Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2015 JNAS Journal-2015-4-11/1174-1179
ISSN 2322-5149 ©2015 JNAS

Effect of Management on Grazing Resources at Elain Natural Forest Reserve in North Kordofan State, Sudan

Omer I. M. Olom[1], Ahmed M. M. Lazim[2], Salih O. T. Kafe AND Maroud E.Maroud[*]

***Corresponding author*:** Maroud E.Maroud

ABSTRACT: The current study was conducted in North Kordofan State at two range sites (Elain natural forest reserve and open area adjacent to it), for two successive seasons (2012/2013/ and 2013/2014), with objective to investigate the effect of management (forested versus open) on some herbaceous vegetation attributes. A (t) test was done to compare data of herbaceous vegetation attributes in forested and open area. Herbaceous vegetation attributes were measured using parker loop (3/4"), line transect and quadrate (m²). The results indicated that there was highly significant ($p < 0.01$) different in forage biomass yield of herbaceous plants between forested and open area in the second season whereas the other herbaceous vegetation attributes recorded no significant ($p > 0.05$) different between forested and open area. The results indicated that forested area had higher plant%, density, forage biomass and carrying capacity, than open area in the two seasons (78.3 and 53.1 % versus 73.8 and 44.33 %, 13.4 and 39.1 plant/ m² versus 12.9 and 29.8 plant/ m², 137.6 and 185.2 kg/ha versus 90.2 and 47.9 kg/ha, 26.1 and 19.4 ha/TLU/8month versus 37.5 and 75 ha/TLU/8month, respectively). Forested area had lower bare ground% compared to open area in the two seasons (9.6 and 3.17% versus 12.0 and 14.0% respectively). *Schoenefeldia gracilis* as annual grass was dominant in both forested and open area. Open area had higher diversity in term of occurrence of many different grasses and forbs species especially in the second season. *Cassia tora as* invader undesirable species was more frequent in open area. The study recommends that reseeding of high palatable endangered species such as *Cenchrus ciliaris, Blipharis linarifolia* and *Vigna sun-hum* in both forested and open area, besides adjustment of livestock number according to carrying capacity.

***Keywords*:** Management, Forage biomass, density, Frequency, carrying capacity.

INTRODUCTION

The Sudan ranks at the top of Africa and Arabian countries in animal Wealth that depends almost entirely on natural pasture for feed. Generally, no nutritional problems are encountered during the rainy seasons, but the forage declines in quality and quantity as dry seasons progress, (Gaiballa , 2003).Sudan is considered to be the future of food reservoir and source of food security, not only for Arab countries, but also for the whole world. This fact is emphasized by the suitable area for crop production is about 200million feddans of which only 20% is now utilized (Darrag, 2007) estimated area for natural range is about 48.1 million hectares. Rangelands in Sudan are considered the main source of feed and they represent about 74% of total animal feed. Sudan is the second largest livestock owning country in Africa. Its animal wealth was estimated in 2007 to be 50.944, 42.987, 41.404 and 4.250 million head of sheep, goats, cattle and camels, respectively. Forage yield is the weight of forage production at a given area during a certain period of time (Darrag, 1996).Forage yield helps in determining range capacity and has a link with range condition.Biomass can be determined by using either direct or indirect sampling methods. Direct methods involve techniques that weight or estimate the actual biomass of plants in quadrates. Indirect methods are based on developing a relationship between plant weight and other attributes such as plant height, rainfall, or cover (Bonham, 1989, Lazim, 2009).The main problem associated with range land management is overstocking leading to progressive reduction in biomass production and plant cover, and in the arid and semi-arid areas leads to soil

degradation (Strange, 1980). The specific objective of present study was to investigate the effect of the different management practices on ground cover (plant cover%, bare ground% and litter%), density, forage biomass yield and carrying capacity of herbaceous plants.The effects of woody plants can also be expressed in varying forms. Firstly, woody plants can affect herbaceous species composition. Secondly, woody species can influence herbaceous species production, biomass allocation, and phenology. Trees can often reduce herbaceous species biomass production (Burrows ., 1990). In mixed woody-herbaceous communities, herbaceous species composition under a tree canopy might be very different compared to that in the inter-tree space. Grasses and shrubs can have different root systems at different depths in the soil profile so that they can use water at different soil depths to coexist (Walker ., 1981).

MATERIALS AND METHODS

Study area

The study was conducted at two range sites (Elain natural forest reserve and open area adjacent to it) for two successive seasons (2012/2013/ and 2013/2014). Elain forest located at south east of Elobied town (26 km), Shikan Locality. It covers an area of about 42000fed. The forest is water reservoir and consider as source of drinking water for Elobeid town and its surrounding. The rainy season begins in June reaches its peak in July and August, Also the Forest provide grazing for nomads who come from South Kordofan. The average rainfall is 250-450mm. The maximum temperature is reaches 34.7 in summer and the minimum temperature is 19.9 in winter. In general, the mean maximum and minimum daily24 temperatures are lowest in January (31 Cº, 13 Cº), and highest in June (39 Cº, 24 Cº), (Eltahir, 2009).

Sampling

Six permanent line transects (100 long) were placed in each forested and open area. Five quadrates were placed along each line transect at 20 meter interval. The variables of herbaceous plants were measured annually late in the rainy season (October).

Range Composition

In this method, the measuring tape (line transect) was stretched on the ground from the centre to each site, then loop was traced along each transect spaced at one meter intervals. All information about the range composition was listed and recorded in special form called composition form.
From the above information the following parameters were calculated:

$$\text{plant}\% = \frac{\text{the total hits of plant}}{\text{the total number of all hits}} * 100\%$$

$$\text{litter}\% = \frac{\text{the total hits of litter}}{\text{the total number of all hits}} * 100\%$$

$$\text{bare soil}\% = \frac{\text{the total hits of bare soil}}{\text{the total number of all hits}} * 100\%$$

$$\text{Rock}\% = \frac{\text{the total hits of rock}}{\text{the total number of all hits}} * 100\%$$

The ground cover % = plant % + Rock % +Litter %
According to (WSARP, 1985, Lazim, 2009).

Plant Density

Density is defined as number of plant individuals per unit area (Stingsby and Cook, 1986). The quadrates were placed along the transect All plants individuals inside the quadrate were counted and recorded. Density in quadrate and in hectare was calculated as follows:

$$\text{Average plant density in a quadrate} = \frac{\text{Number of plants in all quadrates}}{\text{Number of all quadrates}}$$

Plant density in hectare = average plant density in quadrate x10000

Plant Frequency

The frequency is the percentage of the quadrates that contains at least one individual of certain species (Barbour and Hand Pitts., 1987). Species frequency is the probability of occurrence of species in randomly or systematically

in placed quadrates (Stingsby and Cook, 1986). Plant frequency helps in determining plants distribution and their order of dominance (Darrag, 1996).
According to Fashir, *etal* (2012), the frequencies were calculated by using following formula:-
Species frequency =
The number of quadrates containing the individual species X 100
The total number of quadrates taken

Forage biomass yield of herbaceous plants

This term means the amount of dry matter in kg/ha that range site can produce annually. It was determined by quadrate methods of sampling. To determine the dry matter production (1x1m) quadrates was placed along each transect at 20-meter intervals. The plant species inside each quadrate were clipped at 2.5-3cm above ground level (grazing level). The harvested forage species were then placed in paper bags and oven dried at 105^{o}C for 48 hour. Then the oven-dried materials were weighed using an electric sensitive digital balance. The dry matter per quadrate was obtained by dividing the total weight of all quadrates by their number. Then the dry matter per hectare was calculated.

Carrying capacity

The carrying capacity is calculated on basis of total biomass production and amount of the feed requirements per animal unit. Carrying capacity is usually determined using proper use factor (PUF), of 50% in which only half biomass produced is considered available for grazing as stated by Darrag and Suliman 1986). Livestock requires daily dry matter (DM) intake equivalent to 2.5 – 3% of their body weight. Thus Tropical Livestock Unit (TLU) of 250 Kg body weight consumes 6.25 – 7.5Kg dry matter per day (Elnour, 2001).
According to (FAO, 1980 and Lazim *et.al*, 2012). Carrying capacity per 8months was calculated as follows:

$$\text{Carrying capacity} = \frac{\text{the consumption of tropical livestock unit in 8 month}}{\text{the desirable production(half of forage production)per ha}}$$

RESULTS AND DISCUSSION

Range composition, density, forage biomass yield and carrying capacity of herbaceous plants

The results of ground cover, bare ground, density, forage biomass yield and carrying capacity of herbaceous plants are presented in table1.In the first season (2012/2013), the results indicated that there was no significant ($p > 0.05$) difference between forested and open area in all variables measured. Nonetheless, Forested area had higher plant%, density, forage biomass and carrying capacity than open area. On the other hand, forested area had lower litter%, rock% and bare ground% than open area (Table 1).

In the first season, the higher plant%, forage biomass and carrying capacity besides the lower litter%, and bare ground% in forested area might be attributed to the influences of rainfall amount and distribution coupled with grazing pressure in open area. Also, grazing pressures in open area affected the range composition which was reflected in reduction of desirable species besides increasing bare ground incident and animal faces.

The differences between forested and open area in plant density was probably due to the fact that the open area was subjected to grazing during the growing seasons, which caused removal of many plants besides exposing the area to wind and water erosion. Furthermore, 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 result of fluctuating forage production.

In the first season, in forested area, area needed to support one Tropical Livestock Unit/8month was smaller than that needed in open area (26.1ha Vs 37.1ha).

This finding indicated that forested area had higher carrying capacity compared to open area.
Moreover, the carrying capacity in the first season was very low regarding the total number of livestock utilizes the area.

In the second season (2013/2014), the results indicated that there was a highly significant ($p < 0.01$) different in forage biomass yield between forested and open area. Forested area had higher plant%, litter%, rock% density, forage biomass and carrying capacity than the open one. On the other hand, forested area had lower bare ground% than open area (Table2). The highly significant difference in forage biomass between forested and open area might be due to the fact that open area was subjected to human mal practices such as over grazing and illicit cutting. However, herbaceous biomass production under tree canopies can also increase (Burrows , 1990) due to improved nutrient supply, reduced evapo-transpiration (Reid and Ellis, 1995), and increased water availability (Walker ., 1981).

General land misuses and frequent cyclic drought severely affect vegetation species composition and the overall biomass production per unit areas.

Table 1. Range composition, density, forage biomass yield and carrying capacity of herbaceous plants in forested and open area at Elian Natural forest reserve in the two late rainy seasons (2012/2013and 2013/2014)

	Attribute	forested		Open	SE±	t-value	Prob.
	Plant (%)	78.33		73.83	3.08	1.04	NS
	Litter (%)		3.50	5.33	1.22	1.06	NS
2012							
/	Rock (%)	8.50		8.84	1.71	0.137	NS
	Bare ground (%)	9.67		12.00	1.72	0.96	NS
2013	Density(plant/ m²)	13.47		12.9	1.74	0.231	NS
	Forage biomass yield (kg/ha)	137.6		90.2	29.01	1.1	NS
	Carrying capacity (ha/TLU/8month)	26.1		37.5	-	-	-
	Plant (%)	53.17		44.33	4.44	1.45	NS
	Litter (%)	40.16		39.50	3.87	0.122	NS
	Rock (%)	3.50		2.17	1.50	0.63	NS
2013	Bare ground (%)	3.17		14.00	3.54	2.16	NS
	Density (plant/ m²)	39.1		29.87	5.22	1.25	NS
/	Forage biomass (kg/h)	185.2		47.9	24.4	3.9	0.01
	Carrying capacity	19.4		75	-	-	-
2014	(ha/TLU/8month)						

NS= No significant difference
TLU= Tropical Livestock Unit

Frequency of herbaceous plants

The results of herbaceous plant frequencies in forested and open area at Elain forest reserve in the two late rainy seasons (2012/2013and 2013/2014) are presented in Table 2. In the first season (2012/2013), Schoenefeldia gracilis and Chloris gayana had higher frequencies in forested area than the open area. However, Schoenefeldia gracilis was the most frequent in open area. Aristida sp had higher frequency in the open area than the forested one. Eragrostis tremula had the same frequency in forested and open area. The results revealed that Cenchrus biflorus was found only in the forested area (Table 1, 2012/2013).

In the first season, the results indicated that, Schoenefeldia gracilis was the dominant grass in both the forested and the open area. Also, in the first season, Cassia tora as invader undesirable range species had the same frequencies in both the forested and the open area.

In the second season (2013/2014), Schoenefeldia gracilis, Eragrostis tremula and Chloris gayana had higher frequencies in the forested area than the open one. On the other hand, Schoenefeldia gracilis was the most frequent in the open area. Aristida sp had higher frequency in open area than the forested area. Grasses such as Cenchrus biflorus, Echinocloa colonum, Digitaria adscendens and Chloris prieuri were found only in the open area. Also, forbs such as Zornia glochidiata, Ipomea kordofana and Acanthus sp were found only in the open area. In the second season, the results indicated that, Schoenefeldia gracilis was the dominant grass in both the forested and the open area as mentioned in the first season. Cassia tora had higher frequency in the open than forested area (Table2, 2013/2014). The results indicated that open grazed area had higher herbaceous plants (forbs and grasses) diversity compared to the forested area. The results revealed that high palatable endangered and leguminous range species such as Blipharis linarifolia (Bigeel). Cenchrus ciliaris (Hasskaneet naeem) and Vigna sun-hum (Tag taga) were not found in both the forested and the open area. In the second season, the high diversity of herbaceous species in open grazed area might be due to the fact that livestock grazing enhance herbaceous species diversity. Lazim (2009) stated that seeds are carried with animals from parent land in pellet or stomach. Also, seeds which are treated germinate or decay. Furthermore, the low diversity of herbaceous species in forested area might be due to the effect of trees and shrubs on herbaceous composition. woody plants can affect herbaceous species composition (Burrows ., 1990) The relative high frequency of Cassia tora as invader undesirable species in the open grazed area probably due the fact that Cassia tora was unpalatable , less affected by livestock grazing and benefit from elimination of palatable species by grazing. Some species of plants are highly susceptible to the effect of disturbance, while others could not survive without the presence of disturbance such as grazing (Angasa , 2010).

Table 2. Frequency (%) of herbaceous plants in forested and open areas at Elain Natural forest reserve in the two late rainy seasons (2012/2013 and 2013/2014)

Season	Scientific name	Local name	Life Form	Frequency (%) forested	Open
	Schoenefeldia gracilis	Danab El naga	Grass	90	87
	Aristida sp	Gao	Grass	23.3	33.3
	Eragrostis tremula	Bano	Grass	23.3	23.3
2012	Cenchrus biflorus	Hasskaneet Khishin	Grass	23.3	0
/	Chloris gayana	Afan Elkhadeem	Grass	23.3	10
	Cassia tora	Kawal	Forb	20	20
2013					
2013	Schoenefeldia gracilis	Danab El naga	Grass	83.3	70
/	Aristida sp	Gao	Grass	50	60
	Eragrostis tremula	Bano	Grass	33.3	17
2014	Cenchrus biflorus	Hasskaneet Khishin	Grass	0	3
	Chloris gayana	Afan Elkhadeem	Grass	40	7
	Echinocloa colonum	Defra	Grass	0	3
	Digitaria adscendens	Um aag	Grass	0	3
	Chloris prieurii	Abu malih	Grass	0	17
	Zornia glochidiata	Sheleny	Forb	0	3
	Ipomea kordofana	Taber	Forb	0	7
	Acanthus sp.	Tamr-elfar	Forb	0	3
	Cassia tora	Kawal	Forb	10	17

CONCLUSION

Forested area had higher plant cover, density, forge biomass yield and carrying capacity of herbaceous plants than open one, Also had higher density and available browse of *Acacia mellifera*. Open area had higher bare ground % and diversity in term of occurrence of many different grasses and forbs species especially in the second season compared to forested area. *Schoenefeldia gracilis* as annual grass was dominant in the both forested and the open one.

Absence of high palatable endangered species such as *Cenchrus ciliaris, Blipharis linarifolia* and *Vigna sun-hum* and palatable perennial and leguminous species in the both forested and the open one. *Cassia tora* as invader species was more frequent in open area. *Acacia mellifera* is considered as one of the important fodder tree in Elain forest reserve.

Recommendations

1. To improve range in Shikan locality of North Kordofan State and other similar areas, the recommendations of the study can be summarized as follows:-

a- Reseeding and conservation of high palatable endangered range species such as *Cenchrus ciliaris, Blipharis linarifolia* and *Vigna sun-hum* in the forested and the open one, Also Reseeding of suitable high palatable perennial and leguminous herbaceous species.

b- Adjustment of live stock number according to the appropriate stocking rate in open area.

c- Protection and planting of important fodder trees such as *Acacia mellifera* in open area.

2-Further study should cover over story and under story relationships in addition to woody- herbaceous -livestock interaction.

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