatable grasses, *Leptothrium senegalense* (Knuth) W.D. Clayton, and *Cynodon dactylon* (L.) Pers., was greater in the LEX pasture.

Table 1. Relative composition and species diversity of the heavily grazed common pasture (HCG), the moderately grazed short-duration pasture (MSDG) and the livestock exclosure pasture (LEX). Samples collected from these sites in November, 1985 (2 weeks after fence construction) were not significantly different ($p<0.05$) therefore these data were pooled. Grazing treatment cover values with the same letter for the same species are not significantly different ($p<0.05$).[1]

	November 1985	November 1987		
Species	HCG	HCG	MSDG	LEX
Grass				
Eragrostis ciliaris	3.2b	1.8b	12.8a	4.7b
Cynodon dactylon	0.7b	0.3b	0.3b	4.2a
Dactyloctenium scindicum	0.6a	0.3a	1.0a	0.9a
Cenchrus biflorus	0.2a	0.0a	0.5a	0.1a
Cenchrus ciliaris	0.0c	0.0c	13.2a	5.4b
Leptothrium senegalense	0.0b	0.2b	2.1b	6.3a
Aristida adscensionis	0.0b	0.0b	2.4a	0.0b
Brachiaria obtusiflora	0.0a	0.7a	1.3a	0.3a
Digitaria nodosa	0.0a	0.0a	0.1a	0.0a
TOTAL GRASS	4.7c	3.3c	33.7a	21.9b
Forbs				
Indigofera tinctoria	38.7a	36.5a	20.0b	16.2b
Oxygonum sagittatum	24.2a	21.4a	1.8b	3.1b
Commelina forskalaei	12.3b	7.5c	12.3b	21.2a
Psilotrichum tomentosum	8.1ab	11.6a	4.2b	8.5ab
Ipomoea garckeana	4.4b	6.8b	18.2a	22.2a
Pedalium murex	1.6b	5.4a	0.8b	0.3b
Sida filepes	1.0a	0.8a	1.1a	0.5a
Pavonia pirottae	0.5a	0.7a	1.2a	0.3a
Heliotropium cinerascens	0.4a	0.0a	0.0a	0.0a
Asystasia laticapsula	0.3a	0.1a	0.3a	0.7a
Euphorbia granulata	0.3a	0.0a	1.6a	0.0a
Tephrosia subtriflora	0.2b	0.4b	0.4b	3.3a
Abutilon sp.	0.2a	0.0a	0.0a	0.0a
Diodia aulacosperma	0.1b	2.6a	0.0b	0.0b
Alysicarpus glumaceus	0.1a	0.4a	0.0a	0.0a
Ocimum canum	0.1b	0.7ab	2.5a	0.0b
Ocimum tomentosum	0.0a	0.0a	0.1a	0.0a
Digera muricata	0.0a	0.0a	0.3a	0.1a
Hibiscus micranthus	0.0a	0.1a	0.1a	0.0a
Aerva javanica	0.0a	0.1a	0.0a	0.0a
TOTAL FORBS	92.0a	95.1a	64.9c	76.4b
SEDGE				
Cyperus sp. 1	28.a	1.6a	1.3a	0.8a
Cyperus sp. 2	0.0a	0.0a	0.1a	0.9a
TOTAL SEDGE	2.8a	1.6a	1.4a	1.7a
Shannon-Weiner Species Diveristy Index	2.64	2.84	3.43	3.23

[1]Botanical nomenclature follows Hubbard et al. (1981).

Discussion

Forb standing phytomass remained similar in all 3 pastures throughout the study, despite the fact that species composition in the pastures was different. This implies that forb standing crop was limited by an environmental constraint, such as water, nutrient, or light availability, rather than by inherent production potential attributable to particular forb growth forms or livestock grazing pressures. Grazing pressure influenced herbaceous species compo-

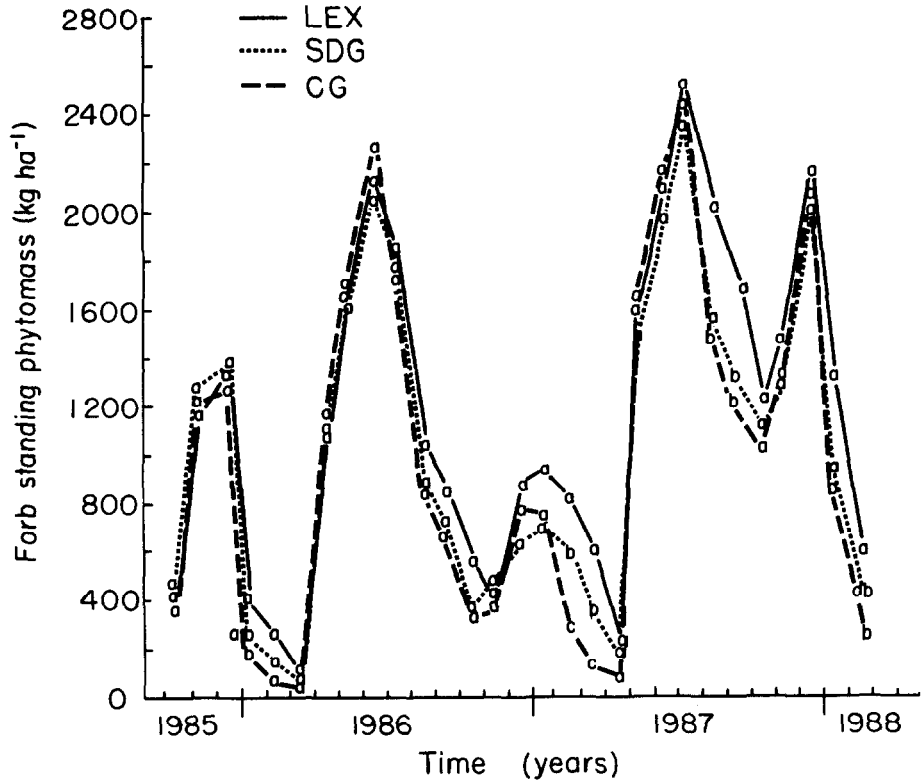

Fig. 2. *Forb standing biomass throughout the study period on the heavily grazed common pasture (HCG), the moderately grazed short-duration pasture (MSDG) and the livestock exclosure pasture (LEX). Grazing treatment means with the same letter for the same sample date are not significantly different (p<0.05).*

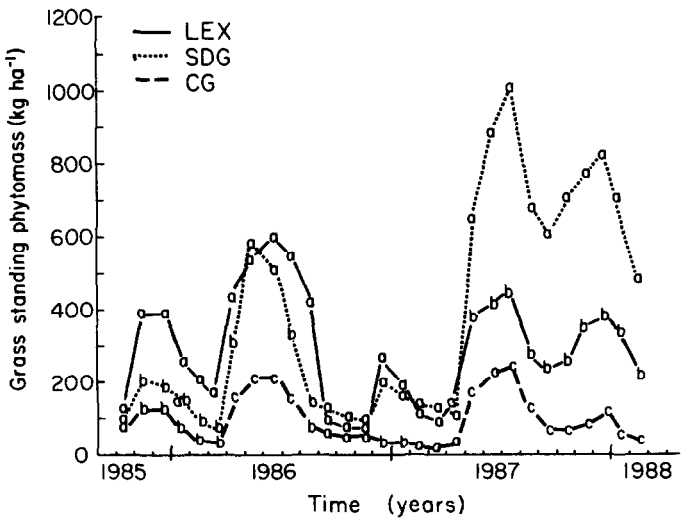

Fig. 3. *Fig. 3. Grass standing biomass throughout the study period on the heavily grazed common pasture (HCG), the moderately grazed short-duration pasture (MSDG) and the livestock exclosure pasture (LEX). Grazing treatment means with the same letter for the same sample date are not significantly different (p<0.05).*

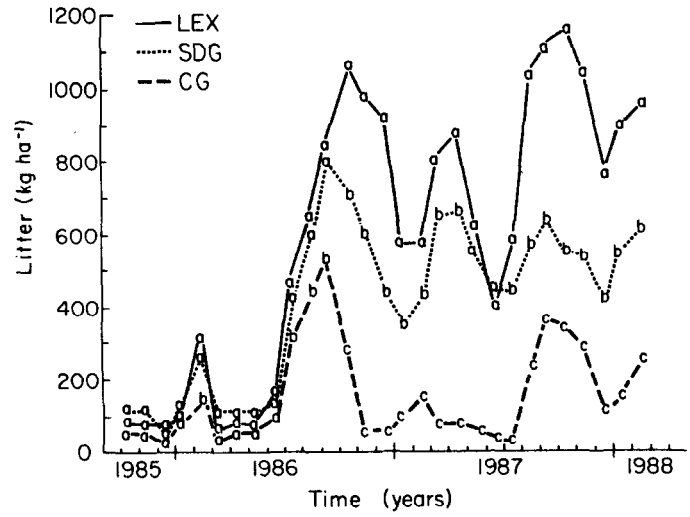

Fig. 4. *Litter biomass throughout the study period on the heavily grazed common pasture (HCG, the moderately grazed short-duration pasture (MSDG) and the livestock exclosure pasture (LEX). Grazing treatment means with the same letter for the same sample date are not significantly different (p<0.05).*

sition and diversity. Unpalatable species dominated the HCG pasture. Palatable vines overtopped and dominated other herbaceous species in the LEX pasture. Periodic grazing in the MSDG reduced the vine cover and allowed other species, especially grasses, to increase. Consequently, species diversity was highest in the MSDG.

Most forb species quickly died, broke apart and entered the litter layer when the seasonal rains stopped. Herbaceous litter phytomass was quickly decomposed by termites and other microfauna (94% decomposition within 1 year) (Thurow unpubl. data). Therefore, complete deferment over the 2-year period did not significantly increase dormant season forage availability. Retrogression studies along grazing intensity gradients (Herlocker et al. 1987, 1988) indicate that the highly palatable bunchgrass *Leptothrium*

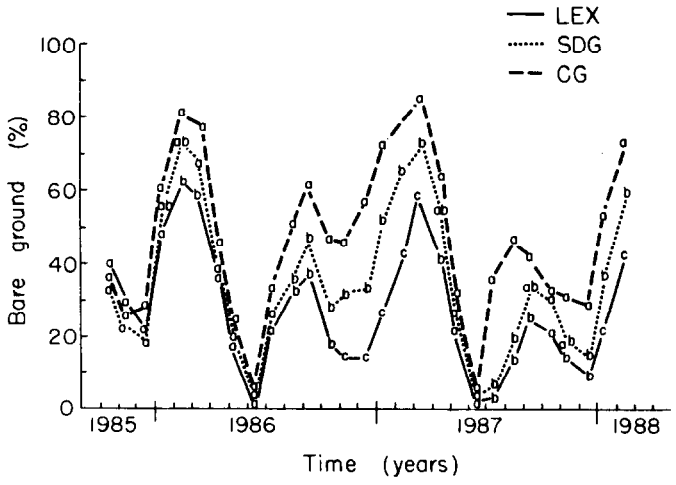

Fig. 5. *Percent bare ground throughout the study period on the heavily grazed common pasture (HCG), the moderately grazed short-duration pasture (MSDG), and the livestock exclosure pasture (LEX). Grazing treatment means with the same letter for the same sample data are not significantly different ($p<0.05$).*

senegalense dominates lightly grazed sites and sites that are grazed only during the growing season. This species had become the most common grass species in the LEX pasture and, based upon the retrogession studies, probably would increase its cover as deferment continued. *Leptothrium senegalense* is of marginal management use for increasing dormant season forage, however, since it would be expected to decrease if moderate livestock use of the site was initiated (the high crowns being susceptable to damage by selective grazing which would take place in the dormant season). Bunchgrasses which increased under the MSDG system, such as *Cenchrus ciliaris*, are more realistic management goals for providing a sustainable source of dormant season forage. An additional benefit of the MSDG system was that it allowed livestock to use some of the short-lived forb phytomass during the growing season when it was available and palatable.

Literature Cited

Brown, D. 1954. Methods of surveying and measuring vegetation. Commonwealth Bureau of Pastures and Field Crops. Hurley, England. Bull. 42.

Brown, L.H. 1971. The biology of pastoral man as a factor in conservation. Bio. Conser. 3:93-100.

Duncan, D.B. 1955. Multiple range and multiple F test. Biom. 11:1-42.

Dunn, O.J., and V.A. Clark. 1974. Applied regression analysis. John Wiley and Sons, Inc., New York.

Herlocker, D.J., and A.M. Ahmed. 1986. The vegetation of the coastal plains, Central Somalia. Somali J. Range Sci. 1:34-58.

Herlocker, D.J., and P. Kuchar. 1986. Palatability ratings of range plants in Ceel Dhere and Bulo Burte Districts, Somalia. Central Rangelands Development Project Tech. Rep. 9.

Herlocker, D.J., A.M. Ahmed, and T.L. Thurow. 1987. Response of vegetation of the *Acacia reficiens/ Dichrostachys kirkii* shrubland range site to use intensity, Ceel Dhere Districts, Somalia. Somali J. Range Sci. 2:10-24.

Herlocker, D.J., A.M. Ahmed, and T.L. Thurow. 1988. Response of vegetation of the *Acacia nilotica/ Dichrostachys kirkii* shrubland range site to land use intensity, Ceel Dhere District, Somalia. Somali J. Range Sci. 3:1-11.

Hubbard, C.E., Milne-Redhead, R.M. Polhill and W.G. Turrill. 1981. Flora of tropical East Africa. Crown Agents for Overseas Govt. and Admin., London.

United Nations Sahelian Office (UNSO). 1984. Inventory of sand movement in Somalia. UNSO/DES/SOM/80/001.