

STRATEGY OF SADCC/ICRISAT REGIONAL PROGRAMME ON THE IMPROVEMENT
OF SORGHUM AND MILLETS AS FORAGES

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INTRODUCTION

Sorghum and millets are the major crops grown in the marginal rainfall areas of SADCC countries. As a proportion of the total area under cereal production, these crops account for 77% of the area under cereal crops in Botswana, 35.6% Tanzania, 27.9% Lesotho, 26.0% Mozambique, 25.1% Zimbabwe, 11.0% Angola, 10.2% Malawi, 8.4% Zambia and 3% Swaziland (FAO 1986). Livestock production is a very important component of the agriculture in the semi-arid regions, because apart from providing milk and meat for food, they also provide traction power, transportation, manure, hides and skins and other industrial products. Sorghum and millets being the most important crops in these regions are thus likely to play a very important role in the nutrition of livestock. Currently only commercial farmers who account for a very small proportion of the farmers in the region grow these crops wholly for livestock feed. However most of the communal farmers who are the majority graze the stover after the grain is harvested. Most studies have revealed that the nutritional quality of the stover is not very good (Martin and Wedin, 1974; Rose et al, 1980; Ross et al, 1983). However, its continued use for grazing is imperative, therefore there is a need to improve the nutritional value of the crop residue without sacrificing grain yield.

Pasture improvement in the SADCC region is concentrated mainly on the improvement of natural grasslands which form the main source of nutrients for Africa's livestock. It is known that in the absence of major animal diseases, nutritional stress is the major constraint to increased livestock production (Chigaru, 1985). Nutritional stress can only be alleviated

through an integrated research involving enhanced nutrient productivity from the land. Successful forage legumes, cereal crop intercrops have been reported in which livestock gets nutrients from both the crop residue and the legume during the dry season (Saleem, 1985), through undersowing of Stylosanthes guianensis three weeks after the grain sorghum. In Botswana, Chandler (1985) obtained high yields with lablab (Lablab purpureus) and velvet beans (Stizolobium spp.) when these were undersown in maize fields. When Siratro (Macroptilium atropurpureum) was established under sorghum and maize it made a very useful contribution to quality by increasing the crude protein content of fodder hay by 2.2%. Several reports have been published on the use of elephant grass (Pennisetum purpureum). The cultivars Gold Coast and Cameroons have been recommended for cultivation in Malawi (Anonymous, 1975). Elephant grass is the most commonly grown grass used a fresh fodder for silage in Mozambique (Timberlake and Dionisio, 1985). Hay (1978) observed that during the wet season, elephant grass, greatly outyielded Rhodes grass (Chloris gayana), coloured guinea grass (Panicum coloratum), stylo (Stylosanthes guianensis), desmodium (Desmodium spp.) and siratro. During the dry season, elephant grass still maintained higher yields than the other species.

Interspecific hybrids between pearl millet and elephant grass were first reported by Burton (1984). The importance of this interspecific cross stems from the fact that the cross, a sterile triploid yields more fodder than either of the parents, its forage quality is better than that of elephant grass and it can be produced commercially (Powell and Burton, 1966). Other useful aspects of this cross are the possibilities of transferring useful traits (e.g. disease resistance) from elephant grass to pearl millet.

The productive potential of the panic grass (Panicum maximum) c.v. Mtchisi for cut-and-carry was found to be about three fourths of that achievable by interspecific crosses between pearl millet and elephant grass (Dzowela, 1985).

The interspecific hybrids between pearl millet and elephant grass have been released in different parts of the world. Some

examples are banagrass in South Africa and NB21, MB67 and PBN-83 in India.

Hanna and Monson (1980) observed a range of variability in dry matter yield distribution and forage quality attributes in different elephant grass by pearl millet interspecific hybrids. The variability thus observed suggests that these factors could be improved by selecting the right elephant grass clones as pollinators.

Increasing the digestibility and intake of forages by using relatively simple inherited genetic characters is one of the most exciting areas for forage improvement. A case in point is the simply inherited dwarf (d2) gene in pearl millet found to reduce the height of plants by one-half, increase the amount of leaf by 50% and still manage to realize 78% as much dry matter per hectare as its near isogenic tall counterpart (Hanna, 1975). The d2 gene in pearl millet produced only 85% as many steer days of grazing as the tall but animals on the dwarf millet made 20% better daily gains while steer gains per hectare were equal for both millets (Burton et al, 1969).

In a study to evaluate the yield and nutritive value of sorghum, (Sorghum bicolor (L.) Moench) maize and pearl millet residues, Mosienyane (1983) observed that the dry matter digestibility of pearl millet was poorer than that of sorghum and maize stover. This is due to high concentration of lignin (Cherney et al, 1988). Efforts are underway to improve the stover quality of pearl millet by reducing the lignin content through modification of the lignification process like the one observed in brown-midrib (bmr) maize plants (Grand et al, 1985). Recently a bmr gene has been found in pearl millet that reduced permanganate lignin concentration in the stems of bmr millet by one half that of normal millet and improved its in vitro dry matter digestibility to a level better than that of sorghum and maize (Cherney et al, 1988). This gene improved the quality of pearl millet similar to that of bmr mutants of sorghum and maize. Thus the bmr trait in pearl millet has an excellent potential of improving the quality of forage pearl millet and even make possible the utilisation of pearl millet stover which otherwise

is left in the field in most countries in Africa. The quality of pearl millet stover is poor in Africa because most of the varieties/landraces grown are very tall (poor leaf:stem ratio) and stems are very thick. In India pearl millet stover is fed to animals but the plants are medium tall, have thin stems coupled with high tillering. It will be worth comparing different types of pearl millet possessing different morphological traits such as leafiness, plant height, stem thickness, brown-midrib, tillering and forage quality traits to establish the association between morphological traits and forage quality.

To get a good picture of the potential role sorghum can play in the livestock industry of the SADCC region, one has to look at the achievements of forage sorghum research work elsewhere. Sorghum bicolor var. sudanense (Sudangrass) was introduced in USA by C.V. Piper and the first variety (Wheeler) was released by Carl Wheeler in 1911. California 23 was distributed to farmers in 1938 (Peterson and Miller, 1950). Tift was another forage sorghum variety selected from a cross between Lotti red sorghum and other sudangrass selections (Burton, 1943). Since then several varieties of sudangrass have been released in USA. Few examples are sweet sudangrass (Karper, 1949), Piper sudangrass (Smith and Ahlgren, 1952), Lahoma (Anonymous, 1954), Greenleaf (Pickett, 1954) and Georgia 337 (Burton, 1964).

During the last twenty years, several forage sorghum varieties have been released in India. These are: JS 73/53, Meethi sudan, HC 136, HC 171, HC 260, UP Chari 2, RC 2, PC 6, PC 9 and PC 23.

STRATEGY

The SADCC/ICRISAT regional programme organised a Cereal Forage Research Monitoring Tour from 10 to 23 February 1988 in which 15 scientists from the region including the PANESA coordinator participated. The group visited five countries: Zimbabwe, Botswana, Lesotho, Swaziland and Mozambique and the future strategy on improvement of sorghum and millets for forages was discussed.

The strategy was discussed with the regional programme's technical advisory panel in March, 1988 at Maseru, Lesotho and with the Donors' Review Panel in June, 1988 at Matopos, Zimbabwe. Their contribution helped in improving our strategy. An outline of our strategy is presented below:

Research strategy

The strategy will aim to specifically:

To improve sorghum and millets for dual purpose particularly by improving the quality of crop residue in high yielding entries. Brown midrib genes will be utilised in sorghum and pearl millet to improve their dry matter intake and digestibility attributes.

To develop better varieties of banagrass i.e. to generate interspecific hybrids between selected pearl millet and elephant grass accessions and to evaluate them for fodder yield and quality under moisture stress situations.

To improve forage sorghum for forage yield and quality. This will be done by generating crosses between sorghum and sudangrass and selecting in segregating generations bmr genes which will be utilised to improve the intake and digestibility.

Intercropping studies involving sorghum and millets with fodder legumes and grasses will be carried out to maximize the grain, crop residue and legume fodder yield. Useful fodder trees and browses will be included in such studies.

Collection and maintenance of all the forage species relevant to the region and to use them in crop association studies where ever appropriate.

Improvement of pearl millet and finger millet for hay and/or silage will be a low priority.

- Determination of usefulness of small millets as forage crops in the SADCC countries. The improvement of small millets for forage in the near future is of low priority.

Support strategy

As there are not many breeders and/or agronomists in SADCC working on this aspect, one of our strategy will therefore be to strengthen the national programmes by providing them with short training courses or training towards a degree.

- Efforts will be made to improve the research facilities such as forage laboratories in different SADCC countries.
- We shall involve ourselves to a limited extent through collaboration with the national programme on feeding trials where large quantities of grains are required.
- Forage breeders, agronomists and animal nutritionists from the region are working hand in hand and the regional programme will act as a co-ordinating unit for improving the utilisation of sorghum and millets as forages.

ACHIEVEMENTS

Introduction and Evaluation

The improvement of sorghum and millets for forages was started late in 1987 and since then the major activity has been introduction, maintenance and evaluation of the materials. A total of 152 sorghums and 106 sudangrass accessions have been introduced from USA, India, Argentina, Australia, Lesotho, Swaziland, Zimbabwe and Tanzania. These include male-sterile lines on A1 cytoplasm as well as lines with bmr genes. 146 accession of pearl millet, 36 of Pennisetum glaucum spp Monodi, 20 Napier grass, 5 pearl millet x Napier grass hybrids and 65 minor millets (5 species) have been introduced from USA, Ethiopia, Indian, West Africa, Botswana, Tanzania, Mozambique, Zimbabwe, Swaziland and Australia. Recently 2 accessions of P. pedicellatum, 5 of P. polystachion and 2 Panicum maximum were

introduced from Tifton, USA. In addition to this 85 forage species were introduced from the International Livestock Centre for Africa, (ILCA), Ethiopia.

Cereal forage yield trial

A trial of 25 pearl millet entries was conducted in all SADCC countries except Angola and Zambia during the 1987/88 season. None of the introductions was superior to Babala millet which was developed in South Africa. However 11 entries: PS 126, PS 135, PS 192, ICMS 7704, PS 472, 84-52, PS 200, 52-9 x 51-13, 86-10242, PS 195 and 435 x 51-5 were selected for high tillering, resistance to diseases, and fodder yields.

Forage Sorghum Introduction Nursery

A nursery of 105 forage sorghum accessions including sudangrass was grown at Aisleby, Zimbabwe and Maseru, Lesotho in single row plots. Based on visual scores, eight entries were selected. During 1988-89 all the entries together with new introductions will be re-evaluated.

Breeding Programme

During the 1988 off-season, the following crosses were generated:

Sorghum x sudangrass: 256

Sorghum A lines x sorghum/sudangrass: 102

Pearl millet x Napier grass: 15

Pearl millet x Monodii: 119

Monodii x Napier grass: 16

All these crosses will be evaluated and advanced during the 1988/89 rainy season.

A forage pearl millet composite is being constituted by recombining 38 forage pearl millet lines.

1988-89 Trials

Eight trials have been organised for the 1988/89 season. The list of trials together with the number of entries and number of locations in each country is given below:

- Cereal Forage Yield Trial: 20 entries, 23 locations in 8 countries.
- Regional Forage Sorghum Introduction Trial: 81 entries, 11 locations in 5 countries.
- Regional Sudangrass Introduction Trial: 90 entries, 11 locations in 4 countries.
- Regional Forage sorghum B-line Evaluation Trial: 49 entries, 8 locations in 4 countries.
- Regional Forage Millet Introduction Trial: 64 entries, 11 locations in 6 countries.
- Minor Millets Evaluation Trial: 64 entries, 5 locations in 3 countries.
- Cereal Forage Preliminary Variety Trial: 10 entries, 2 locations in Zimbabwe.
- Monodji Evaluation Trial: 15 entries only at Matopos.

The above list shows the interest and the commitment among the forage scientists to collaborate on the improvement of sorghum and millets for forages. This also provides an opportunity to provide a large number of accessions to the scientists in the region, with the hope that these accessions can be incorporated in crop-livestock production systems.

COLLABORATORS

The main collaborators on a country wise basis are:

Botswana	Arabia Moyo	Agronomist
Lesotho	Victor R. Ramakhula	Agronomist
Malawi	C.F.B. Chigwe	Breeder
Mozambique	Celia Jordao	Nutritionist
	Inacio Maposse	Agronomist
Swaziland	Paul D. Mkhathwa	Agronomist
	Brenton B. Xaba	Nutritionist
Zambia	Bhola Nath	Breeder
Zimbabwe	Peter Hatendi	Nutritionist
	T. Smith	Nutritionist
Tanzania	G.M. Mitawa	Agronomist

A multi-disciplinary approach is being followed where breeders, agronomists and animal nutritionists are working together. As the project grows, assistance from pathologists and entomologists may be required.

SUMMARY

The improvement of sorghum and millets for forage was started late in 1987. The strategy was developed in February 1988, during the Cereal Forage Research Monitoring Tour in which 15 scientists from the region including the co-ordinator for ILCA/PANESA participated. The strategy was further refined during the Technical Review in March 1988, and the Donor's Review in June 1988. The major research activities have been collection, seed increase and the evaluation of germplasm accessions of sorghum and millets and related species from many sources. Regional trials are being organised and a breeding programme has begun. Crosses have been generated among sorghum, sudangrass and sorghum male-sterile lines as well as among pearl millet, Napier grass and *P. glaucum* sp. *monodii* accessions to produce better varieties of forage sorghum and banagrass (pearl millet x napier grass). Research on the improvement of the nutritive value of crop residue will (dual purpose) be initiated in 1989 once the forage laboratory facilities are established.

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