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Country Perspective

Status of range and forage research in Mozambique†

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Domestic ruminant production in Mozambique is limited by a long dry season and lack of a well-defined breeding season to match forage supply. To date, research on pasture and forages has concentrated mainly on range vegetation mapping, forage adaptation and production from small plots. Little research has been conducted on animal production *per se*, despite numerous projects focusing on animal health. A key to sustainable use of forage resources will require, among other aspects, the determination of pasture productivity and long-term carrying capacity using animal output and land conservation parameters, maximum use of local resources including local seed production, improved use of crop residues and the integrated use of native flora and fauna.

Keywords: range, forage, pasture, Mozambique

Introduction

Mozambique has a huge potential for livestock production given the vast rangelands and the suitability of various areas for forage production. As a consequence of the occurrence of tsetse fly in higher rainfall areas cattle are concentrated south of the Save River and the upper Zambezi River valley. In these zones, where the rainfall varies from 300–800mm per annum, range productivity is very low and forage production is difficult without irrigation.

Early efforts were made by the National Institute for Agronomic Research (INIA) under the Portuguese Administration to characterise range resources (Myre 1968, Balsinhas 1969), their nutritive value (Coutinho 1963, Paiva 1968, Morgado 1969) and brush control (Myre 1970, Almeida 1972). During this period, some cultivated forages were also studied, including cactus pear, tropical legumes (Paiva 1973, Rebelo *et al.* 1974) and some cool season forages (Martinho and Aloeiro 1950, Melo and Da Silva 1970). Early post-independence efforts (led primarily by Food and Agricultural Organisation technicians) characterised communal pastures (Rootselaar and Figueiredo 1981, Stefanesco 1982), provided crude estimates of range grazing capacity (Reddy and Timberlake 1987) and evaluated the introduction of cultivated species on state farms (Timberlake and Dionisio 1984).

Most replicated forage and range trials, utilising sound scientific methodology were carried out in the past decade at the Animal Production Institute (IPA). These have included screening legumes (Maposse and Muir 1991, Muir *et al.* 1992, Muir and Abrão 1999a, Muir and Abrão 1999b) and cereal forages (Jordão *et al.* 1988) for adaptability and forage yield under rainfed conditions. Silvo-pastoral trials focused on *Leucaena leucocephala* (Muir 1999) and small ruminants (Muir *et al.* 1995, Muir and Massaete 1996b, Nguluve and Muir 1999). Animal nutrition trials, based on forages, focused on a number of small species including rabbits (Muir and Massete 1991, Muir and Massaete 1992, Muir and Massaete 1995), pigs (Muir *et al.* 1992), goats (Muir *et al.* 1995, Faftine *et al.* 1998) and fat-tailed sheep (Nguluve and Muir 1999). Range work focused on forage banks (Muir *et al.* 1992, Muir 1993), tree canopy effects (Alage *et al.* 1994), brush control using goats (Muir *et al.* 1997) and range productivity (Alage *et al.* 1994, Muir and Alage 2001).

Stocking rate trials on different range types, especially those focused on cattle or mixed cattle/goat herds, is the next area that needs study. Lack of grazing systems trials (seasons, duration, stocking rate, species mixtures, ecosystems, stocking methods) currently prevents the rational use of forage resources. The available recommendations on grazing capacities (based on pasture primary productivity) can be misleading since they do not take into consideration levels of production. The objectives of this paper are to highlight past research and identify keys to the sustainable use of forage resources in Mozambique.

† Editor's note: This is an invited contribution on the state of the discipline in southern Africa, presented at the 37th GSSA/SASAS Joint Congress, Christiana, May 2002

Background

During the colonial period (before 1975), forage research received lower priority than cash crops. The few reported studies focused on vegetation mapping and forage adaptation with the main purpose of improving milk production and extensive beef systems for consumption in the main cities. Mediterranean forage species were introduced, but the evaluation was limited to demonstration plots and animals were not involved in published forage evaluation trials. Animal research was mainly concerned with health, and concentrated on commercial producers. The communal and smallholder livestock systems were neglected, despite comprising 75% of the national cattle herd. There was never a well-defined feeding strategy to guarantee adequate, year-round feed to domestic ruminants.

In the years that followed the proclamation of independence, the country faced a tremendous lack of qualified personnel, relying mainly on expatriates who were often not familiar with the local environment. There was a drive to promote dairy production which resulted in the cultivation of some forage species, particularly napier grass (*Pennisetum purpureum*), siratro (*Macroptilium atropurpureum)* and perennial soybean *(Neonotonia whitii)*. With the onset of civil war, research was limited to peri-urban areas near the major cities, in what is known as 'Zonas Verdes' (the Green Zones).

History of forage and range research

Range productivity

Following up on the extensive taxonomic and vegetation work done during the colonial period, range work at IPA in the past 10 years has focused on primary productivity and species composition change due to management (Alage *et al.* 1994, Muir and Alage 2001). Extensive research on the effects of brush control (Alage *et al.* 1994, Muir *et al.* 1997) and tree shade (Muir *et al.* 2001) have indicated that improved management of range resources does increase vegetation output. This, in combination with work characterising communal pastures (Faftine *et al.* 2001) indicates that the next foci for range research should be animal production parameters, especially stocking rates, the role of climate and long-term conservation of range integrity. This research should not only look at domestic livestock and small ruminants, but should include native wildlife.

Cool season forages

Melo and Silva (1970) carried out several cutting experiments with oats (*Avena sativa*) and barley (*Hordeum vulgare*). Estimated dry matter yields ranged from 3 to 4 tons ha^{-1} from 2 to 3 cuts. Some alfalfa (*Medicago sativa* L.) was also grown on dairy farms but was characterised by poor persistence. Maposse and Muir (1991) also tested a commercial variety of alfalfa from Italy and CUF 101. The stands persisted for three years and the cultivar CUF 101 gave the best dry matter yields. Dry season plot trials at IPA indicated that reseeding *Trifolium* spp. had limited applicability due to high moisture requirements and low insect tolerance. Currently, various cool season grasses and annual *Medicago* spp. are being evaluated for forage production under irrigation, with the purpose of shortening the period of forage scarcity (Maposse *et al.* 2000).

Dual purpose crops

Maposse and Jordão tested sweet potatoes for forage and tuber production. Cultivar INIA 57 was the highest forage producer, but failed to produce tubers under cutting regimes. No cutting appeared to accommodate the dual purpose potential of this crop. *Leucaena leucocephala* was also tested (Muir 1999) for wood, green manure and forage. *Brassica napus* was also tested under irrigated conditions and showed some promise for human and swine feed during the dry season (Muir *et al.* 1992). Faftine *et al.* (1998) examined the use of *Arachis hypogea* and *Glycine max* stover for dry season supplementation of goats. All these trials demonstrated that there were promising dual purpose forage crops that might fit into small farming systems.

Cereal forages

Irrigated studies in the colonial period (Rodrigues and Rebelo 1974) identified high-yielding forage sorghums (12 to 20 tons ha^{-1} yr^{-1}) designed for dairy silage (e.g. cultivar 4 446). Babala millet (*Pennisetum glaucum*) was found to be the best in terms of dry matter yield (16 to 22 tons ha^{-1}) with maximum yield obtained from November planting. Post-colonial work under the auspices of the International Livestock Research Institute indicated that some sorghum and millet germplasm also produced forage well under dry-land conditions (Jordão *et al.* 1988).

Herbaceous forage legumes

A nation-wide legume evaluation program covering seven provinces was initiated in 1989 (Muir *et al.* 1992). Results indicated that species differed widely in their adaptation to different climates (Table 1). *Stylosanthes guianensis* cv. Cook was especially well adapted to high-rainfall areas whereas *Stylosanthes guianensis* cv. Seca and *Macoptiloma axillare* cv. Archer showed more promise in drier areas. Among the legumes for cut and carry systems, clitoria (*Clitoria ternatea*) yielded the highest dry matter (11 tons ha^{-1} yr^{-1}) (Muir and Jordão 1991), while shrubby stylos (e.g. *Stylosanthes scabra*) were the best among those identified for pasture reinforcement (Muir and Abrao 1999b).

Silvo-pastoral legumes

Leucaena leucocephala was studied extensively in southern Mozambique. Alternative establishment methods, usually based on transplants, were tested by Pudivitr *et al.* (1992). This legume, already naturalised in much of Mozambique, was tested for cut forage (7 tons ha^{-1} yr^{-1}) and firewood (7 tons ha^{-1} yr^{-1}) (Muir 1999). Trials utilising this species for dry season supplementation of rabbits, goats and fat-tailed sheep are described below.

Grasses

Among grasses evaluated for grazing purposes, Rhodes grass (*Chloris gayana* cv Katambora) and buffel grass (*Cenchrus ciliaris*) were among the top yielding species, both in the rainy and the dry season (Muir and Abrão 1999a). With

Table 1: Rainy (R) and dry (D) season vigour (0 = no survival, 1 = low, 10 = high) of tropical forage legumes in seven provinces of Mozambique*

Species and cultivar	Maputo		Gaza		Inhambane		Manica		Zambezia		Lichinga		Sofala	
	R	D	R	D	R	D	R	D	R	D	R	D	R	D
Aeschynomene americana Glen	8	0							8	4				
Alysicarpus rugosus	4	0							4	7				
Cassia Pilosa	8	0												1
C. rotundifolia Wynn	9	3		0		3			7	3				
Centrosema arenarium	4	2				5			2	8				2
C. macrocarpum									7	10				
C. pascuorum									7	2				
C. pubescens		2					8	3	1	1		7		0
Clitoria ternatea	10	6	8	6			5	1	10	5		9		8
Desmanthus fruticosa	5	2		3										
D. virgatus	10	6		3										4
Desmodium heterocarpum	1	0							2	0	2	0		
D. uncinatum	6	10						0						
Galactia striata	3	2	10	7				6	2	0	10	9		0
Macroptilium atropurpureum Siratro	9	5				10	7		2	1	9	2		4
M. lathyroides	10	0							10	0		1		
M. longepedeculatum									2	4				3
Macroptyloma axillare Archer	10	4		6		8	9	9	10	6	9	8		1
M. uniflorum	8	7					1		1	1	1	0		
Neonotonia wightii	10	3		5			9	0	9	9				1
Pueraria phaseoloides	2	0					9	2	9	7	10	4		0
Stylosanthes guianensis Cook	10	7		4			10	9	6	8	10	8		
S. guianensis Graham	10	8	7	4				0		7				3
S. guianensis Oxley	10	7				7	7		5	0		5		0
S. hamata Verano	5	2		0					5	5				
S. scabra Fitzroy	10	6	8	6			8							4
S. scabra Seca	10	8	7	4		6	8	2	5	8		7		2
Vigna adenantha	3	0					7	2	5	6	8	1		
V. parkeri	2	0						0	1	0	3	1		

* Evaluations averaged over 1989–1991; not all entries present at all locations or evaluated both seasons

0respect to napier grass, which has been widely used in dairy farms as a fresh forage cultivar, King (introduced from Cuba) had yields equal to local germplasm (34 vs 32 tons ha^{-1} yr^{-1}), but more than banagrass (*Pennisetum purpureum* X *Pennisetum glauca*) and another variety introduced from Swaziland (both yielded 30 tons of dry matter ha^{-1} yr^{-1}) (Maposse and Abrão, unpublished). Banagrass also showed excellent drought resistance.

Feeding trials

Numerous forage-based rabbit nutrition trials were undertaken during the civil war years. The best diet was a combination of sweet potato leaves, clitoria and industrial pellets (Muir and Massaete 1991). With this diet the animals gained 15.3g animal day^{-1}, which was comparable to the gains achieved with pellets (16.1g). The use of *Leucaena leucocephala* in rabbit diets, both for reproductive does (Muir and Massaete 1995) as for well as growing animals (Muir and Massaete 1992, Muir and Massaete 1996a) resulted in high performance and no clinical signs of mimosine toxicity.

Trials using *Leucaena leucocephala* as dry season supplements for swine in combination with *Brassica napus* produced good results when animals were fed low-quality bran diets (Muir *et al.* 1992). Similar work with goats tethered on range had less promising results (Faftine *et al.* 1998).

Grazing trials comparing tethered and untethered fat-tailed sheep (Nguluve and Muir 1999) and goats (Muir *et al.* 1995, Muir and Massaete 1996b) on range versus a cultivated pasture based on *Leucaena leucocephala* indicated over 100% increases in average daily gains for animals on cultivated pasture. Advantages of the silvo-pastoral system were more distinct in drier years when range productivity was very low in terms of both quantity and quality. Results also indicated that goats tended to ring bark the trees, even when leaves were plentiful, but did not kill them under rotational browsing (Muir *et al.* 1991).

Present research efforts

At present, very little research is focused on animal production based on range. Researchers at the Institute for Animal Production continue to survey communal land-use patterns but do so exclusively in Maputo Province. There are vast communal lands in Gaza, Inhambane and Tete Provinces that also need attention, especially as cattle herds and small ruminant flocks enter into post-war exponential recovery rates. Mozambique has a unique window-of-opportunity to develop land tenure and management practices that avoid range degradation on these lands as animal populations increase.

The Faculty of Forestry and Agronomy at Eduardo Mondlane University and the Ministry of Agriculture's Institute for Animal Production are co-operating in an effort to identify, collect and evaluate native herbaceous legume germplasm from the Limpopo and Nkomati River drainages for potential use in range reseeding as well as in cultivated pastures. Although only a portion of the >100 species purported to exist in the region by Pooley (1998) and Fabian and Germishuizen (1997) have so far been collected, efforts at present have been concentrated on species with a wide climatic and edaphic adaptation, since these are assumed to be better prospects for wide distribution once commercialised. The most promising accessions are being evaluated for productivity, seed characteristics and quality. Table 2 lists the more promising species identified this far, although much information still needs to be collected, especially seed production, before this research effort can be expanded.

Recent efforts at Eduardo Mondlane University have focused on identification of annual cool-season grasses and legumes for use in cattle finishing or dairy operations. This production, since it occurs during the dry season, requires irrigation and other expensive inputs that essentially limit its application to the commercial sector. As local markets develop, this sector will have the means to develop the use of cultivated pastures that, at present, are essentially non-existent. The most promising of these cool season annuals are provided (Table 3).

Future range and forage research efforts

Collectively, research results highlighted in this paper indicate that much has been achieved in terms of assessing range productivity, cultivated grass and legume agronomic characteristics and the feasibility of using cultivated forages for small livestock species. However, these results need to be tested on-farm within commercial and smallholder production systems. Likewise, range productivity, especially in terms of rainfall, ecosystem and animal species, needs further research related to stocking rates and breeding seasons. Only with animals present can true production potentials be measured, including their impact

Table 2: Native herbaceous range legumes collected in southern Mozambique with potential for range-reseeding and cultivated pasture

Species	Cycle	Habit	Seed	Uses
Crotalaria monteiroi	annual	upright	prolific	browse
C. globifera	annual	upright	medium	browse
Rhynchosia minima	perennial	climbing	medium	browse
R. totta	perennial	climbing	medium	browse
Stylosanthes fruticosa	perennial	upright	poor	graze
Vigna vexillata	perennial	climbing	medium	graze
V. unguiculata	perennial	climbing	medium	graze
Macrotyloma axillare	perennial	climbing	poor	both
Neonotonia wightii	perennial	climbing	medium	both
Zornia milneana	perennial	prostrate	medium	graze
Chamaecrista mimosoides	annual	upright	prolific	manure

Table 3: Performance of cool-season annual grasses under irrigation in Maputo, Mozambique

Species	Yields (kg ha^{-1})
Avena sativa	7157
Hordeum vulgare *Hordeum vulgare*	5101
Lolium Multiflorum *Lolium multiflorum* cv Midmar	5518
Lolium multiflorum *Lolium multiflorum* cv Gulf	6563

on natural resources.

Further research is also needed to develop and test integrated range and cultivated pasture systems that provide adequate nutrition throughout the year in Mozambique. The following is a list of the more important topics needing attention:

1. Assess grazing potential of the rangelands, taking into account:
   - Composition, availability and productivity of range
   - Risks of bush encroachment and fire on the rangelands
   - Distribution of rural population and arable lands
   - Distribution of water resources for pasture and animal production
   - Yearly variations based on rainfall
   - Forb germplasm loss to over-grazing
2. Evaluate cool-season forages to shorten the period of forage scarcity
   - With and without irrigation
   - Persistence over time
   - Animal production gains versus costs
3. Evaluate promising new forage species
   - Silvo-pastoral systems
   - Forage banks for dry season supplementation
   - Native legumes and grasses for range reseeding and hay production
4. Evaluate further the feasibility of using crop residues for animal feed
5. Develop and evaluate all indigenous systems that maximise sustainable fauna harvest
   - Study fauna preferences and inter-specific niche competition
   - Identify flora and fauna unique to Mozambican ecosystems
   - Quantify optimal, multi-species production for specific ecosystems
   - Study role of range rehabilitation and pastures for indigenous fauna
6. Determine sustainable, long-term rangeland grazing capacities based on both production and conservation parameters
7. Address land tenure issues as they affect sustainable communal land stewardship
8. Identify and develop local forage seed production of both indigenous and exotic species
9. Determine suitable all-year, commercial grazing systems
10. Define optimum cattle-breeding seasons, by region, based on range/climate parameters
11. Foster resource conservation methodology for all echelons of producers

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