

Sudan Journal of Desertification Research. 2012. 4 (1).

A Note on Impact of Management Practices on Herbaceous Forage Productivity and Carrying Capacity in the Rangelands of South Kordofan, Sudan

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Abstract: The study was conducted, in three sites, at Tillow area, Kadugli locality of the South Kordofan State during three successive years (2005/2006, 2006/2007 and 2007/2008). The main objective of the study was to investigate the effect of four management practices on forage productivity of herbaceous plants. Two trials were carried out in a randomized complete block design (RCBD) with three replicates, one of them during the rainy season and the other during the dry season. The practices applied were: protection by fencing only, protection by fencing and removal of undesirable plant species (protected plots), grazing only and grazing followed by burning (open plots). Forage biomass was measured and the carrying capacity of the herbaceous plants was calculated. The results indicated that there was significant difference in biomass productivity among protected, opened plots and/or grazed plot in the third late rainy and mid dry seasons ($P < 0.05$), with the protected plots recording the highest yields. The study recommends the use of fencing for protection of rangelands, accompanied with bush encroachment control, reseeding and weeding as management practices for improving rangelands in the low rainfall savannah zone especially on clayey sites.

Key words: Management practices, herbaceous biomass, rangelands, carrying capacity, burning.

Sudan ranks at the top of the African and Arabian countries with regard to livestock population that depends almost entirely on natural range for feed. According to Abusuwar (2007), rangelands in Sudan are considered the main source of feed and they represent about 74% of total animal feed. Rangelands in South Kordofan are not grazed intensively by livestock until the dry season, when forage has declined sharply in both quantity and nutritional value. Moreover, the risk of fires is high at this time of the year because of the large accumulation of combustible material resulting from insufficient wet season grazing (WSARP, 1982). In the study area *Dichrostachys cinerea* (kadad) a shrub-tree legume causes a problem of bush encroachment by its thicket forming, because too many trees and shrubs decrease the productivity of grass layer. Furthermore, current knowledge of response of natural rangelands to some management practices, such as protection by fencing, grazing/browsing, burning and removal of undesirable plants under Sudan conditions, is still lacking. Thus, the specific objective of present study was to study of the effect of the pre mentioned management practices on forage productivity and carrying capacity of herbaceous plants.

South Kordofan State, where this study was conducted, is located approximately between latitude 9°00' and 13°00'N and longitude 27° 00' to 32° 00'E. The study was conducted at Tillow area in Kadugli Locality for three successive years (2005/2006, 2006/2007, 2007/2008). The vegetation of Tillow area falls within the low rainfall savannah vegetation zone in special area which is dominated by tall coarse annual grasses and *Dichrostachys cinerea* (L.) Wight & Arn.(Kadad).

The four management practices applied were protection by fencing only, protection by fencing and removal of undesirable plants (protected plots), grazing, "grazing with burning" (opened plots). Nine plots were selected at the three different range sites (A, B and C). The distance between sites was less than one kilometer. The first plot, at each site, was protected by fencing and divided into two equal sub-plots to minimize the cost of fencing; one of the sub-plots was managed by removal of undesirable plants manually using hand for herbaceous plants and traditional hand tools and big clippers for trees and shrubs, while the remaining sub-plot was unmanaged. The second plot at each site was freely grazed and browsed. A third plot at each site was freely grazed and browsed and subsequently burnt annually in early dry season. All trees and shrubs with

height exceeding one meter were removed from each plot or sub-plot at the beginning of the study. The removal of trees and shrubs was done to minimize the differences between the size of plots. Fire lines were opened around plots in each site annually. Plot size was (54m × 54 m). Two meters were left as margin in each of the four sides. The plot was (50m × 50 m). Each plot or subplot was divided into two strata. In each stratum one permanent line transect (50 m long) was placed. A total of two line transects at each plot or sub-plot were placed.

Four permanent (1m x 1m) quadrates were placed along each transect for measuring forage biomass of herbaceous plants. Two quadrates were placed at intervals 20 m for biomass measurement in the late rainy season (early October). Also two quadrates were placed at intervals 22 m for biomass measurement in the mid dry season (early January). Dry weight (g/m²) was obtained. The amount of dry matter (kg/ha) was calculated. According to Mustafa *et al.*, (2000), the proper use factor is (0.5). That means half of the forage production was used for determining the carrying capacity. The carrying capacity was calculated according to the daily requirement of a Tropical Livestock Unit (TLU) which is equivalent to (7.5 kg) as reported by (Gaiballa, 2011). Carrying capacity can be determined as hectare/ Animal unit/ year) (ha/Au/Y), according to (FAO, 1980). Carrying capacity was calculated as follows:-

Carrying capacity =

$$\frac{\text{The consumption of Tropical livestock Unit in a year}}{\text{The desirable production (half of forage production) per ha}}$$

The two trials were carried out in a randomized complete block design (RCBD) with four treatments and three replications in (site A, B and C) in the rainy season and with three treatments and three replications in the dry season. Analysis of variance was done to compare means of forage biomass of herbaceous plant. Least significant difference (LSD) was used to separate the means.

The results of forage biomass productivity and carrying capacity of herbaceous plants inside protected plots and open plots for the three late rainy seasons (2005/2006, 2006/2007 and 2007/2008) are presented in Table 1. There was no significant difference between protected plots and open plots in the first and second seasons. Nonetheless, the protected

plots had relatively higher biomass productivity than open plots in the second season. Lack of significant differences in biomass production inside protected plots and open plots may be due to insufficient utilization of forage during the rainy season. Also, the variation between open and protected plots occurred gradually according to plant succession. Holechek *et al.* (2004) reported that major downward shifts due to drought or over grazing usually require a minimum of 3 to 5 years. These results agreed with previous findings of WSARP (1985) that in Nuba Mountains the remaining livestock scarcely produce any impact on vegetation during the growing season due to the high and rapid rate of plant growth. The results in Table 1 in third season indicated that there was significant difference between protected and open plots, with the protected plots recording the highest biomass value ($P < 0.05$). However, there was no significant difference between protected plot and protected and managed plot, but again the protected plot had comparatively the highest biomass value. These results were supported by the finding of WSARP (1985) that herbaceous productivity was generally higher inside enclosures than outside. Moreover, the results indicated that the third season may be sufficient to detect the variation between protected plots and open plots and maybe there was sufficient grazing inside open plots in the third season. According to NRCS (2003) carrying capacity can be defined as the maximum stocking rate possible without inducing permanent or long term deterioration to vegetation or related resources. The rate may be varying from year to year in the same area as a result of fluctuating forage production. The data in Table 1 (2005/2006) showed that the area needed to support one Tropical Livestock Unit (TLU) was biggest in grazed plot (2.4 ha/TLU/Y) followed by protected and managed plot (2.1ha/ TLU/y) and then protected plot (2.0 ha/TLU/y) and a relatively small area was needed in grazed and burned plot (1.8). These findings indicated that grazed and burned plot had the highest carrying capacity, followed by protected plot, protected and managed plot whereas grazed plot had the least carrying capacity. As stated before the first season may be insufficient to detect the variation between protected and open plots. The results of seasons (2006/2007 and 2007/2008) in Table 1 revealed that in the late rainy season the protected plots had the higher carrying capacity than open plots.

Table1. Effect of four management practices on forage biomass productivity and carrying capacity of herbaceous plants at Tillow area in South Kordofan in the three late rainy seasons

Management Practice	Season					
	2005/2006		2006/2007		2007/2008	
	productivity (g/m ²)	carrying capacity (ha/TL/U/y)	productivity (g/m ²)	Carrying capacity (ha/TL/U/y)	productivity (g/m ²)	carrying capacity (ha/TL/U/y)
Protected	265.4	2	382.3	1.4	445.9 a	1.2
Protected and managed	257.7	2.1	435.9	1.2	387.4 a	1.4
Grazed	223.1	2.4	320.2	1.7	166.3 b	3.2
Grazed and burned	308.1	1.8	338.4	1.6	140.8 b	3.8
SE±	55.94NS	N A	63.61NS	N A	*44.94	N A

* Significant at 0.05 level

Within a column values accompanied by the same or similar letters are not significantly different at P<0.05

NS=no significant difference

NA= Not Available

The variation in carrying capacity in the late rainy season between protected and open plots may be because the second and third seasons were capable of revealing the variation between protected plots and open plots and may be attributed to relatively sufficient grazing was happening inside open plots.

The results of forage biomass productivity and carrying capacity of herbaceous plants for the two mid dry seasons (2006/2007 and 2007/2008) are shown in Table 2.

There was a significant difference between protected plots and grazed plot in the two mid dry seasons, the protected plots had the higher biomass values ($P < 0.05$). Also, the results indicated that although there was no significant difference between protected plot and protected and managed plot in the two mid dry seasons, protected and managed plot had the higher mean biomass production. The results are in line with the findings of WSARP (1985) that most grazing in Nuba Mountain is confined to the dry season when forage has declined sharply in both quality and abundance. Grazing at this time affects the availability of forage during the current growing season simply by removal of plant material.

In the mid dry season the protected plots had the higher carrying capacity than grazed plot (Table 2). The variation in carrying capacity in the mid dry season between grazed plot and protected plots may be due to more grazing pressure in the former.

Table 2. Effect of three management practices on forage biomass productivity and carrying capacity of herbaceous plants at Tillow area in South Kordofan in the two mid dry seasons

Management Practice	Season			
	2006/2007		2007/2008	
	productivity (g/m ²)	carrying capacity (ha/TL/U/y)	productivity (g/m ²)	carrying capacity (ha/TL/U/y)
Protected	340.4 a	1.6	238.6 a	2.3
Protected and managed	385.8 a	1.4	272.6 a	2.0
Grazed	119.3 b	4.5	100.8 b	5.4
SE \pm	*40.21	N A	*39.56	N A

* Significant at 0.05 level

Within a column values accompanied by the same or similar letters are not significantly different at $P < 0.05$

NA= Not Available.

CONCLUSIONS

Protection, as well as protection and removal of undesirable plants increased forage biomass production and carrying capacity of herbaceous plants. The study recommends the use of fencing for protection of rangelands, accompanied with bush encroachment control, reseeding and weeding as a management practices for improving rangelands in the low rainfall savannah zone especially on clayey sites.

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أثر ممارسات الإدارة على الانتاجية والطاقة التحويلية للعلف العشبي في المراعي بولاية جنوب كردفان - السودان
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مستخلص البحث: أجريت الدراسة في ثلاث مواقع بمنطقة تلو، محلية كادقلي، ولاية جنوب كردفان ولمدة ثلاث سنوات متتالية (2006/2005، 2007/2006 و 2008/2007). الهدف الرئيسي من هذه الدراسة هو دراسة تأثير أربع ممارسات إدارة على انتاجية العلف العشبي. أجريت تجربتين أحدهما في موسم الخريف والأخرى في الموسم الجاف، حيث تم استخدام تصميم القطاعات العشوائية الكاملة بثلاث مكررات في كليهما. اشتملت الممارسات التي تم تطبيقها على الحماية بالتسوير فقط، الحماية بالتسوير وإزالة النباتات غير المرغوبة (المواقع المحمية)، الرعي فقط والرعي والحرق (المواقع المفتوحة). أجري قياس للكتلة الحيوية و حسبت الطاقة التحويلية للعلف العشبي. دلت النتائج على أن هنالك فروقات معنوية في انتاجية الكتلة الحيوية بين المواقع المحمية والمواقع المفتوحة أو الموقع المرعي ($P < 0.05$) في اخر موسم المطر الثالث ووسط المواسم الجافة. سجلت المواقع المحمية أعلى انتاجية مقارنة بالمواقع المفتوحة. توصي الدراسة بتحسين المراعي في مناطق السافنا الفقيرة وخاصة الطينية، باستخدام التسوير لحماية المراعي على أن يكون مصحوبا بالتحكم في توغل الشجيرات، نثر البذور وإزالة الحشائش غير المرغوبة.

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