

Vegetation composition and productivity in reserved grazing area of Lubungo village in Mvomero District

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Abstract

Most reserved grazing areas within the villages in Tanzania are continuously grazed and are heavily encroached by bushes. An inventory of 8.4ha reserved grazing land resources of Lubungo village in Mvomero District was conducted towards the end of the dry season of 2018, to assess pasture species composition, ground vegetation cover, dry matter yield, tree density and canopy cover. The soil physical, chemical and plant seedbank characteristics were also assessed. Line interception method was used to assess pasture species composition and ground cover. From each line interception sampling unit of 10m tape measure, two quadrat frame each 0.25m² were thrown at random in left and right side of the sampling unit to sample desirable pastures and soil for determination of the pasture dry matter yield and soil physical and chemical properties. One soil sample at a depth of 5cm and 30cm x 30 cm wide was collected for soil seedbank determination in the bare soil patch around each line interception sampling unit in order to be sure if the grazing land is rested wouldn't come back with desirable vegetation. Eight parallel lines interception sampling units were fitted in each transect line of 700 m at 70 m interval. Three transect lines 40 m apart were established in the reserved grazing land. The Point Centered Quarter (PCQ)

method was used to determine tree density and their canopy cover. The ground cover of desirable pasture, undesirable pasture species, and litter was 67.7 %, 10.5% and 9.4 % respectively. The bare patches covered 12.3 % of the grazing land. The most dominant grass species was *Enteropogon macrostachyus* followed by *Bothriocloa insculpta* and *Heteropogon contortus*. Soil bulk density, pH, organic carbon, Nitrogen, Phosphorus and Potassium were 1.4g/cm⁻³, 6.3, 1.14%, 0.09%, 0.89 mg/kg and 0.33 g/kg, respectively. A total of 11 dicotyledonous species mainly forbs and 9 monocotyledonous species with only four perennial grasses were revealed from the soil seedbank. Dry matter yield of the desirable pasture was 806.8 kg DM per ha and tree density was 1500/ha with the total canopy cover of 63.49%. The most dominant tree species was *Combretum collinum*. The vegetation type of the grazing land was therefore *Combretum-Enteropogon* bushed grassland. From this inventory results it can be concluded that the reserved grazing area had very low pasture productivity, poor soil seedbank and high bush encroachment. In order to improve pasture productivity therefore there is a need of bush clearing and reseeding the reserved Lubungo village grazing land.

Key words: *Ground cover, Canopy cover, Bush encroachment, communal grazing area, Dry matter yield*

Introduction

Most reserved grazing areas in many villages in Tanzania lack proper grazing system, inventory and monitoring of biotic and abiotic resources such as vegetation and soil characteristics and are rather continuously grazed and therefore heavily encroached with bushes and sometimes invasive plant species, covered by

bare patches leading to accelerated erosion and floods. The carrying capacity of most pastoral lands in the country are therefore decreasing that exacerbate increased seasonal livestock mobility seeking pastures and water (Turner *et al.*, 2006), and in most cases ending up in livestock keepers -farmers conflicts. There is a need, therefore, to conduct grazing land resources inventory of every reserved grazing area so as to determine its carrying capacity and to advise appropriate grazing land improvement practices in a given area ((Muir and McClaran., 1997; Gintzburger et al., 2010). This study was therefore conducted in Lubungo village reserved grazing area so as to assess pasture species composition, ground cover and dry mater yield, tree density and canopy cover as well as soil physical, chemical and seedbank characteristics. It was envisaged that the results of this study will help livestock keepers of Lubugo village on how to improve the carrying capacity of their reserved grazing land.

Material and methods

The study was conducted at Lubungo village in Mvomero District which is located at North East of Morogoro Region at 300 to 400 m above the sea level, receiving a mean annual rainfall of 885 mm (Mbage *et al.*, 2017). The village have a communal grazing land of 1200 ha, and 3319 cattle, 766 goat and 159 sheep. Every, household, however, own reserved grazing area locally known as *Ololii*. An inventory of one reserved grazing area (*Ololii*) resources in the village was conducted in October 2018, specifically to assess pasture species composition, ground cover and dry mater yield, tree density and canopy cover as well as soil physical, chemical and seedbank characteristics. The size of the *Ololii* was 8.4 ha and the owner had 97 cattle and 120 goats.

Line interception method was used to assess pasture species composition and ground cover. From each line interception sampling unit of 10m tape measure and two quadrat frame each 0.25m^2 thrown at random in left at 5th meter and right side in 10th meter of the sampling unit to sample desirable pastures and soil for determination of the pasture dry matter yield and soil physical and chemical properties. Desirable pastures (edible to grazing animals) inside the quadrant frames in each sampling unit were harvested, sorted to remove undesirable materials and weighed to get the weight of fresh sample. These samples were packed into labeled paper bag and were then put into plastic bucket that were used to transported them to SUA Animal Nutrition Laboratory to be oven dried to constant weight at temperature of 70°C for 48 hours. The weight of dried sample was recorded and used for the determination of dry matter yield per quadrant and thereafter per hectare.

One soil sample at a depth of 5cm and 30cm x 30 cm wide was collected for soil seedbank determination in the bare soil patch around each line interception sampling unit so as to be sure if the grazing land is rested wouldn't come back with desirable vegetation. Eight line interception sampling units were fitted in each transect line of 700 m at an interval of 70 m. Three transect lines 40m apart were established in the reserved grazing land.

Point Centered Quarter (PCQ) method was used to determine tree density and their canopy cover. In every sampling unit the cross mark was thrown randomly along the transect line and the 4 nearest trees falling in each quarter were identified and measure (Mitchell, 2010).

The soil sample for soil seed bank determination was collected by hand hoe and bush knife. Thereafter packed into the labeled paper bag, put into plastic bucket and transported immediately to Sokoine University of Agriculture where it was incubated for analysis of soil seed bank density and plant species composition. Each soil sample was filled at plastic pot with a diameter of 22 cm and depth of 3.5 cm. The pots were then placed in transparent nylon greenhouse structure measuring 2 m x 2 m x 2 m to prevent incoming seeds from the surroundings. The pots were covered by perforated nylon to minimize moisture loss and the cover was removed after seven days to allow the germinated seeds access more light and remove impedance for growth. Moisture content of the soil was maintained all the time by regular watering with industrial bottled drinking water so as to prevent any foreign seed from river water. Data on seedlings emergence was recorded every 7 days for 8 weeks starting from seventh day since incubating date. Each emerged seedling per pot was counted and the number of seedlings per hectare was calculated so as to obtain soil seed bank density. Identification of germinating plants for botanical composition of the soil seed bank of the area started in 8th week though some of the seedlings died before reaching the stage of being identified.

The data for assessment of vegetation characteristics, productivity and soil seed bank which included vegetation ground cover, dry matter yield, soil seed bank characteristics, soil characteristics, tree density and canopy cover of the communal grazing area were analyzed by means of Microsoft Excel Spreadsheet computer program to generate descriptive statistics including mean, percentage and standard error.

Results

The communally grazing land had relatively high percentage ground cover of desirable plants compared to undesirable plants species, litter and bare soil patches (Table 1).

Table 1. Percentage vegetation ground cover in reserved grazing area at Lubungo village in Oct 2018

Transect lines	Desirable (%)	Undesirable (%)	Litter (%)	Bare soil (%)
1	61.70	13.56	7.58	17.16
2	64.49	12.48	11.20	11.84
3	76.98	5.53	9.56	7.94
Mean	67.72	10.52	9.45	12.31
SE	±2.71	±1.45	±0.60	±1.54

The dominant desirable pasture species were *Bothriochloa intermedia*, *Enteropogon macrostachyus*, *Heteropogon contortus* and undesirable plant species were *Aristida stipoides* grass and the two forbs; *Idigofera arrecta* and *Sida acuta* (Table 2). The dry matter yield of desirables was 806.77 ± 29.9 kg DM per hectare.

Table 2: Frequency of occurrence and ground cover of different plant species in reserved grazing area of Lubungo village in October 2018

Plant specie	Plant type	Frequency of occurrence (%)	Ground cover (%)	Grazing Preference
<i>Bothriocloa intermedia</i>	Grass	29.17	15.42	Desirable
<i>Enteropogon macrostachyus</i>	Grass	33.33	30.17	Desirable
<i>Heteropogon contortus</i>	Grass	25.00	14.50	Desirable
<i>Themeda triandra</i>	Grass	12.50	4.17	Desirable
<i>Bothriocloa pertusa</i>	Grass	12.50	1.39	Desirable
<i>Brachiaria sp</i>	Grass	6.25	0.65	Desirable
<i>Pogonathria squarrosa</i>	Grass	8.33	1.43	Desirable
<i>Aristida stipoides</i>	Grass	18.75	3.57	Undesirable
<i>Indigofera arrecta</i>	Forb	22.92	4.63	Undesirable
<i>Sida acuta</i>	Forb	16.67	2.32	Undesirable

The tree density was 1500 per hectare with the total canopy cover of 63.49% .The most dominant tree species were *Combretum collinum*, *Comiphora africana* and *Piliostigma thonningii*with densities of 864, 163 and 97trees/ha and canopy cover of 22.6%, 6.2% and 5.4%, respectively (Table 3).

Table 3: Frequency of occurrence of different tree species, tree density, crown cover and canopy cover of each tree species per ha

Tree name	Frequency of occurrence (%)	Tree density by specie/ha	Mean crown cover(m ²)	Tree canopy cover by each sp/ha(m ² /ha)	Canopy cover of each specie/ha (%)
<i>Euclea divinorum</i>	4.2	16.3	5.16	84.20	0.84
<i>Combretum hereroense</i>	4.2	16.3	3.78	61.66	0.61
<i>Piliostigma thonningii</i>	12.5	97.8	5.53	541.40	5.41
<i>Dalbegia sp</i>	4.2	48.9	0.95	46.49	0.46
<i>Combretum collinum</i>	87.5	864.1	2.62	2267.44	22.67
<i>Commiphora africana</i>	29.2	163	3.82	624.18	6.24
<i>Acacia nilotica</i>	16.7	81.5	8.69	708.62	7.08
<i>Terminalia seriacea</i>	4.2	32.6	4.43	144.75	1.44
<i>Terminalia brownie</i>	12.5	65.2	1.21	79.51	0.79
<i>Brachystegia bussei</i>	4.2	16.3	5.40	88.18	0.88
<i>Sclerocarya birrea</i>	4.2	32.6	44.17	1440.36	14.40
<i>Combretum schumanii</i>	4.2	16.3	5.95	97.13	0.97
<i>Dicrostachys cinerea</i>	4.2	16.3	4.61	75.26	0.75
<i>Grawia bicolor</i>	8.3	16.3	4.41	72.02	0.72
<i>Rhus natalensis</i>	4.2	16.3	1.11	18.12	0.18
Total		1499.9			63.49

The soil of the reserved grazing area was sand clay loam with 33.22% clay, 2.82% silt and 62.96% sand. It was slightly acidic with pH ranging from 6.1 – 6.5, moderate bulk density, low organic carbon and low Nitrogen(N), Phosphorus(P) and Potassium(K) (Table 4).

Table 4. Physical and chemical characteristics of soil from reserved grazing area of Lubungo village in October 2018

Parameters	BD(g/cc)	OC (%)	PH	N (%)	P(mg/kg)	K(Cmolkg ⁻¹)
Mean Values	1.40	1.14	6.33	0.09	0.89	0.33
SE±	±0	±0.03	±0.04	±0	±0.23	±0.02

BD = Bulk density, OC = organic carbon, N = Nitrogen, P = Phosphorus, K = Potassium

A total of 9 monocotyledon seedlings species were recorded with a total seed density of 476851 seeds/ha on the other hand 11 dicotyledonous seedlings species with seed density of 138888 per hectare were recorded (Table 5). The dominant seedlings in monocotyledon were *Aristida stipoides*, *Dactyloctenium aegyptium* and *Enteropogon specie* with seed density of 180555, 97222 and 60185/ha respectively. On the other hand the dominant seed species in dicotyledonous were *Mullugo nudicaulis* and *Indigofera arrecta* with seed density of 27777 and 32407/ha, respectively as shown in table 5. The seedlings emergence started on 5th day of the soil incubation and some seedlings started dying on 45th day onward before being identified due to shallow soil depth of 3.5 cm.

Table 5. Monocotyledon and dicotyledonous soil seed bank density characteristics

Monocotyledon	Family name	No. Seedlings/ha	Pasture type	Life form
Brachiaria specie	Poacea	13888.9	Desirable	Perennial
Dactyloctenium aegyptium	Poacea	97222.2	Desirable	Annual
Echinochloa colona	Poacea	41666.7	Desirable	Annual
Aristida stipoides	Poacea	180555.6	Undesirable	Perennial
Bothriocloa pertusa	Poacea	32407.4	Desirable	Perennial
Enteropogon macrostachyus	Poacea	60185.2	Desirable	Perennial
Panicum specie	Poacea	27777.8	Desirable	Perennial
Leptocarydion vulpiatrum	Poacea	18518.5	Undesirable	Annual
Digitaria velutina	Poacea	4629.6	Desirable	Annual
Total		476851.9		
Dicotyledon				
Commelina specie	Commelinaceae	9259.3	Desirable	Perennial
Mullugo nudicaulis	Commelinaceae	32407.4	Unedible	Annual
Tridax procumbens	Asteraceae	9259.3	Unedible	Annual
Indigofera arrecta	Fabaceae	27777.8	Unedible	Annual
Portulaca oleracea	Portulacaceae	13888.9	Unedible	Annual
Abutilon indicum	Malvaceae	4629.6	Unedible	Annual
Borreria pusilla	Rubiaceae	9259.3	Unedible	Annual
Vernonia cinerea	Asteraceae	4629.6	Unedible	Annual
Solanum incunum	Solanaceae	4629.6	Unedible	Annual
Cassia tora	Fabaceae	13888.9	Unedible	Annual
Malcastrum coromandelianum	Malvaceae	9259.3	Unedible	Perennial
Total		138888.9		

Discussion

The results of the assessment of vegetation characteristics, pasture productivity and soil seed bank in communal grazing land during the dry season showed that there were high percentage ground cover of the desirable pasture species as compared to undesirable pasture species, litter material and bare soil patches. The dry matter yield was however, rather low (806.77 ± 29 kg/ha) due to high tree density of about 1500 trees per hectare and continuous grazing. High canopy cover of trees may have prevented direct light falling to pasture growing under the tree that affected photosynthesis process, growth and dry matter yield during the previous growing season. Sangeda and Maleko (2018) observed low pasture yield production in areas with high woody plant cover compared to that with low woody cover in Simanjiro district northern Tanzania. This observation was in agreement with Kapu (2012) who noted that bush encroachment and marked bare spaces lead to low pasture yield per hectare and hence decrease in carrying capacity of the rangeland. Apart from that continuous grazing lead to decrease of herbaceous ground cover through deterioration of palatable pasture species (Kioko, 2012).

The soil sample taken from the bare soil patches showed relatively high germinable soil seed bank of monocotyledon and dicotyledon per hectare. Most seeds were annual grasses, undesirable and un-edible annual forbs with very few perennial grasses. This may have been attributed by anthropogenic activities such as overgrazing and shifting cultivation. Continuous grazing system which is practiced in the grazing land of Lubungo village seem, not to allow the desirable perennial grasses to reach seeding stage of growth. Lopez-Toledo and Martinez-Ramos (2011) found that shifting cultivation and heavy grazing introduces a

disturbance to grasslands, which affect negatively the size and composition of grasses in the soil seed bank. Heavy grazing causes removal of immature reproductive plant parts leading to low soil seed bank and thus low recovery of the palatable vegetation and change in pasture species composition of the grazing land (Abolinget *et al.*, 2008). Hiernaux *et al.* (2009) stated that shifting cultivation influence changes in grassland vegetation where by natural perennial grasses may be replaced by undesirable plants.

The seedlings characteristics of the soil seed bank indicated low grazing potential because of prevalence of many annual grasses, undesirable and unedible annual forbs, however, such a soil seed bank characteristic showed possibility of natural rehabilitation of this grazing land following enclosure and some restriction to grazing.

Conclusions and Recommendations

The results of this study shows that the reserved grazing area of Lubungo village under continuous grazing had high percentage ground cover of desirable pasture species compared to undesirables and bare ground patches during dry season. The bare ground patches had high soil seed bank densities which was mainly composed of annual grasses and forbs. Seeds of few perennial grasses and several undesirable and un-edible annual forbs were recorded in the grazing land soil seed bank taken in the dry season. The dry matter yield during the dry season was rather low due to high tree density and high tree canopy cover which could have affected the photosynthesis process, growth and dry matter production of the understory herbaceous vegetation during the previous wet season. From these results it can be

recommended that reserved grazing area under continuous grazing system should have a regular biotic and abiotic resources inventory so as to direct its improvement programmes such as bush clearing to reduce the tree density and canopy cover in order to allow pasture to access enough light for growth and increase pasture dry matter production. Few trees should however, be left during bush clearing so as to give resting places to the grazing animals in the afternoon.

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