Research Application Summary

Effect of soil quality on potential of forage establishment in Chivi fallow lands, Zimbabwe

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Abstract

There have been concerns about the poor communal grazing resources and the resulting degradation and depletion of communal rangelands in Zimbabwe. Different government departments, researchers, and non-governmental organisations have implemented a range of programmes and recommendations to improve communal grazing systems in efforts to conserve communal rangelands. Notable examples include introduction of improved forage grasses, veld legume reinforcement and agro-forestry technology. However, success in improving communal grazing resources has been limited with forage productivity in communal areas declining, soils still being eroded, as well as loss of flora and fauna diversity. The objective of this study was to generate scientific information under communal farm conditions, on the effect of soil quality on potential of forage establishment in Chivi fallow lands, relate soil fertility across different fallow groups to the quantity and quality of native and improved forage species, and to develop recommendations on suitable forage for Chivi communal area. Two legumes and two grasses species were planted in watered plastic pots in a factorial design with different forage species as factor one, i.e., *Neonotonia wightii*, *Desmodium uncinatum*, *Pennisetum purpurium* (bana grass) and *Cynodon nlefluensis* (star grass) and soil from different fallow periods as factor two, i.e., 1-2, 3-5 years, 6-10 years, >10 years, undisturbed land. Results revealed that fallow period had no effect on forage emergence, however it significantly affect weekly change in plant height, tiller count and leaf accumulation.

Key words: Communal grazing resources, forage establishment, forage grasses, legume reinforcement rangeland improvement strategies

Résumé

Il ya eu des préoccupations au sujet depauvres ressources des pâturages communaux et de la dégradation résultanteainsi que de l'appauvrissement des terres agricoles communales au Zimbabwe. Les différents ministères, les chercheurs et les organisations non gouvernementales ont mis en place une série de programmes et de recommandations en vue d'améliorer les systèmes de pâturages communaux dans les efforts de conservation des prairies communales. Les exemples notables incluent l'introduction des herbes fourragères améliorées, le renforcement des légumineuses de bon rendement et la technologie del'agro-foresterie. Cependant, le succès dans l'amélioration des ressources pastorales communales a été limitéavec la production du fourrage parla réduction des régions communales, l'érosionlente des sols, ainsi que la perte de la diversité de la flore et de la faune. L'objectif de cette étude était de produire des informations scientifiques, dans des conditions agricoles communales, sur l'effet de la qualité du sol sur le potentiel d'implantation des fourrages sur les terres en jachère de Chivi, d'associer la fertilité des sols dans les différents groupes de jachère à la quantité et la qualité des espèces fourragères indigènes et améliorées et de présenter des recommandations sur le fourrage adapté pour les zones communales de Chivi. Deux légumineuses et deux espèces d'herbes ont été plantées dans des pots en plastique et arrosées, dans une conception factorielle avec différentes espèces fourragères comme premier facteur p.ex. *Neonotonia wightii, Desmodium uncinatum, Pennisetum purpurium* (herbe bana) et *Cynodonnlefluensis* (chiendent) et le sol de différentes périodes de jachère comme deuxièmefacteur p.ex.1-2, 3-5 ans, 6-10 ans,> 10 ans, des terres non perturbées. Les résultats ont révélé que la période de jachère n'avait pas d'effet sur l'émergence de fourrage, mais elle affecte de manière significative le changement hebdomadaire en hauteur de la plante, le nombre de talles et l'accumulation des feuilles.

Mots clés: les ressources des pâturages communaux, implantation des fourrages, herbes fourragères, renforcement des légumineuses, stratégies d'amélioration des prairies

Background

Poor soil fertility characterising semi-arid region cropping lands, erratic rainfall and rural resettlement has resulted in large tracts of cropping lands being left fallow (Nyoka *et al.*, 2004; Mapfumo, 2005). The fallows form part of key grazing areas in communal crop-livestock production system, characterised by lack of adequate grazing land and degradation of the natural

rangeland (Day *et al*., 2003). This is especially true in the semi-arid region of Zimbabwe, which is more suited to livestock rather than crop production (Muir-Leresche, 2004). This is the case in Chivi where field observations indicates that communal fallow lands in the district are increasingly playing an integral role as grazing lands for small-scale communal livestock. Although there is overwhelming evidence of the suitability of many grass and forage species for rangeland improvement in Zimbabwe, there has been relatively poor adoption of rangeland reinforcement technologies in smallholder and communal farming systems. The current study is evaluating if *Neonotonia wightii, Desmodium uncinatum, Pennisetum purpureum* (bana grass) and *Cynodon nlefluensis* (star grass) can effectively address the aforementioned objectives.

Literature Summary

Many scholars (Mupangwa, 1994; Mugabe *et al*., 2004; Mapiye *et al*., 2007) have noted that poor adoption of rangeland reinforcement technologies in smallholder and communal farming systems is generally due to failure to engage relevant stakeholders when trials are conducted. A participatory approach that recognise the diversity of farmers' needs and be accompanied by awareness campaigns in order to get long-term and widespread adoption of forage technologies in Zimbabwe must therefore be adopted and adapted for communal rangeland grazing resources research. Pengelly *et al.* (2004), Mapiye *et al.* (2006a) and Mapiye *et al.* (2006c) also recommended a participatory approach methodology as it allows for effective linkages among researchers, extension workers, decision-makers, and empower farmers to proffer solutions to their own constraints. Effort should be put into identifying potential legume and grass species that are suited to degraded sand soils of communal fallow lands, in order to improve livestock feed availability and nutrition in the zone. The specific objectives of this study therefore were to: (i) select fast establishing, high quality legume and grass species; (ii) assess fodder biomass productivity of the fast establishing, high quality legume and grass species; and (iii) determine the feed quality as well as to compare performance in comparison with the dominant native pastures.

Study Description

The study was conducted in Chivi district which is located in south central Zimbabwe. The district extends from 20° 14' S to 20° 24' S and lies between 30° 13' E and 30° 57' E. The area receives low and unreliable rainfall ranging from 450-600mm (Marundwe and Kozanayi, 2003) and is generally characterised

by poor crop productivity and food insecurity. Major soils in Chivi were mainly derived from coarse-grained granite and include the chromic luvisols, ferric luvisols and eutric regosols (Anderson *et al.,* 1993).

An open environment pot experiment was set up to evaluate potential of forage production in Chivi soils when rainfall conditions are optimum. Two legumes and two grasses species were planted in watered plastic pots in a factorial design with different forage species as factor one i.e. *Neonotonia wightii, Desmodium uncinatum, pennisetum purpureum* (bana grass) and *Cynodon nlefluensis* (star grass) and soil from different fallow periods as factor two, i.e., 1-2, 3-5, 6-10, >10, undisturbed land .There were three replications per treatment. The number of seeds per pot corresponded to the recommended field-seeding rate of 3kg per hectare for small forage legume seeds and cuttings were planted in the pots for the grasses. The *Neonotonia wightii* legume seeds were scarified by immersing them in boiling water for five minutes. The soil used was taken from a depth of 10 to 15cm in five different fallow groups. The soils were maintained near field capacity moisture levels through regular watering of the pots. The legume and grass planting material were obtained from Makhoholi Research Station and Henderson Research Station, respectively. Representative soil samples were collected from the fallow fields and assessed for inherent fertility. The fertility parameters tested were pH, %OM, N, P and K, Zn, Ca and Mg.

The management of the experiment, which included collection of soil for pot from different fallow fields, planting, weekly measurement of growth parameters and harvesting, was done jointly by farmer representatives and the researcher.

The native, pre-selected dominant species were assessed by harvesting three quadrat (1 m^2) per sampling site (fallow fields). The grassspecies within the quadrats were cut to 5cm above ground level. The cut samples were transferred into properly labelled khaki bags and fastened at the top. The samples were kept under a cool shade until sampling for the day was completed. Each of the samples in the khaki bag was hand separated into different species and the dry matter (DM) of the dominant species determined in an oven (60^{o}C for 72 hours) at the Animal Science laboratory, University of Zimbabwe.

Research Application

There were no significant differences in the overall numbers of plant seedlings emerging per fallow group at four weeks post planting (P>0.05). The uncultivated land had the highest seedling emergence of 84.2% whilst the 6-10 years fallow age groups had the lowest (75%); the other treatments fell in between. These differences were however insignificant. The significant difference in plant height (Table 1), tiller count (Table 2) and leaf count (Table 3) of plant species between different fallow groups indicates that soil quality limits the potential of forage establishment in Chivi fallow lands.

Table 1. Least square means of plant height change eight weeks post planting.

F. group	n	Forage species				SEM
		D. uncinatum	*N. wightii*	*C. nlefluensis*	*P. purpureum*	
0-2	12	4.94[a]	4.66[a]	19.66[b]	14.16[a]	±0.57
3-5	12	4.50[a]	4.55[a]	21.16[bc]	17.66[b]	±0.57
6-10	12	4.70[a]	4.5[a]	22.22[c]	24.16[d]	±0.57
11-20	12	3.94[a]	3.72[a]	16.5[a]	28.11[e]	±0.57
Uncultivated	12	4.66[a]	4.5[a]	27.27[d]	22.55[c]	±0.57

Columns with different superscripts differs significantly (P<0.05).
[a]The means with the same superscript were not significantly different (P > 0.05).

Table 2. Least Square means for leaf counts.

Fallow age group	LS mean	Standard Error Mean
0-2 years	18.01[a]	±1.68
3-5 years	15.51[ab]	±1.68
6-10 years	13.00[b]	±1.68
11-20 years	14.43[b]	±1.68
Uncultivated	19.87[a]	±1.68

LS means with different superscripts differs significantly (P<0.05)

Table 3. Least square means for tiller counts.

F. group	n	Forage species				SEM
		D.uncinatum	*N. wightii*	*C. nlefluensis*	*P. purpureum*	
0-2	15	0.55[a]	0.44[a]	8.3[c]	0.88[a]	±0.61
3-5	15	0.55[a]	0.48[a]	6.61[b]	0.66[a]	±0.61
6-10	15	0.66[a]	0.62[a]	5.00[a]	0.65[a]	±0.61
11-20	15	0.44[a]	0.52[a]	6.68[b]	0.44[a]	±0.61
Uncultivated	15	1.66[b]	2.3[b]	10.06[d]	1.99[b]	±0.61

Columns with different superscripts differs significantly (P<0.05).

The dominant native grass species found in the area were *Cynodon dactylon, Perotis patens, Digitaria eriantha, Brachiaria brizantha* and *Hyperthelia dissolute* in order of abundance. Results from fallow assessment indicated a generally low dry season biomass availability per hectare (Table 4) and low nutritional quality of the dominant grass species. These are the major limiting factors for successful livestock productivity in Chivi fallow lands. The nutritional composition of the grasses was characterised by low crude protein levels (2-5%), high neutral detergent fibre and acid detergent fibre (Table 5).

Table 4. Herbaceous available biomass of dominant grass species in Chivi fallow lands.

Fallow age group	Available biomass (DM Kg/ha)	SEM/	Grazing capacity (ha/LU)
0-2 years	152.67	±22.12	24.56
3-5 years	159.98	±22.12	23.26
6-10 years	105.89	±22.12	35.41
11-20 years	129.94	±22.12	28.86
Uncultivated	152.28	±22.12	24.63

There were no significant differences in biomass availability across fallow groups ($p > 0.05$).

Table 5. Nutrient content of the five most dominant grasses in Chivi fallow lands.

Grass species	DM %	CP %	E.E %	Ash %	CA %	P %	NDF %	ADF %	Lignin %
Perotis patens	94.26	3.62	4.05	8.87	0.35	0.05	70	51.92	11.4
Bracharia brizantha	93.85	2.67	2.14	7.72	0.17	0.03	71.39	71.39	8.52
Cynodon dactylon	92.88	4.35	1.51	7.65	0.29	0.08	65.65	50.9	10.23
Digitariaeriantha	94.59	2.74	1.11	7.02	0.16	0.05	64.49	48.6	9.52
Hypertheliadissoluta	93.37	2.29	1.16	7.76	0.19	0.03	68.5	56.73	12.34

Key: DM= dry mass; CP= crude protein; CA= calcium; P= phosphorus; ADF= acid detergent fibre; EE=etha extract (fats); NDF= neutral detergent fibre.

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