A review of forage legume research for rangeland improvement in Zimbabwe

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Abstract

Results of screening and evaluation trials of forage legumes for rangeland improvement in Zimbabwe from 1980–2005 are reviewed. Attributes used for selecting legumes and rangeland management trends are highlighted. *Stylosanthes* spp., *Chamaecrista rotundifolia*, *Macrotyloma axillare*, *Desmodium uncinatum*, *Desmodium intortum*, *Macroptilium atropurpureum*, *Lotononis bainesii*, *Arachis pintoi*, *Aeschynomene americana* and *Neonotonia wightii*, among others, were recommended for rangeland improvement under the different soil, moisture and grazing management conditions in Zimbabwe. Since 1980, evaluation programs have been aimed at investigating and developing low-input legume-based forage production technologies for the resource-poor farmers in different agro-ecological zones of Zimbabwe. Since 1980, evaluation programs have been aimed at investigating and developing low-input legume-based forage production technologies for the resource-poor farmers in different agro-ecological zones of Zimbabwe. Awareness and adoption of these promising legumes by smallholder and communal farmers were identified as major challenges for rangeland improvement in Zimbabwe. Major constraints in adoption of legume pastures and their possible solutions are reviewed. Innovation, adoption and adaptation of appropriate, target-specific and demand-driven legume-based technologies, in co-operation with farmers and other stakeholders are recommended. Government and other financial agents are urged to support poorly resourced farmers to access the information and technology required to improve rangeland and livestock productivity in Zimbabwe.

Introduction

The problems of the unavailability and high prices of nitrogen fertilisers and purchased protein concentrates for ruminant livestock feeding in Zimbabwe have continued to escalate due to inflation and recurrent droughts (Francis and Sibanda 2001). Legumes can play a vital role in the improvement of tropical pastures, largely due to their ability to fix atmospheric nitrogen. Apart from the direct contribution to livestock production through the provision of protein-rich fodder, legumes can improve the productivity of rangelands by increasing the amount of nitrogen available for uptake by the associated grasses (Giller 2001). Therefore, legumes offer a possible lower-cost alternative to nitrogen fertilisers and purchased protein supplements for improving soil, rangeland and livestock productivity in Zimbabwe.

Considerable investment into legume research in Zimbabwe in the past 25 years has produced many achievements and several challenges have evolved. In order to manage these emerging challenges, there is need to review legume research and identify best practices and strategies. Therefore, this paper focuses on achievements made and constraints encountered in research from 1980 to 2005 and on research needs for improving rangeland and ruminant livestock productivity in Zimbabwe.

Attributes for screening and evaluation

In Zimbabwe, as in most parts of the tropical and sub-tropical world, the main legumes used for pastures are of American origin and few are indigenous (Clatworthy and Madakadze 1988). Since
1980, the screening and evaluation programs have been aimed at investigating and developing low-input legume-based forage production technologies for the resource-poor farmers in different agro-ecological zones of Zimbabwe. The program used the following attributes for screening and evaluation: persistence, vigour, biomass, nutritive quality, in vitro digestibility, drought and frost tolerance, disease and pest resistance, germination percentage, seed yield and plant density in an endeavour to identify suitable species for various agro-ecological zones of Zimbabwe (MacLaurin and Grant 1987; Nyathi and Gambiza 1994). Future research should focus on on-farm determination of agronomic and physiological parameters that give adequate description of growth, yield and persistence of legume species. These measurements should include nutrient requirements, feed quality, resistance to heavy grazing and economic analysis to determine the profitability of using various legume species and accessions.

Rangeland management research trends

Since the 1980s, there has been increased emphasis on forage legume production to correct protein deficiencies in diets of livestock grazing winter pastures and crop residues. This is because research has either targeted only large-scale commercial producers, or has been tested only on research stations and/or large commercial farms, with limited work on smallholder and communally managed rangelands (Mupangwa 1994). This led to the widespread adoption of legume-based technologies for rangeland improvement by commercial farmers in high potential areas, in contrast to marginal areas, where the majority of smallholder and communal area farmers are found. A major problem under communal grazing management is the existence of communally managed grazing systems, which discourages any input into a communally owned resource. On organised communally managed grazing systems, legume reinforcement of pastures had limited success, since high stocking rates do not allow the legumes to persist (Cousins 1988). Many other factors that limit the use of forage legume pastures in smallholder and communal areas include costs of and demands on labour, costs of fencing and fertilisers, lack of seed supplies and poor information dissemination. However, the first phase of communally managed rangelands research has been completed now and several legumes were identified under different systems of grazing management and long-term soil wetness (Mugabe et al. 2004). These authors recommended that grazing management strategies should focus not only on gazing intensity, but also on farmer dynamics and community institutional options for managing the rangelands as common property.

Suitable species for rangeland improvement

In Zimbabwe, rangeland reinforcement is usually practised in low-medium rainfall areas, where the quantity and quality of the natural pasture deteriorates during the dry season. There is a range of species that proved useful for rangeland improvement but their performance depends on the soil and rainfall conditions and grazing management systems employed. In the early 1980s, *Stylosanthes guianensis* (Graham stylo) and *S. hippocampoides* (Oxley fine-stem stylo) were confirmed to be of importance in light-textured soils and medium-high rainfall areas (Clatworthy 1985). *Stylosanthes scabra* (shrubby stylo) performed well in slightly acid sandy-loam soils and low-high rainfall areas (MacLaurin and Grant 1987). *Macroptilium atropurpureum* (siratro) has been successful in medium-high rainfall areas and medium-heavy textured soil sites (Clatworthy and Madakadze 1988). *Desmodium intortum* (Green-leaf desmodium) and *Desmodium uncinatum* (Silverleaf desmodium) performed well in high rainfall areas with heavy soils (MacLaurin and Grant 1987). *Neonotonia wightii* (glycine) also performed well on heavy soils in better-watered areas (Clatworthy 1985).

In the 1990s, the range widened to include *Chamaecrista rotundifolia* (cv. Wynn) and *Macrotyloma axillare* (cv. Archer) in lower rainfall areas and light-heavy textured soil sites (Nyathi and Gambiza 1994). Majee and Chikumba (1995) identified *Arachis pintoi* cv. Amarillo and *Aeschynomene americana*, among other potential legume species, for use in sandy vlei sites. *C. rotundifolia*, *S. guianensis*, *M. atropurpureum* and *Lotononis bainesii* (Beit lotononis) species also proved suitable for vlei areas (Muchadeyi and Chakoma 1995). *C. rotundifolia*, *D. uncinatum* and *S. hippocampoides* were recommended for rangeland legume reinforcement.
as they are persistent under heavy grazing and exhibit a higher degree of compatibility with grasses such as *Cynodon nlemfuensis* (stargrass) and *Paspalum* spp. (Nyathi and Gambiza 1994). Many researchers have recommended continued screening and evaluation of the identified legume species under various farming systems in different agro-ecological zones and under various grazing management strategies to determine their potential yields and field persistence over long periods of time (Clatworthy and Madakadze 1988; Lungu et al. 1997).

Since 1980, limited research has addressed the exploration, collection, characterisation and conservation of local legume forages. Serious genetic erosion may be taking place due to the introduction and adoption of exotic species and varieties to replace the local genetic resources that are well adapted to the local environment (Clatworthy 1991). This can lead to severe under-utilisation of local forage legume genetic resources. In order to fully exploit indigenous legume forage genetic resources and guarantee continued selection of suitable cultivars, there is an immediate need for the inclusion and prioritisation of legume forage conservation research programs in Zimbabwe.

Despite the overwhelming evidence of the suitability of several legume species for rangeland improvement in Zimbabwe, there has been relatively poor adoption of these legume-based technologies in smallholder and communal farming systems (Pengelly et al. 2004). In general, legumes have proved disappointing, as they have not lived up to their potential on paper (Francis and Sibanda 2001). Therefore, the major challenge for legume pasture improvement in Zimbabwe is to gain widespread awareness and adoption of the more appropriate technologies by smallholder farmers.

**Constraints in adoption of legumes and possible solutions**

**Shortage of seed and inoculants**

Adoption of legumes in Zimbabwean rangelands is hampered by high cost and low availability of seed of the recommended varieties (Mupangwa 1994). Setting up a viable seed industry and establishment of seed multiplication plots in smallholder areas can be a cost-effective option for improving the availability of seed to smallholder farmers. This can enable farmers to produce seed commercially to meet their requirements as well as that of external markets.

Several research trials have established the need for inoculation of legume seed with specific or non-specific rhizobial strains to boost biological nitrogen fixation in leguminous species. Selection of effective, competitive strains of rhizobia that are adapted to acid and infertile soils has resulted in large responses in nitrogen fixation and growth of tropical pasture legumes in the field (Giller 2001). These selected strains have proved useful over a wide range of environments. To this end, forage legume seed production and distribution networks have to be established with a system for the production and extension of rhizobial inoculants. Financial resources need to be sourced to develop low-cost seed and inoculant production and distribution systems in Zimbabwe.

**Persistence**

One of the major problems under communal grazing management in Zimbabwe is lack of persistence of legumes, especially in virgin rangelands (Clatworthy and Madakadze 1988). The ability of forage legumes to persist is an important attribute that determines their use as permanent pastures. Climate, management, pests and their interrelations in a given environment influence persistence. Persistence can be improved by use of careful grazing management and moderated fertiliser inputs (Lungu et al. 1997).

Persistence of perennial legumes is typically based on seed production and vegetative regeneration. In Zimbabwe, *Stylosanthes* spp., *Desmodium* spp. and *Macroptilium atropurpureum* cv. Siratro have been able to persist due to their ability to build up soil seed reserves (Jingura et al. 2001). However, there is limited reliable information on persistence of forage legumes in Zimbabwe. Hence, there is a need to establish long-term on-farm monitoring trials to determine field persistence of forage legumes over long periods of time.

**Communal tenure system**

Most rangelands in Zimbabwe are communally managed and individuals maximise their own private benefits at the expense of the collective good
Communally managed pastures have low excludability and therefore no judicious farmer would be willing to invest in them, as the return on that investment would be shared with others. In these situations, until grazing can be controlled, further research and development on new forage legumes or other management practices cannot be justified. Due to the communal land tenure system in Zimbabwe, the smallholder and communal sectors have been unable to fully enjoy the “benefits” of legume reinforcement (Cousins 1988).

In the 1980s, emphasis was placed on collective management of rangeland resources, which resulted in the creation of fenced grazing schemes through donor-funded projects (Nyathi and Gambiza 1994). In general, grazing schemes have not led to an improvement of rangeland condition, but may have reduced labour requirements for herding cattle. Reports by Cousins (1988) on grazing schemes showed that there has been little success in terms of the objective of encouraging the emergence of effective common property management regimens. Research on the potential of community institutions to manage and monitor the use of communally owned grazing resources should be investigated. An assessment of the introduction of market-related user fees, commensurate with the number of livestock the farmer has, is important.

**Poor information dissemination**

Poor information dissemination is one of the major reasons for low awareness and poor adoption of legume-based technological innovations in Zimbabwe (Mupangwa 1994). This can be attributed to lack of a suitable curriculum development by training institutes, lack of financial resources and poor training-research-extension-farmer and stakeholder linkages. Most of the generated information is filed and the little that reaches the farmer is either inappropriate or delayed. If appropriate, it is not fully utilised or there are no proper mechanisms for farmers to give feedback.

Lack of adoption of legume technologies can be ascribed to lack of awareness by farmers of the potential value of improved legume forages for raising the efficiency of animal production and improving the soil. It can also be due to poor accessibility to legume-based technologies (Pengelly et al. 2004). Hence, it is important to simplify legume technologies and effectively distribute them to farmers and stakeholders. Marketing and promotion of legume-based technologies through the print and electronic media can also be useful. Field days, competitions, on-farm research, demonstrations, educational tours and training workshops can improve levels of awareness and adoption of legume technologies among smallholder farmers in Zimbabwe. Expansion of agricultural shows to Ward level or rotation of venues at District level may go a long way in improving the awareness and adoption of legume technologies.

Low adoption rates over the past 25 years may indicate that farmers do not see investment in forages as a priority. Successful adoption of technology is frequently associated with a need to increase production and income generation (Pengelly et al. 2004). Farmers might be expected to ‘demand’ new legume forages only when they can see a financial benefit in the short to medium term, and if these benefits are not associated with a high level of risk. Legume forages are not a commodity in themselves, but a means to providing livestock products. As such, they are not usually high on farmers’ lists of priorities. Hence, researchers and extension specialists should place more emphasis on collaborative and on-farm research to provide evidence to farmers of the economic costs and benefits of legume forages.

**Socio-economic considerations**

Emphasis in extension changed from commercial areas to poor smallholders after independence in 1980. In 2000, the Zimbabwean government embarked on an agrarian reform program. According to Francis and Sibanda (2001), it will result in an increase in the number of smallholder farmers and some legume-based technologies that have been developed to support commercial livestock production will become irrelevant or obsolete. Therefore, the agrarian reform process and low adoption levels of well adapted legumes demand that researchers and extension specialists re-orient themselves to smallholder farmers’ challenges and adopt a new paradigm that ‘recognises’ the socio-economic and cultural factors affecting adoption. Socio-cultural constraints can emanate from differences in social classes as defined by land size and number of animals, such as jealousy, suspicion and lack of trust and
inheritance laws among the farmers (Cousins 1988). To this end, studies of traditional resource management and production systems are required as a basis for identifying constraints and prioritising research and ensuring that new interventions are relevant to the concerns and needs of smallholder farmers.

Adoption will depend on better targeting of extension to farmer needs as successful outcomes will depend on the participation of the farmers and stakeholders in the livestock industry. There is also need to redefine the target group, moving from all resource-poor farmers, many of whom are usually risk-averse, own small pieces of land and have little cash reserves for new initiatives, to the more receptive targets in the group, who have more resources for investment per enterprise and are able to take risks (Pengelly et al. 2004).

Conclusion

Despite the overwhelming evidence of the suitability of several legume species for rangeland improvement in Zimbabwe, there has been relatively poor adoption of these legume-based technologies in smallholder and communal farming systems. Hence, more effort should be focused on generating, adopting and adapting relevant target-specific and demand-driven legume technologies together with the farmers and stakeholders. Research efforts should be also directed towards promoting the use of ley and browse legumes on-farm, as they also play a crucial role in crop-livestock systems. Government and financial providers are urged to assist poorly resourced farmers to access the information and technology required to support the production and adoption of suitable legume species in order to improve soil, rangeland and livestock productivity in Zimbabwe.

Reference


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