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EFFECT OF GROWTH STAGES AND RANGE SYSTEMS ON VEGETATION ATTRIBUTES, CARRYING CAPACITY, STOCKING RATE AND FORAGE PRODUCTIVITY, NORTH KORDOFAN, SUDAN

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ORIGINAL ARTICLE

ABSTRACT: *The range vegetation attributes, carrying capacity, stocking rates and forage productivity were studied in close and open range systems at the flowering and seed setting stages during the September and November 2010, respectively, in El Rosa (El-khuwei locality). Sampling was done by locating 2Km² in close and open range systems in a radiating manner from the centre of each site. Completely Randomized Design (CRD) was used to analyses treatments. Biomass production of plants and plant cover at the flowering stage in the close range system were significantly (P<0.0001) higher than that at the seed setting stage in the open range system. The plant density was significant (P<0.05) higher in the close rang system at the flowering stage and lower at the seed setting stage in the open range system. Bare soil and litter was significantly higher (P<0.0001) in the open range system during the seed setting stage and lower in the close range system during the flowering stage. Forage productivity of plants and shrubs browse kg/ha on rangeland was significantly higher (P<0.05) in the close range system during the flowering stage and lower in open range system at the seed setting stage. Carrying capacity was significantly higher (P<0.0001) in the close range system at the seed setting stage and lower in the open range at the flowering stage. Stoking rates in open range system during the seed setting stage was significantly higher (P<0.0001) and lower in the close range system during the seed setting stage. The frequencies of Huskneet (Cenchrus biflorus), Bano, (Eragrostis tremula), Difra (Echinocloa colonum), leflef Luffa aegyptiaca, Gaw (Aristida sp), Shuleny Zornia glochidiata and Aborakhus* Andropogon gayanus were higher in close system during the two stages of growth. Plants such as *Abodaib Ceraotheca sesamoid, Bigual Blepharis linarifolia, Tmrfar (Oldenlandia senegalensis), Rabaa (Zalea sp), Himeira* Hymerocardia*, Diresa (Tribulus terrestris) and Huntot Merremia pinnata recorded higher frequencies in close range system during the flowering stage than in the open range system during the seed setting stage. The Nuida Sida cordofolia had highest frequency in the open range system* during the two stages of growth.

Key words: *Biomass, Cover, Density, Bare Soil, Litter and Frequency, Forage Productivity, Carrying Capacity, Stoking Rates*

INTRODUCTION

Natural grasslands generally occur in climates that are either too dry or too cold for forest to persist, for example arid or semi-arid areas, monsoonal tropics with a long dry season, mountainous areas above the tree line (Alps) or tundra's in the arctic regions. Therefore, there are generally no natural grasslands in equatorial or temperate lowlands with humid or sub-humid climates. Grasslands are also more likely to occur on heavy-texture soils or in areas that are regularly burnt (Moore, 1964). In humid and sub-humid climates most grasslands are induced (man made), because the climate lacks the conditions needed for natural grasslands. Generally speaking, land is used for animal production from grassland only when other more profitable land useful systems are not possible. Thus, even natural grasslands, such as the prairies in North America, pampas in Argentina, llanos in Colombia, cerrados in Brazil, downs in Australia, steppe in Russia and pusta in Eastern Europe, have been converted to croplands when soil conditions and rainfall were sufficiently favorable for cereal production (Moore, 1964). The species composition of rangeland varies depending on topography, climate and soil types (Skerman,

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1977). Different grasslands contain diverse types of grasses, legumes, and other herbaceous species. The botanical composition of plant community can also change due to factors like altitude, grazing practices, burning, drought, and temperature effects, pest, and erosion. Therefore, due to, the productivity of an area in terms of its capacity to support livestock may change. Change in plant composition results as a result of the adaptability of the plant species to these influences over a period of time Skerman (1977).

The area of North Kordofan is about 25 million ha which is 14.5 million ha are rangeland (AFRICOVER, 2004) it is considered among the leading regions of Sudan in terms of animal and range resources, where more than 13 million heads of sheep, goats, camels and cattle are present (RPA, 2005). Animal production in the North Kordofan is mainly practiced under traditional extensive systems, depending on natural rangeland (Cook and Fadlalla, 1987). Cattle dominate the southern part of the State, while sheep, goats and camels are present in larger numbers in the northern drier part (El-Hag, 1993). Feed resources about 90% of livestock are from traditional pastoral systems, mainly in the western parts of Kordofan and Darfur states and in the southern states. The long term average annual rainfall is about 300-mm, consisting of storms of short duration between July and September with the highest rainfall generally occurring in August. The main objective of this paper was to investigate the effects of range system on vegetation attributes, carrying capacity and stocking rate, North Kordofan, Sudan.

MATERIALS AND METHODS

Study area

This study was conducted at El-khuwei locality (El Rosa). It lies between longitudes 28˚:33' and 28˚:30'N and latitudes 12˚:14' and 14˚:12'E, about 105 Km west of El Obeid town. North Kordofan State lies between latitudes 11˚:20' and 16˚:36'N and longitudes 27˚:13' and 32˚:24'E. The close range system was established in 2007 in an area of about 500 ha, at El-khuwei locality which is a large export market of animals (Hamari sheep) in western Sudan according to (MAR, 2009). The long term average annual rainfall is about 300-mm, consisting of storms of short duration between July and September with the highest rainfall generally occurring in August. The average monthly temperature according to Nimer (2000) is during I987-2002 in El Obeid town (34.6°C) and the coldest months are December and January with mean temperatures of 14.I°C and 13.5°C, respectively. The hottest months are April, May and June with an average mean temperature exceeding 30°C. The soil of the site lies within the sand dune area locally known as "Goz" soil. The site is naturally dominated by grasses namely Huskneet (*Cenchrus biflorus),* Shilini (*Zornia glochidiata*), Bigail (*Blepharis linarifolia*) and Aborakhus (*Andropogon gayanus*). The trees included Humied (*Sclerocarya birrea*), Higlig (*Balanites aegyptiaca*) and Sider (*Zizuphus spina- Christi).* The Shrubs include Kursan (*Boscia senegalensis*), Usher (*Calotropis*), Mereikh (*Leptadenia pyrotechnica*) and Arad (*Leptadenia pyrotechnica)* according to MAR (2009).

Layout of the experiment

Sampling was done by locating $2Km^2$ in the closed and open range system at two different growth stages flowering and seed setting was used to compare vegetation attributes, carrying capacity, stocking rate and forage productivity at each site eight transects of 500m length were located in a radiating manner from the center of the sample site according to Fadlalla and Cook, (1985).

Measurements of Vegetation Attributes

Measuring cover: The traditional loop method was used to measure cover, litter and bare soil according to Parker and Harris (1959). Within the selected plots, 16 transects readings were made, each transect was 100m long. The measurements were taken along each transect using a 100m plastic tape. All parameter were recorded at ten-meter interval, using 3/4" loop to obtain 100 observations. The data was recorded in specified sheets.

Biomass productivity of plants: The double sampling procedure (Wilm et al., 1944) was used to measure biomass production of plants. Samples selected in close and open quadrates within eight transect 500m long were taken in a radiating mater. At each transect 10 quadrates of $1m^2$ were placed at 50m intervals. The three observers' together estimated the weight of the 10 quadrates in the plot, only the 3^{rd}, 7^{th} and 10^{th} estimated first and then cut and weighed. The cut samples were oven dried at $80^{o}C$ for 24 hours and their dry weights recorded and determine the actual weight of available plants in quadrates and calculated that by average weight in closed and open rangeland.

Density and frequency of pasture: Density and frequency readings were obtained from the same quadrates used in double sampling procedure. Samples selected in close 80 and open 80 quadrates within eight transect 500m long were taken in a radiating mater were at each transect 10 quadrates of $1m^2$ were placed at 50m intervals selected samples. Density was determined by counting the number of plants rooted within each quadrate. Frequencies was determined by counting the number of quadrates that containing the species and divide that number by the total number of quadrate used as a percentage individual of a given species according to Morrison et al. (1995) and Kira et al. (1953).

Available browse productivity of shrubs

The Adelaide technique (Andrew et al., 1979) was used to obtain the productivity of shrubs. In this technique, three observers were involved in the simply. Five calibration or standard shrubs were selected at different height classes not exceeding 1.5m. These shrubs were tagged with masking tap. Hand- held production unit for each shrub was used to estimate the unit equivalent in each selected shrubs, and then available shrubs production units were visually estimated. Then twigs of 2mm in diameter were cut, oven dried at 105˚C to determine the actual weight of available browse.

Assessment of Carrying Capacity and Stocking Rates

Carrying capacity: Carrying capacity can be used equation:

$$\text{Carrying capacity} = \frac{\text{Annual forage consumption}}{\text{Available forage productivity (kg/ha)}}$$

Carrying capacity calculated by using the following:

Forage productivity (kg/ha)

1- Forage requirement per animal unit/ month/ year
2- Proper use factor % to obtain available forage for proper use 50%
3- Duration of grazing month or year

Stocking rate: For stocking rate in this case is gussets use carrying capacity and area of the range system in the closed and open range and used the following equation AUM/ year:

$$\text{Stocking rate} = \frac{\text{Area (close and open)}}{\text{Carrying capacity}}$$

Statistical Analysis

CRPD and Duncan Multiple Range test was used for mean separation (Steel and Torrie, 1960). SPSS (Statistical Package for Social Sciences) was used for the statistical analyses.

RESULTS AND DISCUSSION

Biomass productivity of plants

Biomass productivity of plants in the close range system at flowering stage was significantly (P<0.0001) higher than in open range system at seed setting stage (Table 1). Highly significant (P<0.0001) system x growth stage interaction effects was found for biomass productivity. Biomass yield was higher at the flowering and seed stage in the close system and lower in the open range system. These differences in biomass production could mainly due to, the erratic and inadequate rainfall in the rangeland leads to lower forage biomass productivity. These differences in biomass production could mainly be because grazing negatively affects plant communities sometimes, when not at time or the proper stocking rate (HTS, 1975). Dry materials grazing causes relatively little damage to growth in the following season, and grazing during the seed setting stage, causes potentially permanent damage and reduces forage production (HTS, 1975). According to Jerry and Holechek (1989), the amount of rangeland in the world is expected to decline substantially in the next 30 years, and large areas of rangelands in Africa and South America have already been converted to farmland. The main problem of Africa rangelands is the expansion of agriculture into grazing areas (Garcia, 1981). Laca et al. (2001) indicated that at too low or too high levels of plant biomass, rates of nutrient intake are reduced. Intake is influenced by three factors: bite size, bite rate, and grazing time (intake = bite size x bite rate x grazing time). Intake rate is most sensitive to bite size – too little or too much plant biomass diminishes bite size, and either increases (too little forage) or decreases (too much forage) bite rate and grazing time, all of which can diminish animal performance.

Plant density

The plant density was significantly (P<0.05) higher in the close range than in open range system (Table 1). At flowering stage plant density was significantly higher (P<0.0001) than at seed setting stage. A significant range system x growth stage interaction for plant density was detected, were at flowering stage in the close range, plant density highest density was higher. Ministry of Forests wills, (1994) reported that controlling seasonal drift use among forage types or protecting choice grazing areas for selective use, and protecting critical sites from grazing where required. Livestock grazing patterns should be observed prior to new fence construction, prefer to spend their time on grasslands rather than in forested sites. Because many grassland sites on the protected area are being encroached by forest, livestock distribution is being impacted. Control of forest encroachment will improve livestock distribution and overall forage production.

Plant cover

Plant cover was significantly (P<0.0001) higher in close range than in open range (Table 1). At flowering stage plant cover was significantly higher (P<0.05) than at seed setting. Range system x growth stage interaction for plant cover was highly significant. Plant cover at the flowering in the close system was the highest; while at seed setting stage in the open range system was lowest. Frequent occurrence of droughts in 1967/84, 1990/91 and the Sahel drought further accentuated rangeland deterioration. Overstocking and sever intermittent and prolonged droughts further exacerbate the low forage availability decreased animal production (RPA, 1993). Ministry of Forests wills, (1994) reported that fencing is an excellent management tools for controlling plant cover, animal and confirming them to a particular grazing area for an appropriate time.

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Bare soil

Bare soil was significantly higher (P<0.0001) in the open range system that in the close range system (Table 1). At seed setting stage, bare soil was significantly higher than in flowering stage. Range system x growth stage interaction for bare soil was significant. The higher bare soil was found in open range at seed setting stage, while the lowest value was found in close range at flowering stage. This situation is related to the main problems associated with rangeland management and over-stocking leads to progressive reduction in biomass production and plant cover, in arid and semi-arid areas over stock leads to soil degradation (Strang, 1980). Norton (1991) found that the contribution of plant litter to the soil surface enriched organic matter content and concentrated nutrient extracted from deeper horizons. He presumed low level of competition between the species and under storey grasses due to different rooting behavior and suggested that water penetration is improved under the plant canopy.

Litter

The litter was significantly higher (P<0.001) in the open range system than in the close system (Table 1). The effect of growth stage on litter was not significant. Range system x growth stage interaction for litter was significant. Higher litter was found in open range system at seed setting stage. The close range system was protected by fancies; however in the open range system, animals allowed to graze in large numbers, so small litter cover is found. Skerman (1966) stated that replacement of perennials by annuals in arid and semi-arid region was attributed to the removal of litter and ground cover by continuous overgrazing and over cultivation.

Available browse of shrubs and forage productivity

Available browse of shrubs and forage productivity kg/ha on rangeland was significantly higher (P<0.05) in the close range system at the flowering stage than in the open range system and lower at seed setting stage (Table 2). Harrison and Jackson (1958) reported that decrease in the productivity of shrubs browse and forage productivity as affected by degradation and desertification, for the Semi Desert in the North Kordofan and Darfur and low rainfall savannah on sand soil area. In most of the grasslands under seasonal rainfall areas, shrubs make considerable contribution to stock feed especially in the dry season. Goats, cattle and to a lesser extent sheep may all obtain an appreciable proportion of their feed from leaves, flowers, pods, twigs, seeds and even the bark of a large number of species. Wilson (1959) stated that in many places it is a normal practice for native herdsmen to lop branches of certain trees and throw them on the ground for their animals to eat during the dry season. In Africa, probably about 75% of the trees and shrubs are browsed to greater or lesser extent by domestic animals (Webster and Wilson, 1966).

Carrying capacity

Carrying capacity was significantly higher (P<0.0001) in the close range system at the seed setting stage than in flowering stage and lower in the open range system at flowering stage (Table 2). Coppock (1994) reported that the degradation of rangeland is generally caused by poor management of rangeland resources. Louis (1989) defined the major problem of the pastoral regions as over-stocking leading to certain ecological disaster, too little lands, the local rangeland could not carry an increased cattle population and that beside localized problems, and the quality of the environment is deteriorating. At times of drought, pressure on grazing land and water resources is leading to marked deterioration in range productivity (Pears, 1970).

Stoking rates

Stoking rates in open range system during the seed setting stage was significantly higher (P<0.0001) and lower in the close range system during the flowering stage (Table 2). The high similarity indices in the late-dry period were expected because warm-season species had not yet begun rapid growth and the least amount of forage was available. With higher forage availability (late-wet period) the similarity index was low, reflecting the effect of stocking density. Low overlap during wet times occurred when goats on the lightly stocked site concentrated more on forbs than goats on the heavily stocked site Walker et al. (1994). Perhaps the main factor determining stocking rate is the density of the plants infestation and the palatability of the plant. Sparse infestations of relatively nutritious, palatable plants like spotted knapweed may be best controlled with light stocking rates of sheep that can take advantage of the animal's preference for the plant. More dense infestations or less palatable weeds may require a heavy stocking rate to force a more even utilization of forage. In extremely dense infestations, animals are often "mob stocked" to facilitate complete removal of all forage (Hanselka and Paschal, 1992).

Species frequencies

Plant frequencies were higher in close range system during the two growth stages than in open range system (Table 3). Higher frequencies on the Huskneet, Bano, Difra, Leflef, Gaw, Shilini and Aborakhus, wily Fresha was lower frequency. However Abodaib, Bigual, Tmrfar, Rabaa, Himeira, Diresa and Hantoot recoded frequencies only in close range system at the flowering stage. Nuida were higher frequencies in open range system at the two stages. Indirect relevance to animal production; because the relations between yield and frequency, number or area will differ between species, their role is mainly to describe and quantify the population of plants in the pasture (Mannetje, Jones and Stobbs, 1976). Range condition is based on density and production of native, palatable,

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perennial grasses (Holechek, 1984). A better criterion might be the diversity of palatable forage species (Holechek, 1984). It might be desirable if up to 20% of yearly forage production is composed of palatable annuals. Annual forbs are important in nutrition of cattle, sheep, and pronghorn diets and reduce pressure on palatable perennial grasses during the growing season. The greater the forage selection provide to domestic or wild ungulates, the more likely it would meet their nutrient (Holechek, 1984).

Table 1 - Effect of growth stages and range systems on vegetation attributes and biomass of plants at El Rosa, North Kordofan State, Sudan

Parameter	Biomass (kg/ ha)	Density (p/ m²)	Cover (%)	Bare soil (%)	Litter (%)
System					
Close	2028.9	34.86	75.27	14.84	9.89
Open	1205.3	26.58	65.01	22.87	12.20
Mean	1617.1	32.45	70.14	18.85	11.04
SE±	74.5***	1.775*	0.58***	0.49***	0.35**
Season					
Flowering	1922.6	35.381	73.61	16.05	10.47
Seed setting	1311.6	27.19	66.67	21.65	11.62
Mean	1617.1	32.45	70.14	18.85	11.04
SE ±	74.5***	1.77 ***	0.58***	0.49***	0.35
Season x system					
Flowering x close	2261.2a	39.562a	78.14a	11.86d	10.00c
Flowering x open	1584.1b	30.16b	69.08b	20.24b	10.94b
Seed x close	1796.7c	27.52c	72.41c	17.81c	9.77d
Seed x open	826.4d	26.58d	60.94d	25.49a	13.46a
Mean	1617.1	32.45	70.14	18.85	11.04
SE ±	74.5***	1.77 ***	0.58***	0.49***	0.35*

Means in the same column under the same factor with different letters are significantly different. * = significant ($P < 0.05$), ** = high significant ($P < 0.001$) and *** = highly significant. ($P < 0.0001$). a, b, c = marginal mean.

Table 2 - Shrubs browse, forage productivity, carrying capacity and stocking rates in close and open range at the flowering and seed stage in El Rosa, North Kordofan State, Sudan

System	Plants (kg/ha)	Browse (kg/ha)	Forage (kg/ha)	CC (AU/ha/year)	S R (AUM/year)
Close	202.9	190.0	203.1	0.750	36.000
Open	120.5	140.0	120.7	0.450	60.000
Flowering	192.3	0.800	192.3	0.710	38.030
Seed setting	131.2	0.500	131.2	0.480	56.250
Mean	161.7	115.0	161.8	0.597	47.570

* = significant ($P < 0.05$), ** = high significant ($P < 0.001$) and *** = highly significant ($P < 0.0001$).

Table 3 - Species frequencies % in close and open range systems during the flowering and seed setting stages in El Rosa, North Kordofan State, Sudan

Plant species		Flowering stage		Seed stage	
Latin names	**local name**	**Close**	**Open**	**Close**	**Open**
Cenchrus biflorus	Huskneet	27.02	18.82	25.97	23.96
Eragrostis tremula	Bano	18.09	15.93	16.95	14.95
Echinocloa colonum	Difra	11.45	11.93	10.91	10.06
Luffa aegyptiaca	leflef	10.23	10.11	9.94	9.50
Aristida sp	Gaw	9.06	8.98	8.99	7.93
Zornia glochidiata	Shuleny	7.53	6.84	6.97	6.82
Andropogon gayanus	Aborakhus	7.13	6.94	6.75	6.84
Ceraotheca sesamoid	Abodaib	2.41	-	2.33	-
Blepharis linarifolia	Bigual	2.37	-	2.00	-
Oldenlandia senegalensis	Tmrfar	2.33	-	1.83	-
Zalea sp	Rabaa	2.06	-	1.71	-
Hymenocardia acida	Himeira	2.00	-	1.45	-
Tribulus terrestris	Diresa	1.46	-	1.02	-
Merremia pinnata	Hantoot	1.44	-	1.00	-
Tephrosia sp	Fresha	1.38	1.07	1.00	1.00
Sida cordofolia	Nuida	1.37	19.38	1.00	18.94

CONCLUSIONS

+ All vegetation attributes and forage productivity were higher in close range system.
+ Bare soil and litter were higher in open range system.
+ Carrying capacity was higher in the close range system at the seed setting stage.
+ Stoking rates was higher in close range system during the flowering stage.

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RECOMMENDATIONS

In addition to it is therefore could be recommended that increase vegetation attributes and forage productivity a significant in the open range needed more management and improvement.

REFERENCES

Africover (2004). *Sudan Spatial Aggregated Map, Afrikaner Project, FAO, Rome, Italy.*

Andrew MH, Noble IR and Lange RT (1979). *Anon-Destructive method for estimating the weight of forage on shrubs*. Aust. Range, I.J.I:225-231.

Cook RH and Fadlalla A (1987). *Seasonal Variation in plasma phosphorus Level* of transhumant sheep in Kordofan, Sudan. Trop. prod. 19: 57-62.

Coppock DL (1994). The Borana plateau of southern Ethiopia: *synthesis of pastoral research, development and change,* 1980-1991. *ILCA (International livestock Center for Africa),* Addis Ababa.

El-Hag FM (1993). *Conserved range grasses for dry Season feeding goats In shiekan province,* North Kordofan, Sudan, El Obied Agricultural Research Station, 1:1-2.

Fadlella B and Cook RH (1985). Design and implementation of in-herd/on-range trials: use of sentinel herds. In: *Research methodologies for livestock on-farm trials.*

Garica VR (1981). Drought and man. The 1974. Case history: *nature pleads not guilty. Vol. 1 Pergamum*.

Hanselka CW and Paschal JC (1992). *Brush utilization on the Rio Grande Plains. Rangelands.* 14: 169-171.

Harrison N and Jackson TK (1958). *Ecological Classification of the Vegetation* of Sudan.

Holechek J L (1984). Comparative contribution of grasses, forbs, and shrubs to the nutrition of range ungulates. Rangelands 6, 245-248.

HTS (Hunting Technical Services) (1975*).* Livestock and range investigation Ghazala Gawazt. Savannah development project phase.

Jerry Land Holechok Rex (1989). *Range Management Principal and Practices*. Prentice Hall. Inc. England cliff, New Jersey.

Kira T, Ogawa H and Shinozaki K (1953). Inter- a specific composition among higher plants. Competition–density–yield inter-Relationships in regularly *Journal of the Institute of Polytechnology*, Osaka City University Series D 4, 1-16.

Laca E, Shipley LA and Reid ED (2001). *Structural anti-quality characteristics of range and pasture plants*. J. Range Manage. 54:413-419.

Louis FM (1989). Peasant official view of range land in Botswana. Land uses policy July. P. 197-202.

MAR (2009). Ministry of Animal Resource and Fisher, report. North Kordofan, Sudan.

Mannetje LT, Jones RJ and Stobbs TH (1976). Pasture evaluation by grazing Experiments. In: N.H. Shaw & W.W. Bryan (Eds). Tropical Pasture Research. *Principles & methods.* Bull. 51. Commonwealth Agricultural Bureaux. Farnham Royal.Bucks.England. 222-234.

MFW (1994). The Ministry of Forests will prepare a report that identifies these authorized AUM levels*. "(page37, CCLUP 90 Day Implementation Report).*

Morrison A, Le Brocque AF and Clarke PJ (1995). An assessment of improved. *Techniques for estimating the abundance (frequency) of sedentary organisms. Vegetation* 120, 131-145.

Moore CWE (1964). *Distribution of grasslands s. In: Barnar , C. (e .) Grasses and Grassland s.* Macmillan, Melbourne, pp. 182–205.

Nimer AM (2000). Effect of *Acacia Senegal* (L.) willd.on Sandy Soils and Assessment of its foliage Nutrients: Case Study of Demokeya Forest, Northern Kordofan. M.Sc Thesis, University of Khartoum, Sudan.

Norton B E (1991). *Function and productivity of range land ecosystem,* Isr. J. Bot 28-19.

RPA (1993). Range and Pasture Administration. *Annual report. Ministry of Agriculture and Animal Wealth.* South Darfur, Sudan.

RPA (2005). Range and Pasture Admin, North Kordofan State. *Annual Range Survey Report. of measuring understory vegetation.* Proc. Of a symposium at Tifton, Georgia.

Parker KW and Harris RW (1959). *The 3-steps method for measuring condition and trend of forest ranges: a resume of its history, development and use*. In: Techniques' and methods.

Pears CK, Owen E, Mtenga LA, Penning PD,and Mayes RW (1970). Range Deterioration in the Middle East. Proc. 11th int. *Grassland Cong. Australia,* p. 26.

Skerman PI (1966). *Pasture and Livestock of Studies* in Kordofan. Special Fund Project area Sudan.

Skerman PJ (1977). Tropical Forage Legumes, FAO, *plant production and protection series,* No.2, FAO, Rome.574p.

Strang C R N (1980). *African pasture lands Ecology*. Food and Agricultural Organization (FAO) of the UN Rome- Italy.

Steel RCD and Torrie JH (1960). Principles and Procedures of Statistics. McGraw, Hill Book Co. New York (Ends) 454 pp.

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Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

Walker JW SL, Kronberg SL. Al-Rowdily and West NE, (1994). *Managing noxious weeds with livestock*: Studies on leafy spurge. Sheep Research Progress Rep. No. 3, USDA-ARS 1994-4 pgs 125-135.
Webster CC and Willson PN (1966). Agriculture in the tropics. Long man group limited, London.
Willson PN (1959). Studies of the browsing and reproductive behavior of the east Africa dwarf goat, E. Af. Agric. For J. 23-138-47. *Report. Unite Nations Educational, Scientific and Cultural Organization, Unite Nations Environmental Programmer, Food and Agriculture Organization, Paris*, 655 pp.
Wilm HG and Costtello DF (1944). *Estimating forage by double sampling methods*. Amer. Soc. Argon 36:194-203.