International Journal of Development and Sustainability
Online ISSN: 2168-8662 – www.isdsnet.com/ijds
Volume 2 Number 2 (2013): Pages 1075-1083
ISDS Article ID: IJDS13042505

ISDS JOURNALS

Special Issue: Development and Sustainability in Africa – Part 2

Unpalatable and wiry grasses are the dominant grass species in semi-arid communal rangelands in Zimbabwe

J. Gusha [1*], P.H. Mugabe [2]

[1] Department of Para-clinical Veterinary Studies, Faculty of Veterinary Studies University of Zimbabwe
[2] Department of Animal science, Faculty of Agriculture, University of Zimbabwe

Abstract

The study hypothesized that farming system influences species richness, species diversity, bush encroachment and biomass yield. Three farming systems namely communal, small scale commercial (SSC) and Large scale commercial (LSC) each replicated three times were evaluated with a botanical sampling method. Using 100cm x 100cm quadrates the following variables were measured; grass species, frequency, height and biomass. The data was analysed using SPSS and results showed that species richness and species diversity was lower in communal farming system than in SSC and LSC. The dominant species are different with more wiry grasses dominating in communal than in SSC and LSC. More rangelands invasive and weeds were found in the communal farming system than in SSC and LSC. High stocking density and poor grazing strategies were attributed to these results. There is need to have a monitoring strategy for early detection of deviation as some species may be lost

Keywords: Floristic compositional change, Stocking density, Wiry grasses, Unpalatable and invasive species

Cite this paper as: Gusha, J. and Mugabe, P.H. (2013), "Unpalatable and wiry grasses are the dominant grass species in semi-arid savanna rangelands in Zimbabwe", *International Journal of Development and Sustainability,* Vol. 2 No. 2, pp. 1075-1083.

* Corresponding author. *E-mail address:* jtgusha@gmail.com

1. Introduction

Livestock are recognized as essential assets for livelihoods and key to moving out of poverty (Delgado et al., 1999; Rosegrant et al., 2001; Mavedzenge et al., 2005). In Zimbabwe's communal, old resettlement and small scale commercial farming system livestock is the source of draught power and capital for the procurement of inputs such as seeds and fertilizers. Rukuni (1994) reported that the average maize yield per hectare was positively correlated with the size of livestock herd and the consequent manure use. In order for livestock to continue playing this role forage should be always be made available. Mavedzenge et al, (2005) reported the fodder is the major constraint for livestock production. Rangelands are the main and cheap source of fodder for livestock in all farming systems in semi arid regions.

Rangeland degradation is reported to be around 73% in dry lands areas (Bai et al., 2003). Twenty percent of the damage to world's pasture and rangelands has been attributed to overgrazing (FAO, 2005). Rangeland degradation is a threat to human life especially in dry land savanna where survival is mainly by direct and indirect livestock products. Rangeland degradation causes lots of changes in grass species richness, vegetation cover and loss of habitats for other fauna species (Beeskov et al., 1995). Quantification of losses that are taking place in these rangelands need to be done in order to clearly understand the management and mitigation measures to put in place. An understanding of the available resources for livestock production is vital for future development of livestock industry. It is unfortunate that control treatments are difficult to get as few botanical survey where done in some of these areas before. This study will build the foundation for continued monitoring into the botanical changes that are happening in communal, small scale commercial and large scale commercial. It will also lay the foundation of future management of rangeland in different farming systems. In this study, we sampled and identified current species in different farming systems, grass species density, grass heights and biomass yield (2) analyse and establish dominant grass species, (3) investigate the population of invaders and colonisers and the population of trees and (4) recommend rangelands utilization interventions to prevent extinction of some species as well as to improve livelihood in savanna rangelands.

2. Material and method

2.1. Study site

The study was carried out in Masvingo District in three different farming systems. The communal area is located in Zimuto Communal lands. Three villages were randomly selected in this communal area. The rangelands which were being used for grazing were sampled in the study. Small scale commercial (SSC) is located in Mushagashe small scale commercial area in Masvingo District. The farming system is divided into three areas namely Mushagashe south, Mushagashe east and Mushagashe west. A farm in each location was selected randomly to represent the SSC farming system. The large scale commercial (LSC) farms a located in Summerton areas of Masvingo. Three farms were randomly selected out of a list of commercial farmers in the area. These farms were used as representative farms of commercial farming system in this study.

The study sites border onto each other with SSC in between them, their land use, management and disturbance regime differ. The communal grazing is a common property with no grazing management in place. In the SSC and LSC, the farming system has similar tenure, but with different management systems, carrying capacity and disturbance regimes.

2.2. Grass species sampling and measurements

The perimeter of each farming unit was walked around with a GPS to obtain the total area of the unit. After walking around these farms, the information was transfer to Google earth for digitalization and stratification. Top land rangelands were used and vlei and arable land was not included in this study. After digitalizing the sampling points were generated using integrated land and water information system ILWIS 3.3 academic. Five sampling points out of ten generated sampling points were randomly selected and fed in the GPS which was taken to the field for sampling.

Research on the grass species composition of the three land use zones represented in the study area was carried out using methods of plant ecology Quadrant (100 cm x 100 cm). Sampling was carried out in 20m x 20m square transects randomly located within top land grazing areas which were being used as rangelands. At each sampling point, the coordinates point was the centre where a quadrate (100cm x 100cm) was sampled. Four other quadrates were 10 meters away from the center point at 90^{o}, 180^{o}, 270^{o} and 360^{o} using a compass. A total of five quadrates per transect were sampled for grass species, species count, species height and each species biomass. Each species was harvested and weighed and store in a khaki pockets pending chemical composition analysis. Species identification was done at field and verified with the National herbarium of Zimbabwe after taking samples. Fresh biomass was cut at 5 cm above the ground and measured in the field using a digital scale. Dry matter weights were obtained by weighing replicate samples of 100g and dry in oven at 60^{o}C overnight in khaki pockets. *Helichrysum kraussii* species, trees, and shrubs were counted at each sampling points after measuring transect of 20 m x 20 m size and a total of three transect per farm were obtained.

2.3. Statistical analysis

Data was analysed using SPSS. A Kruskal-wallis equal of populations rank tests were done for all the parameter and pair wise correlation tests were done to determine grass species population variation with land use.

3. Results

3.1. Grass species richness

Grass species richness was significantly different among the three farming systems as shown on Table 1 and Appendix. Communal farming area has the least percentage of species of 27.8%, followed by small scale commercial (SSC) 33.8%, and large scale commercial (LSC) 38.4%. *Digitaria pentzii* was the dominant species in all the farming systems with 10.7%, 14.1, and 9.8% in communal, SSC and LSC respectively. However, it was noted that in communal area *Digitaria pentzii* had insignificant biomass and the average height was 11cm which was difficult to harvest. *Heteropogon contortus* was first in the ranking in LSC (17.1%) and tenth in SCC (4.1%) and not present in the communal top land rangelands. There was a significantly higher population of invasive species in the communal farming system compared with other farming system. *Helichrysum krausii* was observed as dominant species in communal area ranked second but not among the first ten species in other farming systems. *Richardia brasiliensis, Cyperus angolensis* and *Melinis repen* represented a bigger proportion in communal rangelands than in other farming systems. *Hyparrhenia filipendula* was observed and identified as dominant species in all farming systems being highest in SSC (8.8%), than in communal (5%) and LSC (4.7%). *Pogonarthria squarosa* species was well represented in all the farming systems, being third, fifth and tenth in SSC (8.8%), LSC (7.3%) and communal (3%) respectively. *Pogonarthria squarosa* was also third in the overall ranking representing 7.2% contribution to species population in all farming systems. The LSC farming area had highest number of species with above average forage value such as *Heteropogon contortus* (17.1%), *Digitaria pentzii* (9.8%), *Urochloa mosambicensis* (7.8%), *Eragrostis superba* (6.7%), *Panicum maximum* (3.6%) and *Brachiaria brizantha* (2.6%).

Table 1. Effects of land use Helichrysum kraussii, shrubs, tree, grass species population, grass height and biomass yield

Item	Communal	SSC	LSC	Sig	Grand mean	Standard error
H kraussii /400m^2	71^a	32^b	0.44^c	***	34.8	28.5
Trees / 400m^2	4.44^b	11.2^a	13.2^a	***	9.63	5.75
Shrub/ 400m^2	5.4^a	1.88^b	4.22^{ab}	***	3.85	3.70
Grass species %	27.8^b	33.8^{ab}	38.4^a	***	32.8	3.7
Grass height(cm)	26.4^b	55.8^a	46.4^a	***	42.9	17.5
Biomass yield/5m$^{2/}$	96.2^b	320^a	234.6^a	***	217	188

^{abc} superscripts in same row indicate significant difference between treatments at ($p < 0.05$)

Table 2. The proportion of different dominant species in rangelands according to farming system

Communal		Small Scale Commercial		Large Scale Commercial		Combined	
Species	%	Species	%	Species	%	Species	%
D pentzii	10.7	*D pentzii*	14.1	*H contortus*	17.1	*D pentzii*	11.5
H krausii	10.7	*H filipendula*	8.8	*D pentzii*	9.8	*H contortus*	8.7
E enamoena	9.3	*P squarosa*	8.8	*S pallidifusca*	9.8	*P squarosa*	7.2
C angolensis	7.1	*S jeffreysii*	7.1	*U mosambicensis*	7.8	*H filipendula*	6.2
A barbicollis	5.7	*E trichophora*	6.5	*P squarosa*	7.3	*A barbicollis*	5.4
C dactylon	5.7	*E enamoena*	5.9	*A barbicollis*	7.3	*S pallidifusca*	4.8
E plana	5	*M repens*	5.9	*E superba*	6.7	*E trichophora*	4.8
H filipendula	5	*M kuntii*	4.7	*E trichophora*	5.7	*E enamoena*	4.8
P pattens	5	*E gummiflua*	4.7	*H filipendula*	4.7	*M repens*	4.6
P squarosa	5	*H contortus*	4.1	*M repens*	4.1	*S jeffreysii*	4.4
S jeffreysii	4.3	*E plana*	3.5	*P maximum*	36	*H kraussii*	3.4
M repens	3.6	*P pattens*	3,5	*B brizantha*	2.6	*U mosambicensis*	3

3.2. Plant height and biomass yield

Grass species from SSC farming area were significantly higher ($P<0.05$) than those from LSC and communal farming system. The mean height of grasses were 26 cm, 46 cm and 55 cm in communal, LSC and in SSC respectively. Grass height was not significantly different between LSC and SSC. However, the of grass species in LSC and SSC were significantly higher than their counterpart from communal farming areas. Plant biomass yield was significantly different ($P<0.05$) between farming systems. The average yields per (5 x1m^2) quadrates were 96, 234 and 320 grams in communal, LSC and SSC respectively. The biomass yield in SSC was not significantly higher than in LSC but both SSC and LSC had significantly higher yield than the harvests from communal farming system.

3.3. Effects of land use on *Helichrysum kraussii*, tree population, shrubs, plant height and biomass yield

The density of *Helichrysum kraussii* was significantly higher in communal area than in other farming zones. *Helichrysum kraussii* population was higher in communal (71 plant per 20m x 20m transect) than in SSC (32) which was also higher than 0.44 in LSC farming area. The opposite of the above scenario was observed on tree densities per same size transect. The density of trees in LSC (13.2 trees per transect) and SSC (11.2) was not significantly different but were different from what was observed in communal area (4.4). The numbers of tree shrubs were significantly higher in communal (5.4) which was not significantly different from LSC (4.2) but significantly different from SSC (2.7). There was a significant ($P<0.001$) negative correlation between *Helichrysum kraussii* population and tree population. *Helichrysum kraussii* population had no significant different positive with shrub density. It was also observed that grass species, grass height and biomass were negatively affected by the increase in *Helichrysum kraussii* and shrub density.

4. Discussion of results

The results indicate that species diversity has changed in communal more than in SSC and LSC in the same ecological zones. This could be a result of high stocking rates (Mavedzenge et al., 2005) and improper rangelands management (Neely and Butterfield, 2004). The stocking rate are reported to be higher (between 0.3 to 0.5 livestock units per hectare) than the recommended 0.1 to 0.14 livestock units per hectare in drier and wetter regions respectively (Mavedzenge et al., 2005). High stocking rates increases the grazing intensity and pressure on certain palatable species in communal areas. The change could spell disaster to rural farmers who heavily rely on cattle for draught power and manure. The change could result in deteriorating capacity for optimum herbage production. The reduction in herbage production affects the carrying capacity hence the output per unit area. More grazing land will be required to sustain the number of animal in the communal yet land is fixed. The proportion of wire grasses such *Aristda* species and *Pogonarthria squarosa* and unpalatable *Eragrostis* species were higher in communal than in most area. This situation may be due to selective and preferential grazing of more palatable species (Todd and Hoffman, 1999). These results are in total agreement with the finding of Jeffries and Klopatek (1987), Beeskow et al. (1995), Todd and Hoffman, (1999) and El-Keblawy (2003) that livestock remove the more palatable grass species such as perennial grasses.

Grass species that are not palatable increase in number dominating the landscape and changing functions of the rangelands. The increase in less palatable species means a reduction in nutrient intake by animals. The animals are likely to harvest lower nutrients than their maintenance requirements. This will in turn likely to affect the performance and overall productivity of the animals grazing in such rangelands. The increase in relative abundance of unpalatable species is in agreement to the weakly interactive model (MacDougall and Turkington, 2005). Species that dominated in the communal areas are largely unaffected by recruitment barrier and environment stressors that are highly limiting to other species (Grime, 2001; Keddy, 2001; Seabloom et al., 2003) *Heteropogon contortus* with good forage value (Grime, 2001) was only limited to LSC where there is proper rotational grazing. In an uncontrolled grazing situation where animal are free to roam around, palatable species are rarely given time to replenish and reseed resulting in overgrazing (Neely and Butterfield, 2004) and complete removal.

Increased grazing intensity could shift the balance of plant community in favour of the invasive and weeds. This could be the reason why we have more weeds and invasive species in communal rangelands. In the wetland study in Zimbabwe done by Gambiza et al. (2009), no general pattern was observed in terms of species richness and species diversity however to the contrary in this study communal farming system had lower species richness and species diversity than the other farming systems. The results showed a definite shift in dominant species contributing to the total biomass in the communal and commercial. In this study *D pentzii* persisted in all farming systems but the yield in communal areas was significantly low and insignificant to contribute to livestock production. Species that dominates in SSC and LSC farming systems were those that were reported to have higher forage value than those in communal farming systems. This should be related to the history of land use rather than stocking rates and overgrazing. The communal areas have high population density leading to overexploitation of resources.

It was observed that the relative abundance of *Helichrysum krausii* in communal areas was higher than in SSC and LSC. The results support the theory of competitive replacements (MacDougall and Turkington, 2005). The removal of palatable species in communal areas opened up space for weeds and invasive species to grow. The increase of *Helichrysum kraussii* further reduce biomass yield as there was a negative correlation between the biomass and *Helichrysum kraussii* abundance. The level of bush encroachment was higher in communal than in SSC and LSC. This could be due to reduced frequency and fuel load of fire in communal areas. These findings are in support of the earlier work which reported that low biomass reduce fuel load which reduce intensity of fire resulting in the increase of woody vegetation (Trollope, 1994; Savage and Swetnam, 1990; Kaufmann et al., 1994; van Langevelde et al., 2004). There were fewer trees in the communal than in SSC and LSC. The biomass yield was higher in SSC than in LSC which also significantly higher than in communal. This could be attributed to rate of harvest and grazing pressure reported to higher in communal areas.

5. Conclusion

Rangeland degradation is taking place in all the farming system and there is a general increase in species that cannot be used by livestock. These threaten the livestock production sector and rural people livelihood as well as the floristic composition of the rangelands. Monitoring should be continual and indicators should be set to monitor change early. Holistic grazing management strategies should be encouraged in communal set up in order to reduce species loss and promote biodiversity and proper ecological functioning.

Acknowledgements

We are very much grateful to the University of Zimbabwe, Research Board Funds for funding this project. We are also grateful to the village heads of Mutatiri, Zireva and Zimuto siding allowing us to conduct this research in their rangelands. Agritex officers also assisted with area maps especially Mr. Mashingaidze. Individual farmers at each small scale farms namely Mrs. Somerai, Mr. Vheremu and Mr. Munguri helped us a lot during ground truthing with GPS. Commercial farmers of Home Rue, Avoca Farm and Ireland farm contributed immensely for the success of this study. Makoholi Research Institute Head and staff helped us a lot with motorcycle and sampling equipment that were used in the study. To all those who contributed but not mentioned here, I say thank you very much.

References

Al-Rowaily, S.L. (2003), “Present condition of rangelands of Saudi Arabia: Degradation steps and management options (Arabic)”, *Arab Gulf Journal of Scientific Research,* Vol. 21, pp. 188-196.

Beeskow, A., Elissalde, N.O. and Rostagno, C.M. (1995), “Ecosystem changes associated with grazing intensity on the Punta Ninfas rangelands of Patagonia, Argentina”, *Journal of Range Management* (U.S.A), Vol. 48, pp. 517-522.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S. and Courbois, C. (1999), “*Livestock to 2020: The Next Food Revolution”.* Food*,* Agriculture, and the Environment Discussion Paper 28, Washington, DC: IFPRI/FAO/ILRI *(International Food Policy Research Institute/Food and Agriculture organization/International Livestock Research Institute)*.

Gallacher, D.J., Hill, J.P. (2006), “Effects of camel grazing on the ecology of small perennial plants in the Dubai (UAE) inland desert”, *Journal of Arid Environments,* Vol. 66, pp. 738-750.

Gambiza, J., Bond, W., Frost, P.G.H. and Higgins, S. (2000), “Land use options in dry tropical woodland ecosystems in Zimbabwe”, *Ecological Economics*, Vol. 33, pp. 353–368.

Grime, J.P. (2001), “Plant strategies, vegetation processes, and ecosystem properties”, John Wiley and Sons, Chichester, UK.

Heyman, B. (2004), “Can communities monitor the health of their ecosystems Implementing the Dimbangombe”, *Ecosystem Health Pilot Project,* Tufts University.

Jeffries, D.L. and Klopatek, J.M. (1987), “Effects of Grazing on the Vegetation of the Blackbrush”, Association. *Journal of Range Management* (U.S.A), Vol. 40, pp, 390-392.

Kaufmann, J.B., Cummings, D.L. and Ward, D.E. (1994), "Relationships of fire, biomass and nutrient dynamics along a vegetation gradient in the Brazilian cerrado", *Journal of Ecology,* Vol. 82, pp. 519–531.

Keddy, P.A. (2001), *Competition*. Kluwer Academic Press, Boston, Massachusetts, USA.

MacDougall, A.S. and Turkington, R. (2005), "Are invasive species the drivers or passengers of change in degraded ecosystem?", *Ecology*, Vol. 86 No. 1, pp. 45-55.

Mavedzenge, B.Z., Mahenehene, J., Murimbarimba, F., Scoones, I. and Wolmer, W. (2005), "Changes in the Livestock Sector in Zimbabwe Following Land Reform": *The Case of Masvingo Province. A Report of a Discussion Workshop*. IDS, Brighton.

Mtetwa, R. (1978), 'Myth or reality: the "cattle complex" in SE Africa, with special reference to Rhodesia'. *Zambezia*, Vol. VI, pp. 25-35.

Nduiwa, S. and Butterfield, J. (2004), "The Africa Centre – revitalizing a community", *In Practice*, Vol. 98, Nov-Dec. 2004. Albuquerque, New Mexico.

Neely, C.L. and Butterfield, J. (2004), "Holistic management of African rangelands", *Leisa Magazine,* December 2004.

Rosegrant, M.W., Paisner, M.S., Meijer, S. and Witcover, J. (2001), *"2020 Global Food Outlook: Trends, Alternatives, and Choices",* Washington, DC: International Food Policy Research Institute.

Rukuni, M. (1994), "*Report of the Commission of Inquiry into Appropriate Agricultural Land Tenure Systems*" Volume II: Technical Reports. Harare: Government Printers.

Savage, M. and Swetnam, T.W. (1990), "Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest", *Ecology*, Vol. 71, pp. 2374–2378.

Scoones, I. (1990), "Livestock populations and the household economy" "A case study from southern Zimbabwe", PhD thesis, University of London.

Scoones, I. (1992), "Land degradation and livestock production in Zimbabwe's communal areas", *Land Degradation and Rehabilitation*, Vol. 3, pp. 99-113.

Seabloom, E., Harpole, W.W.S., Reichman, O.J. and Tilman, D. (2003), "Invasion, competitive dominance, and resource use by exotic and native California grassland species", *Proceedings of the National Academy of Sciences*, Vol. 100, pp.13384–13389.

Todd, S.W. and Hoffman, M.T. (1999), "A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa", *Plant Ecology*, Vol. 142, pp. 169-178.

Trollope, W.S.W. (1998), "Effects and use of fire in the savanna areas of Southern Africa", Department of Livestock and Pasture Science, Faculty of Agriculture, University of Fort Harare, Alice, South Africa.

van Langevelde, F., van de Vijver, C.A.D.M., Kumar, L., van de Koppel, J., de Ridder, N., van Andel, J., Skidmore, A.K., Hearne, J.W., Stroosnijder, L., Bond, W.J., Prins, H.H.T. and Rietkerk, M. (2003), "Effects of fire and herbivory on stability of savanna ecosystems", *Ecology,* Vol. 84 No. 2, pp. 337-350.