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Effect of Seasonal Herbage Yield and Grazing Capacities in Tullun Gwanki Communal Grazing Reserve in Semi Arid Sokoto State, Nigeria

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Abstract: *The study was conducted in a communal Grazing Reserve (Tullun Gwanki) between August 2002 and December 2003, to assess herbage yield, estimate livestock units and grazing capacities for different livestock species in the reserve. Treatments consisted of a factorial combination of 6 sources (1km transects) of 1. North high (NH); 2. North medium (NM); 3. North low (NL); 4. South high (SH); 5. South medium (SM); and 6. South low (SL) vegetation densities, and four seasons (1.Early rainy season (March - May), 2. Late rainy season (June - August), 3. Early dry season (September - November) and 4. Late dry season (December - February) were laid out in a Randomized complete block design (RCBD). Data collected on herbage yield and livestock units were used to estimate seasonal and annual carrying capacities of the reserve. The results of the present study indicated a significant ($P<0.05$) source and season interactions for herbage yield ($KgDMha^{-1}$) in the reserve. The herbage yield was highest (1338.7 $kgDMha^{-1}$) in early rainy season and lowest (299.7 $kgDMha^{-1}$) in late dry season. The annual livestock units for all livestock species in the reserve was 20,270, with the densities of 10.7 head/ha. The herbage production could not support the teeming livestock units in the reserve. The generally low annual carrying capacities (Cattle 0.02LU/ha; Sheep 0.3LU/ha; Goats 0.003LU/ha; Donkeys 0.2LU/ha; Camels 0.2LU/ha and total livestock 8.6LU/ha) obtained for different livestock species in the reserve suggest over stocking. Livestock had to complement grazing with browsing in all seasons, while pastoralists had to resort to alternative sources of feeds for their livestock outside the reserve. It was recommended that pastoralists be mobilized with government efforts to reseed the reserve with appropriate perennial herbage and ligneous layers.*

Keywords: *Herbage Yield, Grazing Reserve, Semi Arid, Sokoto State, Nigeria*

1. INTRODUCTION

The concept of carrying capacity has been widely and diversely used in Natural Rangelands Resource Management [1]. However, in Range Management context understanding the types, uses, densities and composition of livestock per unit area are necessary in planning for maximum range utilization and sustainable livestock productivity. Livestock farmers in Nigeria depend mostly to natural ranges and marginal lands as the major sources of feeds for herbivorous [2]. However, these rangelands are mostly degraded due to continuous grazing and other man made activities [3]. Thus grazing areas are now producing edible forages at the less than their potentials [4], consequently lowering carrying capacities and livestock productivity. Despite the efforts made by successive governments to address the issues, the transhumance migrations to the

southern parts of the country and beyond International boundaries in search for feeds are on the increase [5]. The fact that information on seasonal herbage yields, livestock densities and carrying capacities of communal grazing reserves in the present Sokoto state is not readily available, therefore justified the study. The aims of this study were to assess the seasonal and yearly above ground graze able herbage biomass, estimate livestock units, and calculate seasonal and yearly grazing capacities for different livestock species in the communal grazing reserve.

2. MATERIALS AND METHODS

2.1. Study Area

The Tullun Gwanki Grazing Reserve, in Silame Local Government Area of Sokoto State, Nigeria is located between latitude 12^0 54' and 13^0 02' North and longitude 4^0 52' and 5^0 00' East. It was surveyed in August 1989 and gazette on the 10^{th} day of June 1991. The reserve has a surface land area of 4,312.54 hectares. The climate in the area consists of a long dry season (November - April) and a short rainy season (May - October). The annual rainfall of the study area averages 531.66 and 456.61mm for the years 2002 and 2003 respectively [6]. The rainfall in Sokoto state increases both in quantity and intensity from the northern to the southern parts of the state [7]. The dry season include a cold spell usually between November-January, known as the period of Harmatan. The Temperature varies widely, the mean monthly minimum and maximum temperature are 15^0c and 40^0c respectively, the maximum temperature occurs in May. The soil is moderately deep and well drained [8].

2.2. Treatment and Experimental Design

Treatments consisted of a factorial combination of 6 sources (1km transects) of 1. North high (NH); 2. North medium (NM); 3. North low (NL); 4. South high (SH); 5. South medium (SM); and 6. South low (SL) vegetation densities and four seasons (1.Early rainy season (ERS), 2. Late rainy season (LRS), 3. Early dry season (EDS) and 4. Late dry season (LDS) with thirty replications (200m intervals) were laid out in a Randomized complete block design (RCBD) Data collected on seasonal herbage biomass production and livestock census / units were used to estimate seasonal carrying capacities of the reserve.

2.3. Herbage Sampling

A stratified sampling method along transects was conducted as described by Kallah **[**9**]**. The reserve was divided into two strata (North and South). In each stratum, three (1km) transects were identified based on vegetation densities (High, Medium and Low). The vegetation densities were identified using visual assessment, based on heterogeneity of the soil and herbage density **[**10**]**. Vegetation assessments were carried out using modified rated points for range condition analysis described by Stoddart **[**11**]**. The areas in each stratum with 60-75, 40-59, and less than 39% herbage cover were considered as high, medium and low vegetation densities respectively. Five 1 m^2 quadrants were thrown at 200 meter intervals along each transect, upon which herbage samples were collected. Samplings were conducted at five weeks intervals for 12 months, from 1^{st} September 2002 to 31^{st} August 2003. The samples were air dried and saved separately.

The herbage yield of the reserve was calculated using the formula described by Kallah [9]

Herbage yield (g/m^2) = P (1)

Herbage yield ($kgha^{-1}$) = P X C (2)

Total herbage yield (kg) = PXCXA (3)

Where P = Mean herbage yield /quadrant, C = Conversion factor which is 10 for a quadrant size of $1m^2$, A = Surface area of the reserve in hectares.

2.4. Livestock Census

Samplings for seasonal livestock population in the reserve were conducted along the existing transects used for biomass production at monthly intervals for 12 months. Along each transect, livestock species encountered within an average of 10 meter distance on either side were counted and recorded. Livestock population was calculated using the following formula described by Bello [5]:

LP = R / nT x L

Where LP = Livestock population / Area / Time; R = Total area in hectares; nT = hectares covered by total number of transects; L = Number of livestock observed on transects in the reserve.

2.5. Livestock Units (LU)

Livestock units (LU) was estimated using the formula described by Schãfer [12], who reported cattle in Sahel have average live weight of 171kg or 0.68 LU, while standard for livestock unit (LU) is an average Zebu Cattle weighing 250kg / 5 sheep or 6 goats. The cattle herd's composition of 51% cows, 11% breeding bulls, 20% growing cattle (1-3years) old and 18% calves (under 1year) reported by Schãfer [12] for Zamfara reserve in similar environment with the study area was used to classify herd's compositions in the reserve.

2.6. Carrying Capacity

The carrying capacity of the reserve was calculated using the following formula:

G= F ÷ R x LU

Where G = carrying capacity in LU/Area/period.

F= yield of available herbage per area.

R = total feed required by LU for the period.

LU = 250kg live cattle weight / 5 sheep or 6 goats with average feed requirement of 6.8kg DM/day.

3. Results and Discussion

3.1. Herbage above Ground Biomass Production

The results of the present study indicated a significant ($P<0.05$) source and season interaction for above ground biomass ($KgDMha^{-1}$) in the reserve. The mean seasonal biomass had shown clear trend with seasons. The biomass was highest (1338.7 $kgDMha^{-1}$) in early rainy season and lowest (299.7) in late dry season (Fig. 1).

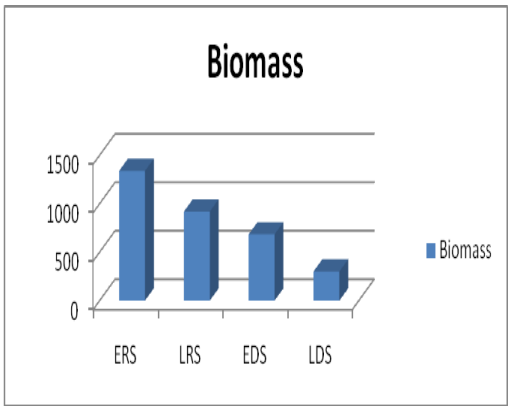

Fig 1. *Seasonal herbage biomass production in the reserve ERS= early rainy season, LRS= late rainy season, EDS= early dry season, LDS= late dry season*

The highest biomass recorded in the early rainy season was probably due to the standing hay and litter from the preceding year. The linear decreased in seasonal herbage yield (Fig. 1) was in agreement with the findings of Schãfer [12], who reported a continuous decrease in dry biomass per unit area with advancing dry season in Zamfara reserve. The mean annual herbage yield obtained in the present study was within the range of herbage yield reported for semi-arid rangelands [13]. The herbage yield was however not sufficient for the productivity of teeming livestock in the reserve in all seasons. The herbage was dominated by unwanted plants species leading to in range degradation [2]. Livestock in at this point had to compliment grazing with

browsing on the barks, leaves and twigs of woody species, crop residues and concentrates supplementation in both rainy and dry seasons [14 and 15].

3.2. Seasonal Livestock Units and Densities (Head/Ha-1) for Different Livestock Species in the Reserve

Table 1 presents the seasonal livestock population in the reserve. The result of the present study indicated seasonal and yearly variation for livestock densities in the reserve. The higher cattle population 7,727 (4,908LU) with the density of 1.8 head/ha in late rainy season was probably due to bounty of grasses and water in the reserve. This confirms the earlier findings of Adegbola [16] who reported 80% of National cattle population found in Northern provinces when grasses were available in wet seasons. The lowest number of cattle population of 5,257 (3,339LU) recorded in early dry season (October– January) was probably due to migration of the pastoralists outside the reserve for crop residues grazing. Crop residue grazing was reported to complement dry season carrying capacity by contributing additional fodder as crop aftermaths [14]. The increased in cattle population observed in late dry season was probably due to retained pastoralist's cows, and the mixed farmer's herd that relied on the reserve for grazing yearly round. Similar findings were also reported by Kallah [14] and Adegbola [16]. Livestock at this time compliment their nutrients requirements with browsing from twigs, leaves and fruits of trees and shrubs during the dry season [5, 10, 12]. The higher Sheep and goats densities (403LU and 422LU) respectively recorded in early dry season were probably due to agro - pastoralits and mixed farmer's flocks that were released in the reserve after crop residues grazing.

Table 1. *Seasonal livestock population in the reserve*

S/N	Season	Cattle	Sheep	Goats	Donkeys	Camels	Total
1	ER/Season	5,355	827	1,438	144	252	8,016
2	LR/Season	7,727	1,545	2,300	1,222	359	13,153
3.	ED/Season	5,257	2,947	3,701	719	611	13,235
4.	LD/Season	5,606	2,444	2,264	863	719	11,892
5.	Year	23,943	7,763	9,703	2,948	1941	46,296

The higher density of small ruminants encountered in October – December (Fig. 2) disagreed with Schãfer [12] who reported high density of sheep and goats in Zamfara reserve in July 1993. The high value of donkeys recorded during late rainy season grazing was probably due to increased in the proportion of pastoralists in the reserve. Pastoralists use donkeys for water conveyance, loads and children carriers during migration. This agreed with Schãfer [12] who reported on the same pastures, donkeys and less often camels were mentioned to be owned by pastoralists in Zamfara reserve.

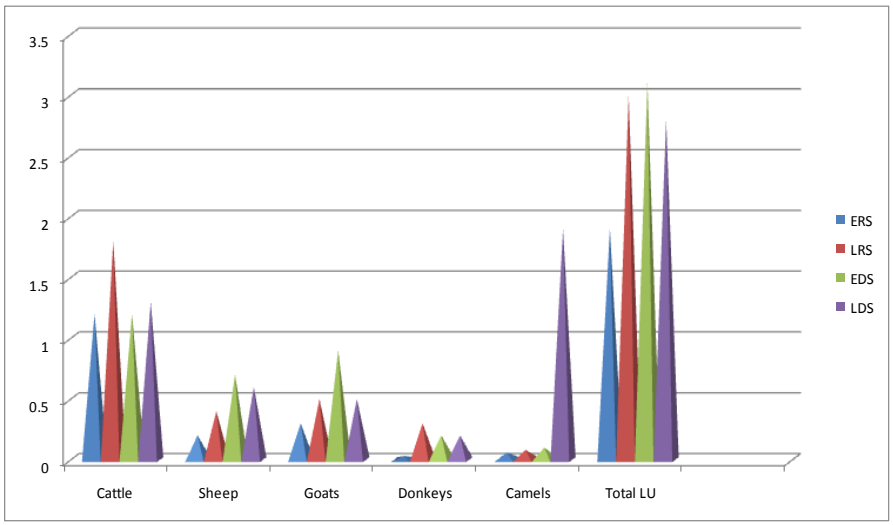

Fig 2. *Seasonal Livestock densities for different species in the reserve*

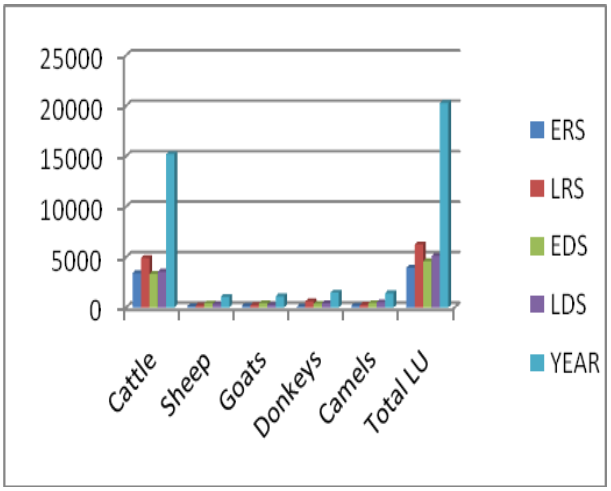

Fig 3. *Seasonal and yearly livestock units (LU) for different species in the reserve*

On the contrary, the high values of camels in late dry season was probably due to camels owned by mixed farmers that were allowed to graze and browse unattended in the reserve. The seasonal variation in livestock densities obtained in the present study was in agreement with the report of Schãfer [12] for Zamfara reserve. The cattle densities of 1.2 and 1.8 head/ha and 1.2 and 1.3headha^{-1} reported in this study during the early and late rainy and dry seasons respectively were higher compared to the cattle density of 20-30 / km^2 (0.2 – 0.3 headha^{-1}) and the values of 2-4/km^2 (0.02 – 0.04 headha^{-1}) reported by Adegbola (1982) in Damaturu Borno State in wet and dry seasons respectively. The values were within the range of the cattle density of 1.9head/ha reported by Schãfer [12] in Zamfara reserve during the rainy season. The yearly cattle density of 5.6 headha^{-1} reported in the present study was high compared to 0.94 headha^{-1} reported by Schãfer [12]. The generally high values for livestock densities recorded in the present study compared to the values reported in Zamfara reserve was probably due to the smaller size of the present study area with 4,312.54ha compared to Zamfara Reserve with surface land area of 203,320ha [10].

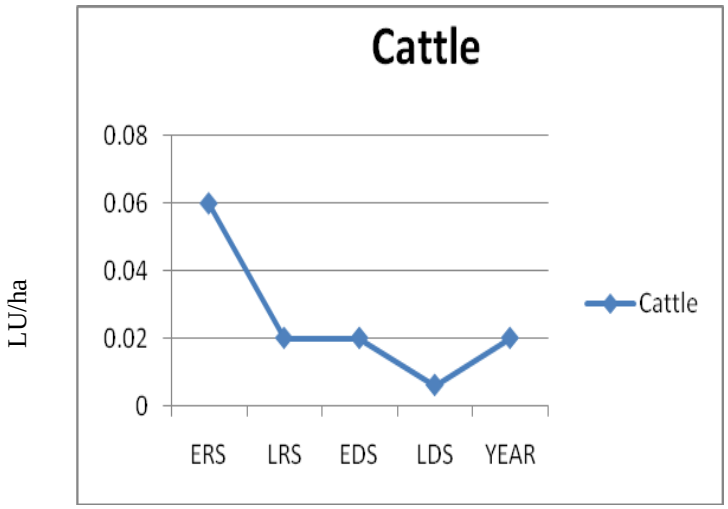

Fig 4. *Seasonal and yearly grazing capacities for cattle specie in the reserve*

Key ERS = Early Rainy Season LRS = Late Rainy Season EDS = Early Dry Season LDS = Late Dry season

The higher values for grazing capacities obtained for all species of livestock in early rainy season (Fig. 4, 5, 6, and 7) compared to other seasons was probably due to fewer number of livestock as pastoralists at this time were returning from traditional nomadism in neighboring states. It was earlier reported that pastoralists using the reserve have few number of livestock / herd, thus migrate only to the neighboring states in search of more feeds for economic reasons [15]. This was also in agreement with most authors' findings that the nomadic tradition of the pastoralist's management system is well organized to practice rotational grazing on a national scale [16, 17].

The linear decreased in grazing capacities with advancing dry season obtained in the present study was probably due to seasonal decreased in biomass production. Similar trend was also reported by most authors [10].

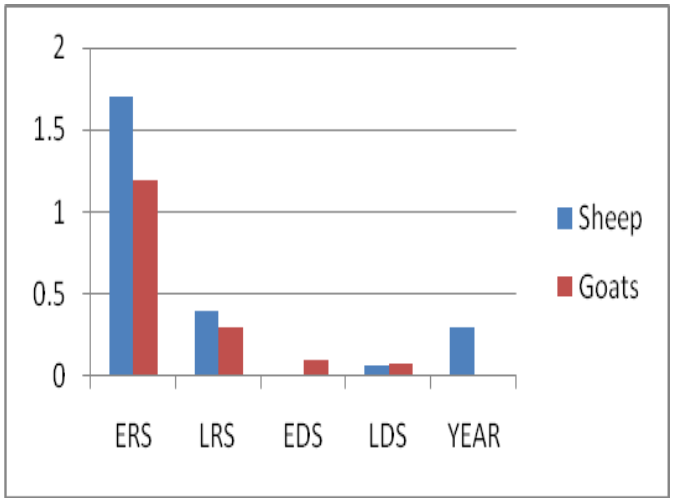

Fig 5. *Seasonal and yearly grazing capacities for sheep and goats in the reserve*

Key ERS= Early Rainy Season LRS= Late Rainy Season EDS= Early Rainy Season LDS= Late Dry Season

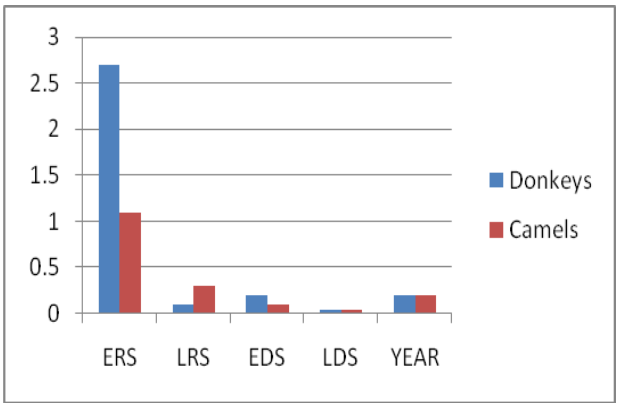

Fig 6. *Seasonal and yearly grazing capacities for Donkeys and Camels in the reserve*

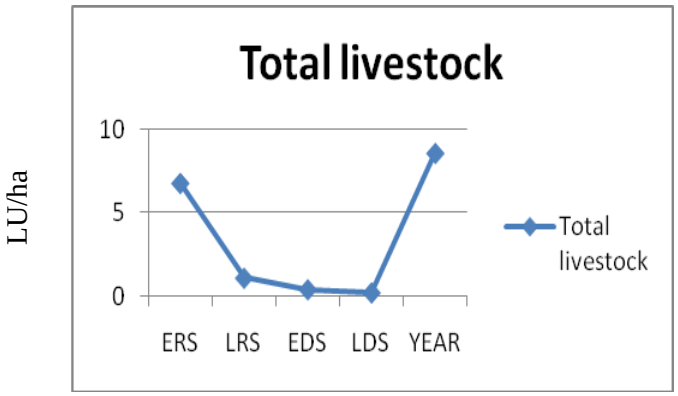

Fig 7. *Seasonal and yearly grazing capacity for total livestock in the reserve*

The low values of yearly grazing capacities for different livestock species obtained in the present study (Cattle 0.02LU/ha; Sheep 0.3LU/ha; Goats 0.003LU/ha; Donkeys 0.2LU/ha; Camels 0.2LU/ha and total livestock 8.6LU/ha) were probably due to low herbage production in the reserve. This was in agreement with Malami [10] who reported a decrease in biomass production at places where stocking rates were extremely high. The value obtained for cattle was lower compared to 1.25 LU/ha reported for yearling steers on grasses, and 2.5 LU/ha on cultivated cereals [18]. Similarly, the values of grazing capacities obtained for sheep and goats in the present study were also lower compared to 1.8 - 4.7 LU/ha reported (0.5 – 1.5 LU/ha) for low quality

pasture and (1.5 - 3.0 LU/ha) for good quality native pasture reported by McDonald [19]. The generally low seasonal and annual grazing capacities obtained in this study suggests over stocking. The herbage production of the reserve could not support the teeming livestock population. Pastoralists had to resort to alternative sources of feeds for their livestock outside the reserve.

4. CONCLUSION

It was concluded that temporal and spatial variation in the quantity and quality of forages necessitated rotational grazing pattern in Tullun Gwanki grazing reserve. The yield of graze able herbage could not support the teeming livestock units in the reserve. The low herbage yield in the reserve was probably due to intense grazing without re-seeding. The values for seasonal and yearly grazing capacities obtained in the present study indicated overstocking. This led to range degradation consequently affecting livestock productivity in the reserve. Livestock had to complement grazing with browsing in both rainy and dry seasons. The pastoralists had to resort to alternative feeds for their livestock outside the reserve. It was recommended that the pastoralists are to be mobilized to participate in re-seeding the reserve with appropriate perennial herbaceous species such as *Andropogon gayanus, Brachiaria spp, Digitaria spp, Cajanus cajana* etc and drought tolerant browse able ligneous layers such as *Cactis, Saltbushes* and *Wattles plant species* in the reserve.

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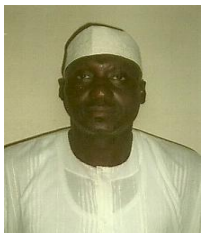

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