A Review[1] of the Potential of *Brachiaria brizantha* as a Forage Crop for Livestock in Zimbabwe

Grasslands Research Institute (GRI), Marondera
Department of Research and Specialist Services
Ministry of Agriculture, Mechanization and Irrigation Development

March 2014

Background

---

[1] **This Review was compiled by L. Taderera, D. Hikwa, A. Tigere, C. Mudzengi and M. Zimondi**

Sub-Saharan Africa is the centre of genetic diversity of tropical grasses, with over 90% of the major cultivated forage grasses indigenous to the rangelands (Boonman, 1993). Despite the fact that these grasses are widely used to improve the extensive cattle grazing lands in Latin America and other major livestock producing countries, they remain extensively under exploited in their native lands. One such under-utilized grass is *Brachiaria brizantha* which is native to tropical Sub-Saharan Africa from 25ºS to 12ºN.

Brachiaria brizantha is a warm-season grass for the lowlands. *B. brizantha* performs poorly at elevations above 1800 m above sea level (Ndikumana and Leeuw de, 1996). Optimum temperature for growth is about 30-35°C. Temperatures lower than the latter tend to depress growth. The leaves are frost-sensitive, although the plant can survive light frost. In general *B. brizantha* requires in excess of 500 mm of rain or irrigation water per annum and can withstand dry seasons of 3–6 months, during which it remains green. It is more productive under light shade, particularly when soil nitrogen is low. It can grow on a wide range of soils, ranging from light to heavy textured, with a wide range of soil nutrients and a pH range of 4-8. However, production increases when soil nutrients are high. Information gleaned from Cook *et al*. (2005) and FAO, (2010) indicates poor tolerance to flooding by *B. brizantha*, depending on the variety.

Productivity of *Brachiaria brizantha*

B. brizantha makes an excellent multi-purpose and productive pasture that can withstand high livestock stocking rates, with good persistence under continuous or rotational grazing. Under good management, *B. brizantha* pastures can remain viable for up to 20 years. *B. brizantha* has the ability to suppress weeds due to its fast growth rate and persistence (FAO, 2010; Husson *et al*., 2008; Cook *et al*., 2005). The grass is also valuable for cut-and-carry feeding, hay and silage, as well as fattening systems (Cook *et al*., 2005). The data on nutritive value indicate that the forage from *B. brizantha* is highly palatable and has a high nutritive value to stock, leading to high intake (Ndikumana and Leeuw de, 1996). The mean *in-vivo* organic matter digestibility (OMD) obtained on 25 samples of *Brachiaria* species was 57.8% ± 9.2 % (range 40-77 %). It corresponds to a maintenance energy ME content of 8.0 ± 1.7 MJ/kg DM (range 4.6-11.7). *B. brizantha* produces high yields and shows excellent response to fertilizer application. An addition of fertilizer may also have an effect on chemical composition and nutritive value as shown in the Table 1.

Table 1: Effect of nitrogen application on yield, crude protein content and in vitro degradability of *Brachiaria brizantha* in Tanzania

N level (kg/ha)	Yield (t DM/ha)	Crude protein (%DM)	*In vitro* OM degradability %
0	2.85	5.7	51.5
62.5	6.0	5.0	54.0
125	8.25	6.4	56.5
187.5	9.0	6.8	55.0

Source: Fredericksen *et al*., 1980

Deficiencies of *B. brizantha*

Brachiaria brizantha is greatly dependent on the fertility of the soil. On average, crude protein ranges from 6-17% depending on soil fertility and management, but can decline rapidly with age of the leaf, from 10% at 30 days to 5% at 90 days of growth. *B. brizantha* is sensitive to *veldt*/ rangeland fires. In Zambia, annual burning of predominantly *Hyparrhenia* grassland for three years reduced the *B. brizantha* cover from 0.38 to 0.09 percent (Brockington, 1961). In the natural *veldt*, *B. brizantha* spreads slowly by seed due to a high dormancy level of seeds. Heating and sulfuric acid are treatments that could be used to overcome seed dormancy. However, seed deterioration may be accelerated during storage, particularly if subjected to the heating treatment before storage (de Almeida *et al*., 2002).

Another widespread problem with use of *B. brizantha* as a forage is a toxicity syndrome called hepatogenous photosensitization. This syndrome results in sheep, goats and cattle developing skin lesions, facial oedema, liver damage (larger quantity of foamy macrophages in the hepatic parenchyma), mesenteric lymph nodes and ruminal stasis. This could result in severe drops in weight gain of up to 40% and possibly death if the animals are not removed from the pasture (Moreira *et al*., 2009). The cause of toxicity appears to be the presence of saprophytic fungus, *P. chatarum*, which produces spores thought to contain toxic sporidesmin (Andrade *et al*., 1971). Outbreaks of *Brachiaria* spp. poisoning in central western Brazil are frequently observed in pastures that have not been grazed for more than 30 days. Toxicity usually occurs during the growing stage of the pastures at the start of the rainy season (Brum *et al*., 2009).

History of *Brachiaria* Research in Zimbabwe

A number of *Brachiaria* spp. have been recorded in Zimbabwe. These include *Brachiaria brizantha, B. serrifolia, B. mutica, B. dictyoneura, B. nigropedata, B. solute, B. humidicola, B. radicans, B. serrata, B. jubata, B. leucocrantha, B. platynota and B. bovonei*. The most common of these species is the *B. brizantha* of which some limited research work has been documented in Zimbabwe.

Results obtained at Grasslands Research Institute:

During the period 1990-1993, six *Brachiaria* species were evaluated on Grasslands Research Farm on 1.5m X 2.0m plots in a *vlei* (seasonally waterlogged/ wetland) area. The species that were evaluated included:

1. *Brachiaria arrecta,*
2. *Brachiaria bovonei,*
3. *Brachiaria brizantha,*
4. *Brachiaria decumbens,*
5. *Brachiaria humidicola,*
6. *Brachiaria subulifolia.*

Data collected included initial stand establishment, flowering, wet and dry season herbage production, frost tolerance, leaf shed, pests and diseases, stand persistence and spread, and nutritive quality of herbage. From the data collected, *Brachiaria brizantha* had very competitive results compared with the other *Brachiaria* spp. (Table 2).

Table 2: Summary of yield (dry matter and crude protein) of various *Brachiaria* spp. evaluated under *vlei* (wetland) conditions at Grasslands Research Farm in Marondera

Spp. Code No.	*Brachiaria* Species	Dry Matter (%)	Crude Protein (%)	Yield, t/ha
2	*Brachiaria arrecta*	26.09	15.73	1.24
7	*Brachiaria brizantha*	34.09	15.07	2.56
16	*Brachiaria bovonei*	39.86	8.68	1.24
18	*Brachiaria subulifolia*	33.04	12.20	0.35
23	*Brachiaria humidicola*	25.39	15.20	3.50
27	*Brachiaria decumbens*	31.88	14.68	12.54

Source: Grasslands Research Institute, 1992: (unpublished data)

Further research on *Brachiaria* would need to include:

1. Management and utilization of *Brachiaria* under the different agro-ecological zones of Zimbabwe and,
2. Scientific performance evaluation of indigenous livestock breeds such as the Mashona and Tuli cattle, as well as indigenous goats fed on *Brachiaria*-based fodders and forages.

History of germplasm collections and development of the *Brachiaria* species

Development of new cultivars depends on germplasm diversity and deliberate collection missions, which were virtually non-existent until a large collecting effort was undertaken by CIAT in collaboration with the International Livestock Centre (ILCA) now International Livestock Research Institute (ILRI) and several African institutions that included Grasslands Research Institute between 1980 and 1984. This germplasm collecting expedition was supported by the International Board for Plant Genetic Resources (IBPGR). Several *Brachiaria* species germplasm were collected in wild East African and Zimbabwean Savannahs. CIAT then transferred part of the collection to the Brazilian Agricultural Research Corporation (EMBRAPA) for intensive evaluation programmes (Keller-Grein *et al*., 1996).

The accessions tabulated in Table 3 were responsible for successes within the beef industry in Brazil as they currently account for almost 85% of pastures in the Latin American country. The development of improved varieties in foreign countries would have been impossible without the germplasm obtained from Zimbabwe, but none of the profits are being returned to Zimbabwe by seed companies operating in Brazil. What does this imply?

1. That plant resources, including naturally occurring forages such as *Brachiaria* should be valued comparably with other natural resources such as precious mineral ores or crude.

2. That Zimbabwe should invest in a breeding programme to select and develop its own improved varieties of grasses from the rich diversity that exists in nature, in order to improve productivity of pastures, and subsequently that of livestock.

Table 3: *Brachiaria* accessions whose germplasm was obtained from Zimbabwe, with codes, identification numbers, register and area of origin as documented by EMBAPA Gado de Corte

Accession	Code	Identification	Register	Origin
B. nigropedata	B. nigro 3	N191	BRA005916	Hwange
B. nigropedata	B. nigro 4	N202	CIAT16921	BIKITA
B. nigropedata	B. nigro 5	N19	CIAT16911	Hurungwe
B. humidicola	B. humi 1	H10	BRA004952	Inyanga
B. humidicola	B. humi 2	H12	BRA004979	Inyanga
B. humidicola	B. humi 3	H13	BRA005011	Masvingo
B. nigropedat	B. nigro 1	N203	CIAT1692	Masvingo
B. brizanth	B.briz Mar	Marandu	02250	Marondera

Source: A.C Ambiel et al., (2010)

Given the potential of these underutilized *Brachiaria* species for improved animal nutrition, better food security as well as income generation from seed production, efforts have to be put in place not only to promote their production, but to also develop and release them back into production as improved plant genetic material. Once improved, they would be treated like any other crops that are accounted for and protected through registration under the Plant Breeders Rights Act (*Chapter 18:16*). In addition, Zimbabwean conservation programmes would have to strengthen collection missions for some of these naturally occurring germplasm for inclusion/ duplicating in the national Genetic Bank for future development and use in agriculture. This effort would support the active, but small genetic banks kept by the livestock institutes, mainly for research purposes and for limited distribution to farmers. The upscaling of utilization of pastures and forages at farm level, backstopped by research institutes as sources of material, needs to dovetail with the national development strategies for food security and poverty reduction.

Current *Brachiaria* Crop at GRI in Marondera

In November 2012, a Brazilian company (Braz Seeds) through an agent based in South Africa, supplied Grasslands Research Institute with two improved varieties of *Brachiaria sp.* These included *Piatã*, and cultivar *Marandu. Brachiaria brizantha* cv. *Marandu* (IRI 822; BRA-000591), was released in 1984 in Brazil by EMBRAPA. The cultivar was selected/ developed from germplasm introduced to the Ibirarema region in Sao Paulo, Brazil, from Grasslands Research Station in Marondera, Zimbabwe (Nunes *et al*., 1984).

B. brizantha cv. BRS *Piatã* was also released by EMBRAPA. This grass is recommended for pasture diversification in various types of cultivation, especially due to its high rate of leaf growth, high leaf/stem ratio and nutritive value. It tolerates drought well and yields an average 9.5 MT of dry matter/ha/year, with 57% leaves, of which 30% is obtained in the dry season of May to November (EMBRAPA, 2005).

On 5 December 2012, soil preparation began with the ploughing of 2 hectares for the establishment of the two *B. brizantha* varieties, after soil samples had been collected. The plots were limed at a rate of 1000 kg/ha. On 18 December the same year, rows were prepared at a spacing of 90 cm apart. Seed was planted at a rate of 5 kg/ha and basal fertilizer applied at a rate of 150 kg/ha of compound D (NPKS 7:14:7:6.5). The seeded rows were then covered using a drag harrow.

On 20 March 2013 the plots were dressed with urea fertilizer at a rate of 100 kg/ha along the rows. Weeding was then carried out to reduce the competition between weeds and the *Brachiaria sp.* as well as to improve establishment. During the first season, both varieties did not establish well due to the following factors:

1. Low seeding rate:

The initial seeding rate of 5 kg/ha as had been recommended by the seed supplier proved insufficient. This was rectified in the second rainy season. During the second year of establishment, a good stand of *Brachiaria brizantha* cv *Piatã* and *Marandu* was achieved thanks to a gap filling exercise carried out at the beginning of the 2013/14 rainy season. The gap filling exercise was done using vegetative material obtained from healthy *Brachiaria brizantha* plants within the plots to increase the plant population. Figures 1 and 2 show the comparative plant stands in the first and second years.

Fig 1: The *Brachiaria brizantha* in March **2013**

The *B. brizantha* crop had poor vigour during the 1st year of establishment from seed.

Fig 2: the *Brachiaria* crop in March **2014**

Noted improvements were observed in the 2nd season after gap filling using vegetative material.

2. Acidic soils (pH 4.3):

Liming and fertilization are important actions to improve soil fertility. In several experiments carried out in Brazil it has been shown that the effects of incorporating lime and fertilizer in soil for pastures were not evident in the first year of establishment. Liming and fertilization using fertilizers with N-P-K and micronutrients showed an increase in forage and root yield, mainly from the second year (Oliveira *et al*., 2001). A good root volume is a good indicator of the robustness of a grass species ability to survive in its vegetative state.

3. Pest and diseases:

In the first year of establishment, infestation by white grub and termites was noted between August and December. These disappeared with the onset of the rainy season, once the canopy was prolific and had covered the ground. No diseases of significant importance have been noted on both varieties to date.

It should be noted that when the indigenous *B. brizantha* accession was assessed in natural pastures in the *veldt*/ rangeland at Grasslands Research Farm and at Charter Estates, it was found to be susceptible to rust (*Uromyces setariae-italicae*). Although this was currently not evident with the improved *B. brizantha* accessions from Brazil. However, it is prudent to keep an eye on the rust and other diseases in this particular crop.

4. Weeds:

The *B. brizantha* accessions faced stiff competition from weeds during the first year of establishment before ground cover by the crop canopy. The major weed species being *C. nlemfuensis*. This was eradicated manually and by second season it was only evident on the fringes of the plots. This has implications on the importance of keeping the plots weed-free, especially in the first year of establishment.

After the vegetative gap filling exercise in the second season, the crops were top dressed with urea application at a rate of 100 kg/ha in January 2014. A visual assessment of the plant vigour of both *Brachiaria brizantha* cultivars showed a drastic improvement in the second year (2014) after establishment. In 2014, samples are going to be taken from both accessions and measured for biomass, both fresh and dry. Seed will also be harvested for further multiplication after germination tests are carried out.

Recommendations on future national programmes and policies

Besides further research on the potential benefits of *Brachiaria*, various authors, including Hiemstra *et al*. (2006) recommend a range of policy instruments that could be applied to conserve such indigenous plant genetic resources. These include the following possibilities:

1. Each country developing clear procedures for **access** and **benefit** sharing.
2. Carrying out a national inventory and mapping of naturally occurring spp. with potential for use in agriculture, such as *Brachiaria species*, using modern tools and techniques, including Geographical Information Systems (GIS).
3. Regulation of export and import of indigenous plant genetic resources and this is only possible if procedures for access and benefit sharing alluded to in (1), are in place.
4. Support the systems of *in-situ* and *ex-situ* conservation, including an improvement in infrastructure for strengthening genetic banking; on-farm management as well as development of indigenous plant genetic resources for utilization.
5. Cryo-conservation (by freezing) of plant seeds or shoots for future use in agriculture.

6. Improved understanding by policy makers and the general public, of the economics and strategic importance of genetic resources conservation and their sustainable use.

Concluding Remarks

- *Brachiaria* spp. has remained largely unexploited in its native land.

- This grass species could have a significant impact on animal production in Zimbabwe considering its local adaptation, high biomass production capabilities coupled with the ability to withstand high grazing pressures and stocking rates.

- The fact that the species has performed very well in countries where it has been introduced should act as a catalyst to utilize this useful animal feed resource.

- There is, therefore, a need to identify more local accessions and through selfing, select varieties that produce viable seed for propagation in the different ecological zones of Zimbabwe. Simultaneously, it would be useful to test further the improved varieties that have come from Brazil, including use in livestock feed trials at local level.

- Due to its attributes *Brachiaria brizantha* may be able to provide alternative forage to ensure availability of extensive low-cost feeding (grazing) as well as for fodder cultivation to be used in the cut-and-carry system, especially for smallholder livestock producers.

References

Ambiel et al., 2010. *Brachiaria* germplasm dissimilarity as shown by RAPD markers

Andrade *et al*., 1971, Estudos sobre *Brachiaria* sp. (Tanner Grass). III- Ocorrencias de intoxicacoes de bovines durante um ano (1970-1971) e niveis de nitrato em amostras da graminea. Arquivos do Instituto Biologico, Sao Paulo 38: 239-252

Boonman, J.G. 1993. East Africa's grasses and fodders: Their ecology and husbandry. Kluwer Academic Publication, Dordrecht, the Netherlands.

Brockington, 1961. Studies on the growth of *Hyparhenia dorminant grasslands in Northern Rhodesi,. II.* Fertilizer response. III. The effect of fire, *J. Brit*, *Grassld Soc.* 16

Brum *et al*., 2009. Toxicity of signal grass (*Brachiaria decumbens*): A Review Article

Cook *et al*., 2005. CSIRO, DPI&F (Qld), CIAT and ILRI, Brisbane, Australia

De Almeida *et al*., 2002. Impact of different grazing systems for bovine cattle on the soil microbiological and chemical characteristics

EMBRAPA, III Plano Diretor da Embrapa Gado de Corte: 2004-2007. Campo Grande, MS, 2005.

FAO, 2010. Grassland Index. A searchable catalogue of grass and forage legumes.

Fredericksen, J.H. and Kategile, J.A. 1980. The effect of nitrogen fertilization and time of cutting in first growth in *Brachiaria brizantha* on yield, crude protein content and *in vitro* digestibility. *Tropical Animal Production* 5:136-143.

Husson *et al*., 2008. CIRAD, Manuel pratique du semis direct à Madagascar, Vol. III, Chap. 3, par. 4.1

Keller-Grein et al., 1995. Natural variation in Brachiaria and existing germplasm collections. In: Miles, J.W.; Maass, B.L and Valle, C.B. do (eds.). *Brachiaria*: Biology, agronomy, and improvement. CIAT and Epresa Brasiliera de Pesquisa Agropecuaria/Centro National de Pesquisa de Gado de Corte (EMBRAPA/CNPGC), Cali, Colombia. (In press)

Miles, J.W.; Maass, B.L and Valle, C.B. do (eds.). *Brachiaria*: Biology, agronomy, and improvement. CIAT and Epresa Brasiliera de Pesquisa Agropecuaria/Centro National de Pesquisa de Gado de Corte (EMBRAPA/CNPGC), Cali, Colombia. (In press)

Moreira *et al*., 2009. Ciencia Animal Brasileira, 10 (1): 184-194

Muchadeyi et al., 1992. Division of livestock and pastures annual report 1991-2, Grassland Research Institute, Zimbabwe

Ndikumana and Leeuw de, 1996. Regional experiences with *Brachiaria* Sub-Saharan Africa.

Nunes *et al*., 1984. *Brachiaria Brizantha* cv. Marandu sob diferentes cargas-animale dosificações com anti-helmintico em solo de cerrado. Compo-Grande, EMPRAPA-CNPGC
Oliveira *et al*., 2001. Liming and fertilization to restore degraded *Brachiaria decumbens* pastures grown on an entisol

Urio *et al*., 1988. In: African forage plant genetic resources, evaluation of forage germplasm and extensive livestock production systems, Proc. 3rd Workshop, Arusha, Tanzania, 27-30/04/1987, ILCA