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REVIEW [REVISIÓN]

A REVIEW OF IMPROVED FORAGE GRASSES IN ZIMBABWE
[PASTOS MEJORADOS EN ZIMBABWE: UNA REVISIÓN]

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SUMMARY

The shortage of feed particularly during the dry season is one of the major factors limiting livestock productivity in Zimbabwe. Improved grasses show great potential to alleviate this problem. In contrast to forage legumes, improved grasses are generally bulky and high yielding crops with high residual soil fertility utilisation capacity and broad environmental adaptation. There is strong need to continuously search for high yielding, climatically and edaphically adapted grasses that respond to existing and evolving constraints as well as changing demands and opportunities to increase feed supply for livestock especially during the dry season, under different utilisation systems. This paper reviews the history of research on selection and adoption of improved grasses for improving rangeland and livestock productivity in Zimbabwe and makes suggestions about future work. In Zimbabwe, a number of key genera of grass species with broad adaptation to environmental stresses, and high feed quality have been identified. It was suggested that, the selection of improved grasses should continue, with collaborative research on multi-locations under various utilisation systems using farmer participatory methods to ensure long-term and widespread adoption of forage technologies in Zimbabwe.

Key words: adaptation, adoption, dry season, improved grasses, Zimbabwe

RESUMEN

La escasez de alimento, particularmente durante la época de sequía es una de las principales limitantes para productividad animal en Zimbabwe. Los pastos mejorados muestran un gran potencial para reducir este problema. En contraste a las leguminosas

forrajeras, los pastos mejorados son generalmente cultivos voluminosos y de alto rendimiento con una gran capacidad de emplear la fertilidad residual del suelo y de adaptación ambiental. Existe una necesidad continua por encontrar pastos con altos rendimiento, climática y edáficamente adaptados que respondan a las limitantes existentes y en continuo cambio, así como a las demandas cambiantes y oportunidades de incrementar el abasto de alimento para los animales especialmente durante la época de sequía y bajo diferentes sistemas de empleo. El presente trabajo revisa la historia de la investigación sobre selección a adopción de pastos mejorados incrementar la productividad animal en Zimbabwe y presenta sugerencias sobre las necesidades de investigación futura. En Zimbabwe se han identificado numerosos géneros y especies de pasto con una amplia adaptación al stress ambiental y de alto valor como alimento. Se sugiere que la investigación sobre pastos mejorados debe continuar con un esfuerzo de trabajo colaborativo entre localidades y bajo varios esquemas de utilización, empleando métodos de investigación participativa que aseguren un uso en largo plazo y con mayor adopción de tecnologías para el uso de los forrajes.

Palabras clave: Adaptación, adopción, sequía, pastos mejorados, Zimbabwe.

INTRODUCTION

There is growing demand for meat, milk and other animal products in Zimbabwe. However, the shortage of feed particularly during the dry season is one of the major factors limiting livestock productivity in Zimbabwe. On the other hand, due to poor quality of the existing feed, seasonal changes in climate and growth stages of plants, grazing animals are often unable to satisfy their nutritional requirements

especially during reproductive and most productive phases. As a result, animals go through cycles of weight gain in the wet summer months between November and May and weight loss in the remaining dry season (Elliot and Folkertsen, 1961; Minson, 1981; Clatworthy, 1998).

There are several alternative means by which rangeland productivity can be raised above natural levels. These alternatives include introduction of improved grasses, and forage legumes. In contrast to forage legumes, improved grasses are often better known cultivated species by farmers, have a higher natural occurrence in most rangelands, are more resilient and have broad environmental adaptation (Gammon and Maclaurin, 1998). Improved grasses are generally bulky and high yielding crops. They have high residual fertility utilisation capacity and provide quick soil cover to land, minimising soil erosion (Scoones, 1992). Some are resistant to nematodes and ideal for use in crop rotations (York and Nyamadzawo, 1990). Thus, improved grasses play a major role in sustaining and improving rangeland and livestock productivity in Zimbabwe. Therefore, there is strong need for continuous search of high yielding, climatically and edaphically adapted grasses to respond to existing and evolving constraints and changing demands and opportunities to increase feed supply for livestock especially during the dry season under different utilisation systems. This paper reviews research on screening, evaluation, conservation, utilisation and adoption of improved grasses for improving rangeland and livestock productivity in Zimbabwe and makes suggestions about future work.

SCREENING AND EVALUATION

The selection criteria have considered the following parameters; ease of establishment (propagation), persistence, adaptability, yield, associative ability, nutritive value and animal production (Clatworthy, 1985; Nyathi and Gambiza, 1994). The criteria should include assessment of the potential of grasses to protect soil and to control pests.

To date, many grass species have been introduced and found suitable in Zimbabwe but their performance depends on the prevailing edaphic, climatic and utilisation conditions. Rangeland reinforcement in Zimbabwe has consisted mainly of planting rows of improved grasses into vleis (Clatworthy, 1985). *Acroceras macrum* (Nile grass), *Panicum repens* (Torpedo grass) and *Paspalum urvillei* (Upright paspalum) have generally been more successful for rangeland improvement in higher rainfall (> 1000 mm) areas on more fertile sand and sandy-clay soils (Nyathi and Gambiza, 1994). These grasses also do well in vlei areas (Clatworthy, 1985).

Cenchrus ciliaris (Fox tail grass), *Paspalum notatum* (Paraguay paspalum) and *P. repens* were found suitable as permanent dryland pastures in medium rainfall areas (600- 800 mm) with sandy and sandy-clay soils. *Pennisetum clandestinum* (Kikuyu grass) and *Cynodon* species (Star grasses) have been recommended both as permanent dryland and irrigated pastures in a wide range of soils in medium to high rainfall areas (Clatworthy, 1985; Henderson Research Station, 2005). Studies done by Mutisi *et al.*, (1994) in communal areas of Zimbabwe recommended *Cenchrus ciliaris* and *Cynodon nlemfuensis* in low precipitation environments with infertile sandy soils. At Henderson Research Station there has been an ongoing work on screening and evaluation of *Cynodon* accessions. From 88 accessions in the late 1970s four have been selected after over 15 years of study, promising accessions found to outperform the traditional CV no. 2 (*C. nlemfuensis*, in terms of yield and quality include G1260, G1280 and G1256. Following this research, fertilized Star grass no. 2 dryland pastures gained prominence as a complement to range grazing in the commercial sector (Henderson Research Station, 2005).

Grasses that were found to do well as irrigated-fertilised pastures include *Lolium multiflorum* (Midmar ryegrass) and *Avena sativa* (Oats), and these have been recommended in sandy-clay and clay soils under high rainfall areas (> 1000 mm) during winter months (Manyawu, 1993). In high rainfall areas, integrating crops and livestock through use of ley pastures has led to greater and more stable farm production (Clatworthy, 1998). Ley grass pastures range from unfertilised grass fallows to heavily fertilised pastures. Examples of improved grasses that are used as temporary dryland pastures (leys) in Zimbabwe are given in Table 1. Most of the grasses, except *Chloris gayana* (Giant Rhodes grass) are used to control root-knot nematode in crop rotations. The most extensively sown ley pasture grass in Zimbabwe is Katambora Rhodes grass (*Chloris gayana Kunth*) (York and Nyamadzawo, 1990). Katambora is grown in rotation with tobacco to control *Meloidogyne javanica* (root-knot nematode). A four-year ley is recommended (Martin, 1967) to overcome the longevity of nematode eggs even in bare fallow soil.

In Zimbabwe, Napier grass (*Pennisetum purpureum*) and hybrids between Napier grass and Pearl millet (such as Bana grass) are widely used as fodder in large- and small-scale commercial dairy sectors (Manyawu *et al.*, 1993; 1999). Developing fodder banks through systems of fodder production and conservation has focused on dry matter (DM) production of *Pennisetum* hybrids and forage sorghum. Conclusive evidence obtained at Grasslands Research Station over the past decade indicates that in humid parts of Zimbabwe (> 800 mm of rainfall

annually), Napier grass (Accession SDPP 7, SDPP 48, SDPP 19 and SDPP 10) yields more digestible dry matter than hybrids. The hybrids tended to be non-persistent, although they produced 10-12 t DM/ha in the first two years of the trial. On average, the hybrids were most productive in the first three years of establishment. In contrast, four-year data from Matopos and Makaholi Research Stations indicate that both hybrids (SDPP 3 and SDPP 38) and Napier grass (SDPP 7 and SDPP 10) can be equally productive in the drier environments (600 mm of rainfall annually). In both humid and dry environments, average yields were 8-11 t DM/ha annually for Napier grass (Manyawu, 1998).

Table 1. Edaphic, climatic and altitudinal conditions suitable for improved grasses commonly used as temporary dryland pastures (leys) in Zimbabwe (Nyathi and Gambiza, 1994)

Species	Soil type	Rainfall (mm)	Altitude (m)
<i>Chloris gayana</i> (Katambora Rhodes grass)	Sands/sandy clays	>800	>1 000
<i>Chloris gayana</i> (Giant Rhodes grass)	Sandy clays	>800	<1 500
<i>Eragrostis curvula</i> (Weeping love grass)	Sands/sandy clays	>800	<1 200
<i>Panicum maximum</i> (Panicum)	Wide range	>800	<1 500
<i>Digitaria eriantha</i> (Smuts finger grass)	Sands/sandy clays	>800	<1 500

In 2000, Matopos and Makaholi Research Stations concluded research in forage sorghum and *Pennisetum* accessions leading to release of three grasses for use by the farming community. The national variety release committee proved the release of these three grasses, NG1 and NG2 (forage sorghum) and PN1 (*Pennisetum* hybrid). In addressing problems of fodder production in the high-medium potential areas of Zimbabwe, it is important to take note of the positive contribution of Napier grass. Its dry-matter productivity is phenomenal. But there are gaps to be filled in terms of agronomic practices that would go a long way towards ensuring even higher productivity and more efficient utilization by animals.

Generally, research has concentrated on selecting species on-station and or commercial farms in high potential agro-ecological zones (Mupangwa, 1994). There is urgent need to divert focus and select grasses species that are appropriate on-farm and in communal areas of low agricultural potential (poor soil fertility, low and erratic rainfall).

AGRONOMY

The major problems of most improved grasses are the unavailability and high prices of seed and planting material, and poor persistence of some species under heavy grazing (Mupangwa, 1996). For instance, *Chloris gayana* and *Pennisetums* have been a failure in communal areas (Mutisi *et al.*, 1994). Most of the grasses have poor germination levels that vary from 10-25 % (Mupangwa, 1996; Clatworthy, 1998). Thus, there is need to carry out research to determine seed pre-sowing treatments that can improve germination levels of these grasses. Furthermore, most grasses require application of nitrogen and phosphorus fertilisers at establishment. Inorganic fertilisers are generally unavailable and expensive for smallholder farmers (Nyathi and Gambiza, 1994). In this context, the importance of developing functional seed and fertiliser (nitrogen and phosphatic) delivery systems and grass-legume pastures is emphasised.

In many cases forage yields from improved grasses are low because poor soil fertility and repeated harvesting which depletes the soil of nutrients, which are then not replenished. Farmers should, therefore, be educated on the value of fertilizer application for increasing forage production and be advised to practice it either using chemical fertilizers, or more appropriately, manure which would also improve the texture of the soil. Experiments to determine the appropriate levels of fertiliser and manure are required to sustain herbage production in Napier grass and hybrid *Pennisetums* have been completed at Henderson Research Station (Henderson Research Station, 2005). Results indicate that manure could be used in place of inorganic fertilisers. The performance of other grass species under various types and levels of manure warrants further investigation. Priority should be placed on selecting grass species with high residual fertility utilisation capacity. Research on harvesting, cleaning and storage of seed is essential as little information is available.

GRASS-LEGUME PASTURES

Combinations of grass and legumes such as Star grass-Silverleaf, Kikuyu-Siratiro and Stargrass-Graham stylo pastures have been widely used by Zimbabwean commercial farmers. Yield, persistence and compatibility of 8 subtropical legumes grown in

association with two grasses were compared over three seasons at Grassland Research Station. The legume species evaluated were *Stylosanthes guianensis* var. *intermedia* cv. Oxley, *S. humilis*, *S. Graham*, *Lotus pedunculatus*, *Lotononis bainesii*, *Chamaecrista rotundifolia* cv. Wynn, *Arachis pintoii* (broad leaf) species and *A. pintoii* (narrow leaf) species. The two grasses were *C. nlemfuensis* (Stargrass no 2) and *P. notatum*. Among the grass-legume mixtures preferred by sheep, *P. notatum* with *S. guianensis* var. *intermedia* cv. Oxley and *S. Graham*, and *C. nlemfuensis* with *C. rotundifolia* (cassia) were recommended. These pastures had legume content above 20 % at the end of three-year period (Lungu *et al.*, 1993).

Currently, researchers at Grasslands Research Station are in the process of further evaluating these recommended combinations under large-scale grazing experiments to determine the productivity of each grass-legume combination, using Merino wethers. In future, these studies should be expanded to evaluate other grass species (especially indigenous grass species) under different environments and utilisation systems for longer periods. Currently, there is little inclusive and out-dated data on livestock production from grass-legume pastures, especially in communal areas (Chinembiri and Mache, 1993; Mutisi *et al.*, 1994), and it merits investigation.

UTILISATION AND CONSERVATION

Nutritive Value

The average annual herbage yield of improved grasses varies from 5-15 t DM/ha under dryland conditions, to 10-40 t DM/ha under fertilised and irrigated conditions (Clatworthy, 1998). Seasonal changes in the nutritive value of improved grasses have been quantified on hand-clipped forage (Elliot and Folkertsen, 1961) and on oesophageal extrusa. The most important feature is the decline in protein content as the wet season progresses (as the plant matures). Protein content is highest in November (8-15 %) and lowest in May/June (1-5 %). Fibre content increases from 25-30 % in early growing season to 50 % in late growing season. The low protein content causes low digestibility (total digestibility declines from about 65 % in late November to about 40 % in late June) and feed intake causing energy deficiency (Clatworthy, 1998). Vitamins and mineral content drops as the season progresses due to oxidation, lignification, evapo-transpiration and translocation from leaves to fruits and roots (Elliot and Folkertsen, 1961; Minson, 1981). Selection of grass species that retain nutrients well into the dry season is recommended. It is also important to conserve high quality fodders grown in one season for use in another season to ensure viable and sustainable livestock production. In Zimbabwe, fodder is mainly

conserved as silage, hay or forage under intensive and semi-intensive production systems.

Silage

Napier grass has been studied in various projects due to its importance as fodder crop. Effect of wilting Napier was assessed in 1995 and it was concluded that high moisture content of Napier depressed intake and digestibility but did not affect rumen fermentation. It was also concluded that, Napier grass should be harvested when re-growth is 6-7 week old with afternoon harvest yielding highest water-soluble carbohydrates. In the same study, maize meal incorporation into silage as practised by smallholder farmers resulted in enhanced fermentation quality, digestibility and intake by cattle. Pre-wilting the Napier was however, shown to be more effective than maize meal in the making of silage (Manyawu, 1998). In the same trial, two Napier grass cultivars (SDPP 48 and SDPP 7) were identified and released on the basis of their compatibility with smallholder production systems. The performance of Napier grass in grass-legume silages warrants further investigation. It is important to evaluate other high yielding grasses with high water-soluble carbohydrates such as *Panicum maximum* cv. Nethisi for silage making.

Forage

An evaluation and screening of tropical grasses for forage grazing is nearing completion at Grasslands Research Station. The experiment seeks to determine the growth characteristics, herbage production, nutritive value and efficiencies of utilization of *Panicum maximum* cv. Sabi, *Digitaria eriantha*, *Andropogon gayanus* cv. Planaltina, *Cenchrus ciliaris* cv. Biloela and *Panicum maximum* cv. Nethisi when grazed *in-situ*, during the dry season. Preliminary results indicate superiority of *P. maximum* cv. Nethisi over the other species in terms of biomass production, nutritive quality and digestibility. Dry matter yield is generally higher in ungrazed pastures, but quality is poor. The converse is true for pastures closed off at some point during the main growing season (Chikumba; Head of Pastures Research, Grasslands Research Station: Personal communication). The search for suitable species for forage production should continue and widened to include grass-legume mixtures, especially in marginal agro-ecological zones of Zimbabwe.

Hay

Most of the aforementioned grass species have been used to make hay under different production systems in Zimbabwe. Mutisi *et al.*, (1994) recommended the growing of improved grasses in fallow lands in communal areas and harvest them for hay during the

early or medium growing stages when their digestibility and CP contents are still high to maximise their utilisation by ruminants.

Animal Production

Beef production studies using improved grasses done at Henderson Research Station have shown potential live weight and carcass weight gains of 100 kg and 500kg/ha/year, respectively. The effects of stocking rates, level of nitrogen application and supplementation on live mass gains of various classes of livestock were studied. Star grass was used extensively in dairy and grass fattening systems, especially in high potential agro-ecological zones of Zimbabwe. These studies came up with recommendations of fertiliser applications and stocking rates that are in practical use in Zimbabwe today (Henderson Research Station, 2005). Generally, the performance of livestock fed on hay, silage, forage and leaf meals from improved grasses need to be investigated, as data available is inadequate to make good conclusions and recommendations.

ADOPTION OF IMPROVED GRASSES

Research has recently been conducted in a number of areas that are of interest to the smallholder sector but there has been no long-term and widespread adoption of the resultant technologies (Mupangwa, 1994; 1996). Almost 30 % adoption of improved sorghum and pearl millet varieties was reported at Matopos Research station. Irrigated grass pastures, mainly based on heavy nitrogen fertilizers and Star grass and Kikuyu were not widely taken up, as the system could not give high enough returns compared to competing production systems (Henderson Research Station, 2005). Although the results of the grass-legume silages research were promising, there has been limited adoption, possibly because of the difficulty in growing adequate amounts of legumes, especially in the drier months in smallholder areas (Manyawu, 1998).

The rate of adoption of livestock-related technologies in smallholder crop-livestock systems worldwide is consistently low (Chinemhiri and Mache, 1993; Francis, *et al.*, 1997). However, a participatory approach has been developed for legumes in Zimbabwe, which enhanced both forage legumes technology development and its scaling out to new areas (Pengelly *et al.*, 2004) and this should be adopted and adapted for improved grass forages. The future challenge is to strengthen this participatory approach in the development of forage technologies, especially in the process of scaling out such technologies. This approach should realise 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. This approach should be improved to guarantee effective linkages among researchers, extension workers, decision-makers, farmers and other stakeholders, who have a complex knowledge base and widely dispersed expertise.

CONCLUSION

In marginal environments of the sub-humid tropics, the central challenge of agriculture is to increase productivity and raise living standards, while at the same time halting the degradation of natural resources (Scoones, 1992). Improved forage grasses and legumes show great potential for helping accomplish the abovementioned challenges. In Zimbabwe, a number of key genera of grasses with broad adaptation to biotic and abiotic stress, and high feed quality have been identified. It is suggested that, the selection of these grasses should continue with collaborative research with stakeholders on multi-locations in various utilisation systems using farmer participatory methods to ensure long-term and widespread adoption of forage technologies. This will ensure continuous supply of feed throughout the year, and subsequently lead to improved and sustainable livestock production in Zimbabwe.

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