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## OPTIMISING STOCKING RATES ON LIVESTOCK FARMS NEIGHBOURING WETLANDS FOR SUSTAINABLE PRODUCTIVITY AND ECOLOGICAL STABILITY

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### ABSTRACT

Uganda's wetlands, especially in south-western Uganda are increasingly being invaded by cattle herders, particularly during droughts. Such uncontrolled grazing is accelerating wetland degradation. The objective of this study was to assess seasonal forage availability on farms neighbouring Ekigaaga wetland in south-western Uganda, and to determine their optimum stocking for sustainable productivity and ecological stability. The grazed area on each side of the virgin wetland was taken as a block, giving two blocks. In each block, three square metre sampling plots were demarcated along a transect line cutting across farms adjacent to the wetland. Some of these plots were fenced and others were left open to grazing by livestock. Two months after setting up the study, vegetation samples were collected from the fenced and unfenced plots in each block once every month, for a period of six months. Livestock classes and numbers grazing on each block were established and standardised into Tropical Livestock Units (TLU); where one TLU is equivalent to a cow weighing 250 kg. During wet and dry seasons, *Cynodon dactylon* was the most abundant forage species in the unfenced plots in both blocks. Fencing increased the prevalence of *Chloris gayana* and *Themeda triandra* in block 2. *Sporobolus pyramidalis* was the most abundant weed in both blocks. Fenced and unfenced plots in block 1 had higher grazeable forage yields (488.05 and 399.97 kg ha<sup>-1</sup>, respectively) than block 2 (432.08 and 371.97 kg ha<sup>-1</sup>, respectively). The TLU that could be safely grazed on blocks 1 and 2 were 121 and 107, respectively compared to the TLU being grazed on blocks 1 (279) and 2 (381). Therefore, to sustain the productivity and ecological stability of these grazing areas, there is need to control weeds/thickets, improve forage resources by oversowing with quality forages, and to adjust livestock numbers to match with forage quantities available for grazing.

**Key Words:** Carrying capacity, grazeable forage, stocking rate

## RÉSUMÉ

Les marécages de l'Ouganda, en particulier dans le Sud-Ouest de l'Ouganda, sont de plus en plus envahies par les éleveurs de bétail, en particulier pendant les sécheresses. Ce pâturage incontrôlé accélère la dégradation des marécages. L'objectif de cette étude était d'évaluer la disponibilité saisonnière de fourrage dans les fermes voisines de marécage d'Ekigaaga dans le Sud-Ouest de l'Ouganda, et de déterminer leur chargement optimal pour une productivité durable et une stabilité écologique. La zone pâturée de chaque côté de marécage vierge a été prise comme un bloc, ce qui donne deux blocs. Dans chaque bloc, des parcelles d'échantillonnage de trois mètres carrés ont été délimitées le long d'une ligne de transect coupant les fermes adjacentes au marécage. Certaines de ces parcelles ont été clôturées et d'autres ont été laissées ouvertes au pâturage par le bétail. Deux mois après la mise en place de l'étude, des échantillons de végétation ont été prélevés sur les parcelles clôturées et non clôturées de chaque bloc une fois par mois, pendant une période de six mois. Les classes de bétail et le nombre de pâturages sur chaque bloc ont été établis et normalisés en unités de bétail tropical (UBT) ; où une UBT équivaut à une vache pesant 250 kg. Pendant les saisons humides et sèches, *Cynodon dactylon* était l'espèce fourragère la plus abondante dans les parcelles non clôturées des deux blocs. La clôture a augmenté la prévalence de *Chloris gayana* et de *Themeda triandra* dans le bloc 2. *Sporobolus pyramidalis* était la mauvaise herbe la plus abondante dans les deux blocs. Les parcelles clôturées et non clôturées du bloc 1 avaient des rendements fourragers plus élevés (488,05 et 399,97 kg ha<sup>-1</sup>, respectivement) que le bloc 2 (432,08 et 371,97 kg ha<sup>-1</sup>, respectivement). Les UBT qui pouvaient être broutées en toute sécurité sur les blocs 1 et 2 étaient de 121 et 107, respectivement par rapport aux UBT broutées sur les blocs 1 (279) et 2 (381). Par conséquent, pour maintenir la productivité et la stabilité écologique de ces zones de pâturage, il est nécessaire de contrôler les mauvaises herbes/fourrés, d'améliorer les ressources fourragères en sursemant avec des fourrages de qualité et d'ajuster le nombre de bétails en fonction des quantités de fourrage disponibles pour le pâturage.

*Mots Clés* : Capacité de charge, fourrage pâturable, taux de charge

## INTRODUCTION

In Uganda, wetlands cover approximately 26,308 Km<sup>2</sup>, which is about 10.9 percent of the country's total land area. These wetlands are vital in ecosystem functioning, as well as provision of socio-economic services, which include maintenance of water table, water storage and distribution in space and time, sediment trapping and water purification, and regulation of the micro-climate. They also provide socio-economic benefits to the neighbouring communities by providing water and pasture for livestock watering and grazing, among others (Kaggwa *et al.*, 2009; Turyahabwe *et al.*, 2013).

Crop and livestock production in areas adjacent to the wetlands is providing an opportunity to the neighbouring communities

to diversify food and income resources, and to contribute to improved human health and nutrition, and household food security. For the case of pastoralists and agro-pastoralists, wetlands provide water and forage for livestock, which in turn provide humans with the means to food security.

However, the wetlands have an ecological limit for sustainable utilisation. Uganda's wetlands have come under considerable pressure and are, thus on the brink of total degradation. By the year 2009, Uganda had lost about 11,268 Km<sup>2</sup> (30%) of its wetland area, down from 37,575 Km<sup>2</sup> in 1994 to about 26,308 Km<sup>2</sup> (WMD, 2009). The main cause is largely the insatiable desire of the neighbouring communities to obtain livelihoods from them, which is exacerbated by high annual human population growth rates

and increasing economic development (Kaggwa *et al.*, 2009).

The main activities resulting in wetlands loss and degradation include draining to convert them into farmland and residential areas, resource extraction and livestock grazing. Invasion by livestock farmers has increased environmental stress on the wetland areas, this compromising their ability to provide services. Livestock farmers adjacent to the wetlands are gradually encroaching on them, especially during drought as they search for fresh forage and water for livestock. Wetland encroachment by grazers is projected to increase in the face of climate change and reduced upland per *capita* as human and livestock populations grow.

A living example is that of the Ekigaaga wetland in Isingiro district which is at the risk of being degraded due to increased search for pastures and water for livestock. During drought, pastoralists invade the edges of this wetland for grazing and watering animals since the wetland vegetation remains hydrated. Currently, this is done without following any appropriate guidelines of wetland management and utilisation. Continued unguided and unsustainable wetland practices are risking the resource to degradation, which is likely to result in reduced productivity of livestock, and consequently affect the livelihoods of the dependent communities.

The objective of this study was to assess the seasonal forage availability in the grazed areas (on farms) neighbouring Ekigaaga wetland in Isingiro district, and then determine their optimum stocking for sustainable long-term productivity and ecological stability.

## MATERIALS AND METHODS

**Study site.** The study was conducted on smallholder livestock farms neighbouring Ekigaaga wetland in Kabingo sub-county, Isingiro district. The rainfall pattern of the area is bimodal, with the first rains falling in late March to early June; while second rains are

experienced from September to early December. The area experiences severe dry periods from late June to August, and late December to early March. During these periods, livestock spend most of the time grazing the areas close to the wetland due to presence of fresh vegetation.

The wetland has two arms one draining into Lake Nakivale, and the other draining into Lake Mbuho. The wetland is utilised by the neighbouring communities as source of water for both domestic and livestock. These areas are heavily grazed, especially during drought due to lack of moisture in upland areas.

**Vegetation composition in the grazing areas.** The study followed a completely randomised design (CRD) with two treatments, comprising of plots which were fenced off to restrict grazing by livestock, and grazed plots which were not fenced to allow grazing to continue as before the study. Assessment of the vegetation composition and forage dry matter (DM) yields started with establishing boundaries of the area neighbouring the wetland that was grazed by livestock. The wetland edge was determined following the wetland delineation procedures stipulated in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory, 1987). The grazed area on each side of the virgin part of the wetland was taken as one block, thus forming two blocks numbered 1 (one) and 2 (two). Block 1 with an area of 57.5 hectares is covered by farms owned by five farmers; while block 2 covering 54.5 hectares belongs to four farmers.

For each block, sampling points were marked along the wetland edge at every 100 metre distance along the transect line across the farms adjacent to the wetland. The length of transect was 2000 metres for block 1 and 1850 metres for block 2; and the total numbers of sampling points were 20 for block 1 and 12 for block 2. At each sampling point, a three square metre plot was demarcated. The first plot from one end of each block, and the other

plots that were marked with odd numbers were fenced off to give the vegetation therein a chance to recover from the grazing pressure. This was done to allow plant species that are preferred by livestock and frequently defoliated, to recover and be identified. The plots that were marked with even numbers were not fenced, and served as sites for sample collection in the unfenced area.

Sampling the vegetation was done once every month beginning with October 2012 till early March 2013, covering the wet season (October - December) and dry season (January - March). Vegetation samples were collected from each of the fenced and unfenced plots using a one metre square metallic quadrat. The quadrat was thrown randomly within the area of each unfenced plot to get the sampling point. This was followed by determination of vegetation height within the quadrat using a tape measure, vegetation composition by identifying the species in the quadrat, and the species coverage by estimating the percentage area covered by each species, as well as bare ground (Mitchell *et al.*, 1986; Sollenberger *et al.*, 2005). The vegetation within the quadrat was then cut using a sickle, placed in a polythene bag, weighed to determine fresh weight of the biomass cut at ground level and then labelled. The same sampling procedure was followed to collect samples from fenced plots for areas not previously sampled.

**Forage available in the grazing areas.** All the plant samples collected were oven-dried at 60 °C for 72 hours for dry weight determination, which were subsequently converted to kg DM per hectare in each block. Then the forage quantities available for grazing without causing degradation (grazeable biomass) in the fenced and unfenced plots during wet and dry seasons were computed by multiplying the available biomass per hectare with the correction factors according to Le Houérou and Hoste (1977).

Application of first correction factor (grazing efficiency) reduced the biomass DM yields of vegetation in blocks 1 and 2 by 27 and 15%, respectively to cater for areas not accessible by grazing animals due to shrubs and thickets (Le Houérou and Hoste, 1977). The resultant quantities of biomass DM yields in block 1 were then reduced by 48 and 49 %, while those in block 2 were reduced by 62 and 57%, respectively, to cater for weeds in the unfenced and fenced plots. Forage losses due to senescence, trampling and fouling during grazing were considered negligible (Le Houérou and Hoste, 1977). The biomass DM yields obtained for the fenced and unfenced plots, in each block, were further reduced by 50 % to cater for the quantities of forage that should remain in the grazing areas to enable forage plants recover from grazing (proper use factor) (Le Houérou and Hoste, 1977).

**Estimation of optimum stocking rates.** The livestock classes and numbers that were grazed on each block were established by interviewing livestock farmers bordering the wetland. Through interviews, all livestock in the area were enumerated and documented, then standardised into tropical livestock units (TLU) (Table 1). One TLU was taken to be equivalent to one cattle with body weight of 250 kg (Chesterton, 2006).

Seasonal optimum stocking rate (carrying capacity) of each block was determined by dividing the corrected seasonal primary production (grazeable biomass) by the average monthly feed requirements of a tropical livestock unit (De Leeuw and Tothill, 1990). The daily DM requirement of a TLU is equivalent to 2.5% of its body weight (Mugerwa, 2001). Thus, the monthly forage requirement of a TLU =  $2.5/100 \times 250 \times 30$  days = 190 kg/TLU/month. Carrying capacity was then expressed as stocking rate in tropical livestock units per hectare (TLU ha<sup>-1</sup>) (De Leeuw and Tothill, 1990).

TABLE 1. Population sizes of livestock species grazed on farms adjacent to Ekigaaga wetland in south-western Uganda

Livestock classes	TLU conversion factor	Block 1		Block 2	
		Livestock numbers	Equivalent TLU	Livestock numbers	Equivalent TLU
Mature bull (>2 years)	0.9	10	9.0	24	21.6
Young bull (1½ – 2 years)	0.6	28	16.8	58	34.8
Cow and calf pair	0.9	62	55.8	76	68.4
Cow, non-lactating	1.0	41	41.0	53	53.0
Heifer, non-lactating (>2 yrs)	0.7	37	25.9	57	39.9
Yearlings (15 – 24 months)	0.6	117	70.2	130	78.0
Calves (6 – 12 months)	0.6	85	51.0	116	69.6
Sheep	0.1	69	6.9	111	11.1
Goats	0.1	23	2.3	48	4.8
Total		472	279	673	381

**Data analysis.** Data collected were analysed using analysis of variance (ANOVA) procedure for a completely randomised design (CRD), using the Statistical Analysis Systems (SAS, 2005). Mean comparisons were made using the Least Significant Difference (LSD) at 5% level of significance.

## RESULTS

**Vegetation composition.** During the wet season, Bermuda grass [*Cynodon dactylon* (L.) Pers] was the most abundant grass species in the unfenced areas of both blocks, followed by Signal grass (*Brachiaria decumbens* Stapf) (Fig. 1a). Fencing significantly ( $P < 0.05$ ) increased the prevalence of Rhodes grass (*Chloris gayana* Kunth) in both blocks, and Red oat grass (*Themeda triandra* Forssk) and Indigofera (*Indigofera* species) in block 2 (Fig. 1a). The forage legume content was very low in both blocks, in spite of its significant increase in the fenced areas.

As for weeds, Sporobolus (*Sporobolus pyramidalis*) was the most abundant in both blocks (Fig. 1b) in south-western Uganda; while the abundance of Kyllinga (*Kyllinga*

*erecta* and *K. odorata*) and *Dyschoriste* [*Dyschoriste nagchana* (Nees) Bennet] was higher ( $P < 0.05$ ) in block 2 than in block 1.

During the dry season, the abundance of forage and weed species changed. *Cynodon dactylon* was the most abundant forage species in block 1, but reduced significantly in block 2 (Fig. 2a). Fencing significantly ( $P < 0.05$ ) increased the abundance of *Brachiaria* species in block 1, but significantly reduced its abundance in block 2. The increase in abundance of *Chloris gayana* and *Indigofera* species was significant in both blocks, while the increase in *Themeda triandra* was only significant in block 2 (Fig. 2a).

The abundance of Sporobolus significantly increased in both blocks during the dry season, while that of *Dyschoriste*, a herbaceous broad leaved weed, and *Kyllinga* species was significantly reduced (Fig. 2b). An increase in the abundance of Sporobolus is an indication of tolerance of this species to drought. But the foliage of *Digitaria* and *Cyperus* species completely dried up.

**Vegetation heights.** The seasonal variation in vegetation heights for the fenced and

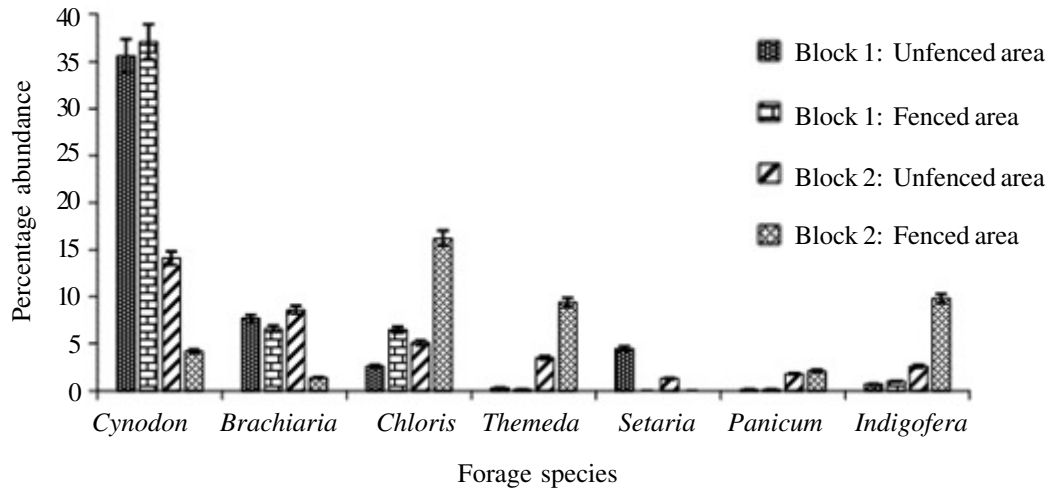


Figure 1a. Abundance of forage species in the grazing areas neighbouring Ekigaaga wetland in south-western Uganda during the wet season.

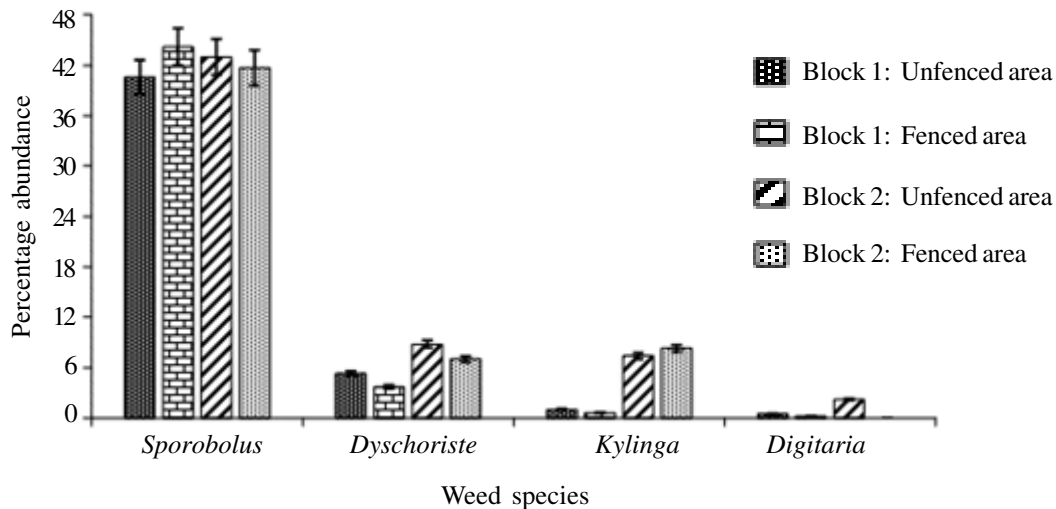


Figure 1b. Abundance of weed species in the grazing areas neighbouring Ekigaaga wetland in south-western Uganda during the wet season.

unfenced areas in both blocks are presented in Table 2. During the wet season, there were no significant ( $P>0.05$ ) differences in the vegetation heights of fenced and unfenced areas. However, during the dry season, the vegetation heights of fenced areas were higher ( $P<0.05$ ) than those of unfenced areas (Table 2). Also, the vegetation heights of fenced areas during the dry season were higher ( $P<0.05$ )

than those of the wet season. But for the unfenced areas, the vegetation heights for the two seasons did not differ significantly (Table 2).

**Forage dry matter yields.** The total and corrected forage DM yields available for safe grazing (grazeable forage biomass) in each block for both seasons was determined (Table



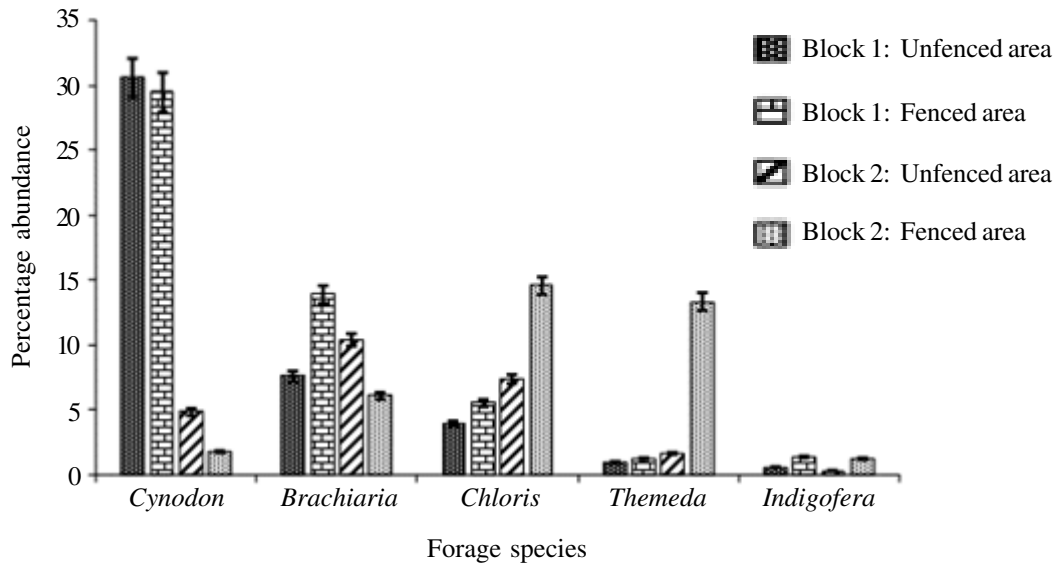


Figure 2a. Abundance of forage species in the grazing areas neighbouring Ekigaaga wetland in south-western Uganda during the dry season.

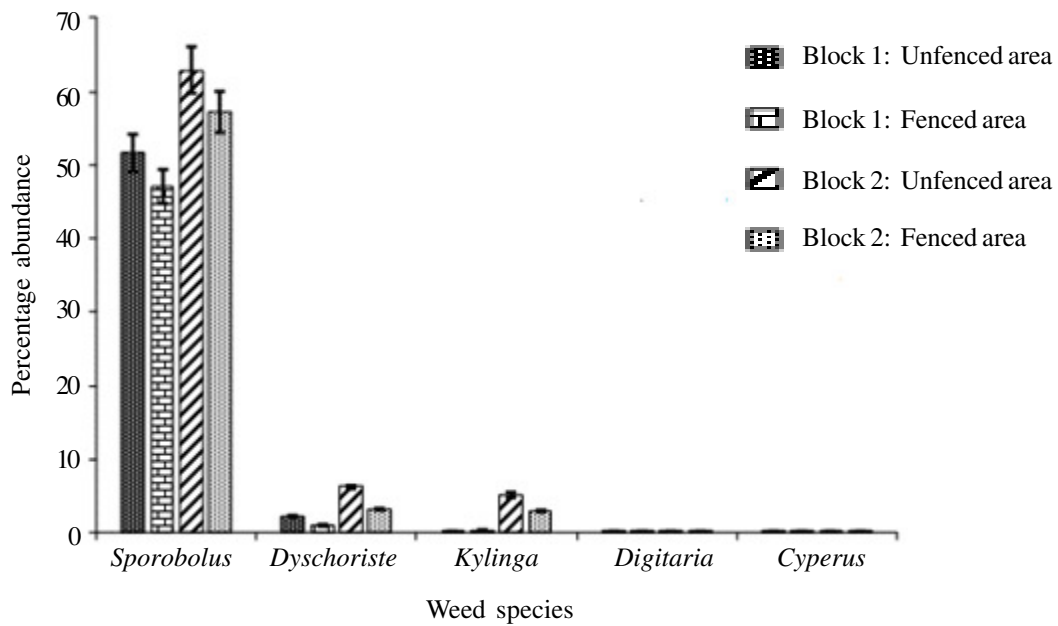


Figure 2b. Abundance of weed species in the grazing areas neighbouring Ekigaaga wetland in south-western Uganda during the dry season.

3). In block 1, the total and grazeable forage biomasses in the fenced areas was significantly greater than that in the unfenced areas. For block 2, the total forage DM yields differed significantly between the fenced and unfenced areas, but the grazeable forage biomasses was not significantly different (Table 3).

**Seasonal optimum stocking rates (carrying capacities).** The seasonal quantities of forage (kg DM ha<sup>-1</sup>) available for grazing, without causing degradation (grazeable forage biomass) in each block during wet and dry

seasons, and the corresponding carrying capacities (TLU ha<sup>-1</sup>) are given in Figures 3a and 3b. For block 1, the forage yield during the wet season was greater ( $P < 0.05$ ) than that during the dry season. However, for block 2 the forage yields during the wet and dry seasons were not significantly different. Also, the mean forage yield for block 1 was not different from that of block 2 (Fig. 3a).

For block 1, the seasonal carrying capacity during the wet season was higher ( $P < 0.05$ ) than that during the dry season (Fig. 3b). However, for block 2 the carrying capacities

TABLE 2. Effect of seasonal variation and fencing on heights of vegetation in Ekigaaga wetland area blocks in south-western Uganda

Treatment	Season		P. value	LSD <sub>(0.05)</sub>
	Wet	Dry		
Fenced area	11.26	21.35	<0.0001	2.34
Unfenced area	10.49	10.68	0.854	1.97(ns)
P. value	0.428	<0.0001		
LSD <sub>(0.05)</sub>	1.91(ns)	2.39		

<sup>ab</sup>Means within the same column and same row having different superscripts are significantly ( $P < 0.05$ ) different; LSD = Least Significant Difference; ns = Not significant

TABLE 3. Forage dry matter yields available in fenced and unfenced areas in Ekigaaga wetland area for both seasons in south-western Uganda

Treatment	Block 1		Block 2	
	Total forage DM yields (kg ha <sup>-1</sup> )	Grazeable forage DM available (kg ha <sup>-1</sup> )	Total forage DM yields (kg ha <sup>-1</sup> )	Grazeable forage DM available (kg ha <sup>-1</sup> )
Fenced area	2596.50 <sup>a</sup>	488.05 <sup>a</sup>	1792.20 <sup>a</sup>	432.08
Unfenced area	2108.50 <sup>b</sup>	399.97 <sup>b</sup>	1409.30 <sup>b</sup>	371.97
Mean	2352.50	444.01	1600.75	402.03
P. value	0.0005	0.0009	0.0022	0.0525
LSD <sub>(0.05)</sub>	271	51	240	61 (ns)

<sup>ab</sup>Means within the same column having different superscripts are significantly ( $P < 0.05$ ) different; LSD = Least Significant Difference



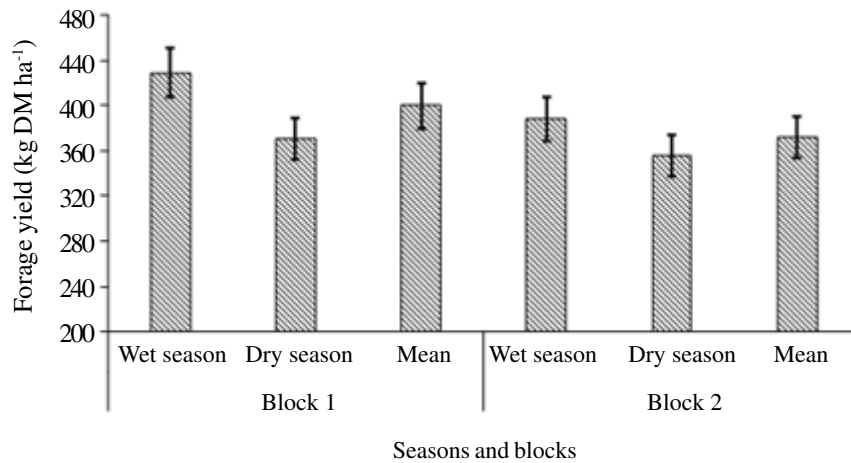


Figure 3a. Seasonal forage quantities available for grazing in the grazing areas neighbouring Ekigaaga wetland in south-western Uganda.

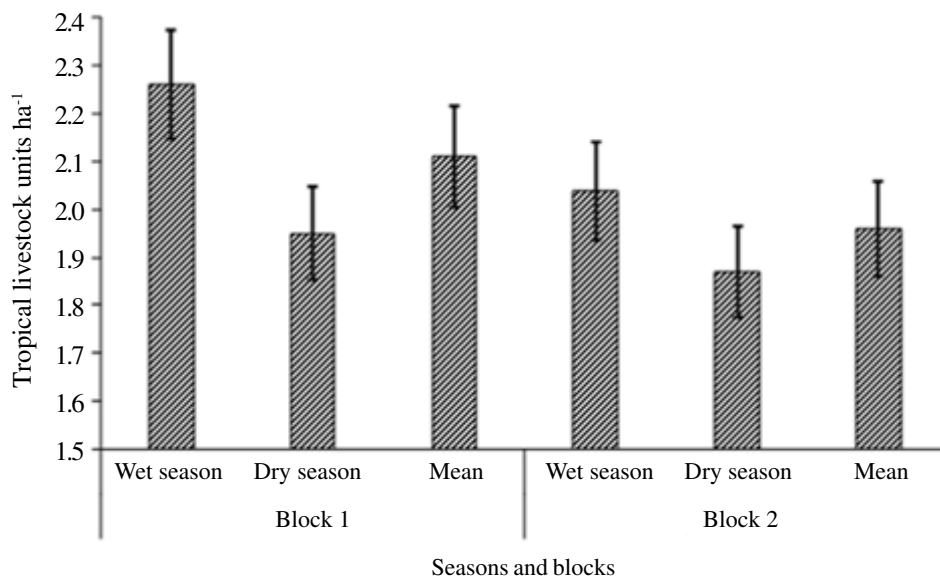


Figure 3b. Seasonal carrying capacity (TLU ha<sup>-1</sup>) (optimum stocking rate) for the grazing areas neighbouring Ekigaaga wetland in south-western Uganda.

during the wet and dry seasons were not significantly different. Also, the mean seasonal carrying capacity for block 1 (2.11) was not different from that of block 2 (1.96). The tropical livestock units that can be sustainably grazed on blocks 1 and 2 without causing degradation (optimum stocking rates) were 121 (57.5 hectares x 2.11) and 107 (54.5 hectares x 1.96), respectively. However, the

livestock units that were being grazed in block 1 (279) and block 2 (381) were far higher than the numbers each block could sustainably support (Table 1).

## DISCUSSION

**Vegetation composition.** Vegetation in the grazing areas adjacent to the Ekigaaga wetland

area in south-western Uganda is grassland with a few shrubs and thickets scattered all over. About 27 and 15% area of blocks 1 and 2, respectively were not accessible to livestock for grazing due to presence of shrubs and thickets. Grazed areas close to the portion of the wetland that is still virgin are being overrun by water-loving invasive plants, which farmers claimed to have overtaken a significant part of the area they used to graze a few years ago. Shrubs and trees affect growth of forage species around them by altering the availability of resources (Jackson and Ash, 2001). For instance, radiation and precipitation inputs may be reduced due to interception by tree/shrub canopies, while allelopathic effects may suppress herbaceous layer growth.

*Cynodon* was the most abundant grass species in the grazing areas (Figs. 2a and 2b), which was attributed to its fast-growth and resilience as it resists animal trampling, it recovers quickly when grazed or burnt and can tolerate a few weeks of flooding (Cook *et al.*, 2005). It is also highly aggressive and out competes most other pasture species; while invading other habitats. It is very drought tolerant by virtue of rhizome survival through drought-induced dormancy.

Signal grass, which was second in abundance in the unfenced areas of both blocks during the wet season, is a tropical warm-season forage that is very persistent and remains green during dry periods (FAO, 2016; Heuzé *et al.*, 2017). It grows on a wide range of soils, and is adapted to soils of low fertility and tolerates short-term flooding, but not prolonged water-logging. It can grow in many environments ranging from swampy to shady forest, but grows best in savanna areas (Torres González and Morton, 2005).

In light of the present study, the shrubs and thickets that are occupying about 27 and 15% land area of blocks 1 and 2, respectively and hence preventing accessibility to livestock for grazing should be cleared. Also, the water-loving, invasive plants that are overrunning grazed areas close to the virgin wetland need

to be controlled. Removal of shrubs and thickets, as well as controlling the invasive water-loving plants, will give the opportunity to the resilient and adapted forages, particularly *Cynodon* and Signal grass, a chance to spread further in these areas, which will in turn increase the quantities of forage available for grazing.

The increase in abundance of *Chloris gayana* and *Themeda triandra* in the fenced areas, suggests that they are the species being severely affected by grazing (Tothill, 1992; SANBI, 2011). Their increase in abundance is evidence that they declined due to overgrazing. The results also showed that the abundance of *Chloris* and *Themeda* in both blocks was not affected by the dry season. This is a further indication that they are well adapted to the climatic conditions of the area. Cook *et al.* (2005) and Moore (2006) reported that *Chloris* thrives under annual temperatures ranging from 16.5 to 30 °C, and optimal annual rainfall of about 600-750 mm; though it can grow within the range from about 500 to 1,500 mm. Due to its deep roots, it can withstand long dry periods (over six months) up to 15 days of flooding (Cook *et al.*, 2005; FAO, 2014). *Themeda* grows in warm-wet or cool-dry climates with moderate to high rainfall (500-800 mm to 6250 mm) (SANBI, 2011), and has some drought tolerance, though it is sensitive to flooding (FAO, 2011; Heuzé *et al.*, 2015). The foliage of *Panicum* and *Setaria* species completely disappeared from the vegetation, indicating that they are susceptible to drought. Therefore, to increase the amount of forage for grazing especially during drought, *Chloris* and *Themeda* which showed resistance to drought can be oversown in the grazing areas in both blocks.

The low content of forage legumes could be due to shading by grasses. Most grasses are erect plants which grow upwards, while legumes crawl on the ground. When grasses and legumes grow together in the same area, grasses end up cutting off light from the

legumes leading to their reduced growth rate (Dodd *et al.*, 2005).

The increase in abundance of *Indigofera* species in block 2 is an indication that its growth is severely hampered by grazing. It has been reported that generally, legume content in Uganda's natural pastures is very low, and that both the digestibility and protein content in several locations fall short of the requirements for highly productive animals, especially dairy cattle (Mugerwa, 2001). *Indigofera* crawls on the ground and this growth form could be an adaptation and response to high grazing pressure (Cornelissen *et al.*, 2003). Studies on plant trait response to grazing have shown a relationship between the direction of response to grazing and habit. Erect plants have a tendency of responding negatively to grazing, while prostrate plants tend to respond positively (Diaz *et al.*, 2007).

The dominance of *Sporobolus* in the fenced and unfenced plots of both blocks and in both seasons was a sign of degradation of wetland vegetation as a result of overgrazing (Figs. 1b and 2b). Weeds in pastures increase in abundance due to faulty grazing management. Indiscriminate stocking rates and uncontrolled grazing patterns are detrimental to the natural resource base as they lead to the decline in productivity and plant biodiversity. Livingstone (1991) noted that changes in the vegetation are usually indicated by a change in plant cover, biomass and biodiversity. Changes in vegetation can also be indicated by a change in the proportional occurrence of unpalatable plant species and weeds, together with shifts between vegetation states (Livingstone, 1991). Grazing areas which were close to the watering points were the most affected as they were continuously grazed by herds whenever they came for water.

**Vegetation heights.** Fencing protected the vegetation from disturbance by grazing animals, hence leading to increases in vegetation heights in both blocks (Table 2). Plant height is the shortest distance between

the upper boundary of main photosynthetic tissue of a plant and ground level (Pérez-Harguindeguy *et al.*, 2013). It is associated with competitive vigour, whole plant fecundity, and with time intervals plant species take to grow between disturbances like grazing (Kleyer, 1999; Cornelissen *et al.*, 2003). When pastures are grazed frequently, forage plants are denied chance to grow and generate on sufficient foliage, and this limits their growth heights. Only those species which are aggressive in growth survive under such conditions of grazing. Pastures should be given ample rest every after each round of grazing, so that the forage plants can restock their nutrient reserves in their storage structures (roots and stems) for later use, and also put on sufficient biomass for the next round of grazing. When this rest period is long enough, some forage plants can produce seeds which are later dispersed in the pastures, hence improving the pasture stand.

**Forage dry matter yields and stocking rates.** The total forage yields and the quantities available for grazing without causing degradation (grazeable forage DM yields/biomass in block 1 were higher than those in block 2 (Table 3). This is an indication of overgrazing in block 2, which is confirmed by the higher stocking rates on the block (Table 1). Also, the high stocking rates on block 2 could be responsible for the high populations of *Sporobolus*, *Dyschoriste* and *Kyllinga* weeds. As the palatable forage species are continuously defoliated, their growth rates are reduced, hence giving chance to the weed species to flourish.

The mean seasonal carrying capacities for both blocks were similar, and thus the TLU grazed on both blocks were also not different (Figs. 3a and 3b). However, the stocking rates were quite high compared to the TLU that could be sustainably grazed on each of the blocks. This was the sign of overstocking, which would result in low productivity of both grazing areas and the livestock grazed on them.

In order to improve and sustain the productivity of the grazed areas, it may be inevitable to adjust the stocking rates. Stocking rate is one of the most powerful management tools available to livestock farmers, allowing them to match the amount of forage available for grazing with the livestock numbers. One of the steps that can be taken to reduce livestock numbers, and so achieve optimum stocking is to cull off some of the non-lactating cows and bulls (Table 1). Culling off less productive animals will make more forage available to the productive animals, which will in turn result in efficient use of resources (Methewman and Perry, 1985).

### CONCLUSION

During the wet season, fencing significantly ( $P < 0.05$ ) increased the prevalence of *Chloris gayana* in both blocks, and that of *Themeda triandra* and *Indigofera* in block 2. *Cynodon dactylon* was the most abundant species in the unfenced areas of both blocks, followed by *Brachiaria decumbens*. But during the dry season, *Brachiaria decumbens*, *Chloris gayana* and *Indigofera* became abundant in block 1, while *Themeda triandra*, *Chloris gayana* and *Indigofera* were abundant in block 2. *Cynodon* was still the most abundant species in the unfenced area of block 1, but reduced significantly in block 2. For the case of weeds, *Sporobolus pyramidalis* was the most abundant weed in both blocks, while *Kyllinga* and *Dyschoriste* were abundant in block 2. The previously degraded pastures recovered after fencing off, and this was indicated by the significant increases in the vegetation heights and forage dry matter yields in the fenced areas.

The stocking rates in blocks 1 and 2 neighbouring Ekigaaga wetland were 279 and 381 TLU respectively, and were far much higher than the livestock numbers that could be sustainably grazed on each of the blocks. But the study revealed the optimum stocking rates as 121 and 107 TLU for blocks 1 and 2,

respectively. This indicated that these areas were being overgrazed, thus compromising their capacities to sustainably provide ecological services.

Thus the results revealed a change in species composition and abundance when seasons change, and also as a result of grazing pressure. Fencing made it possible to identify forage species that are badly affected by overgrazing due to high stocking rates. In order to improve and sustain livestock grazing on farms close to Ekigaaga wetland, there is need to control weeds and thickets that are preventing accessibility to some grazing areas and competing for growth resources with forages. Forage resources can also be improved by oversowing better quality forage species into the grazing areas, such as *Chloris* and *Themeda* which showed potential of regeneration under good grazing management. Also, adjusting the stocking rates so as to match livestock numbers with the available forage resources can have a positive impact on the productivity of the grazing areas, and consequently the animals grazing them.

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