INCREASED ANIMAL PRODUCTION THROUGH THE DEVELOPMENT OF HIGH-QUALITY TROPICAL FORAGES

Liana Jank; Santos, M.F.; Valle, C.B. do; Barrios, S.C.; Simeão, R.M.
Embrapa Beef Cattle, Campo Grande, MS, Brazil

Animal production in the tropics and subtropics is based almost entirely on pastures. Only in Brazil, 167 Mha of pastures sustain 211 million heads of cattle, and just 11% of the slaughtered animals are terminated in feedlots (ABIEC, 1014). Cattle reared on pastures have a competitive advantage for export, eliminating the risks presented by the mad cow disease (bovine spongiform encephalopathy) and considerations related to animal welfare. To sustain all this huge pasture area and animal production, new cultivars of improved pastures must continuously be developed.

Despite the great importance of tropical forage, breeding is a very recent activity worldwide. Only in the last 40 decades, have investments been made to develop new cultivars through selection within large germplasm collections and then through breeding. In addition, many traditional programs were closed as the tropical legume programs at CSIRO (Commonwealth Scientific and Industrial Research Organisation), Australia and CIAT (International Center for Tropical Agriculture), Colombia.

Since the 1980s Brazil invested in importing large germplasm banks and in hiring and training forage breeders, thus, today Brazil is the leader in tropical forage breeding and new high-quality forage cultivars are continuously being developed. For this to be possible, strong breeding programs and research teams must always be prioritized. Breeding is underway for the genera *Brachiaria*, *Panicum*, *Pennisetum*, *Cynodon*, *Paspalum* and important legumes as *Arachis, Cajanus* and *Stylosanthes* (Jank et al., 2014).

The process of tropical forage cultivar development

The development of tropical forage cultivars is a process in which several stages must be met in order to obtain a superior genotype, candidate to be released as a cultivar (Jank et al., 2014). The development of high-quality forages depends on the use of wide variability germplasm, knowledge of the biology of the species, as number and ploidy level of chromosomes and breeding methods, and the generation of a great number of hybrids to be evaluated. Evaluations consist of three main stages, beginning with plot evaluations of the yield and quality of the hybrids under manual cutting, involving large amount of hybrids in small plots (300 to 2000 hybrids). The best 20 to 100 hybrids (depending on the program) are then evaluated in a second stage in diverse regions, also in plots under manual cutting, and finally few selected candidate to cultivars are evaluated in the last stage under grazing to certify their merit. In this process, parallel experiments are conducted to assess the merit of the new proposed cultivar under different kinds of stresses, both biotic and abiotic, and also to orient management once released, as spacing and depth of planting, management for seed production and fertilization strategies. Once all the information is available, the new cultivar must be baptized with a name and registered at the Ministry of Agriculture, Livestock and Supply before it can be commercialized. The institutions also invest in the protection of the cultivars, which generates royalties to the developers of the cultivar and guarantees that a high quality seed is commercialized. In the past nine years, six cultivars of *Brachiaria* and *Panicum maximum* were

released, and other two, one high-quality cultivar of each species, will soon be released.

Objectives of the breeding programs

The main objective of any breeding program is to select and release a cultivar which will contribute with pasture diversification and an increase in animal production with resistance to the main pests and diseases. Increase in yield is the first and easiest step in any program, especially in apomictic species which rely on large germplasm banks collected at the site of origin of the species and representative of the variability present in the species. This was achieved with the introductions of the *P. maximum* and *Brachiaria* collections in Brazil in the 1980's. In *P. maximum*, the first two cultivars released had a direct effect in the intensification of animal production in the country, due to a large increase in yield. Cultivar Tanzania, the first cultivar to be released in 1990, produced 85% more leaf yield in the dry basis than cultivar 'Colonião' existent in the country. The second release, cultivar Mombaça in 1993, produced 23% more leaf dry matter yield than cv. Tanzania, reason why it is still appreciated by many beef cattle producers in the country and abroad.

Another objective of breeding programs is to develop cultivars which will attend specific needs or have specific resistances to pests and diseases. *Panicum maximum* cv. Zuri was thus developed for showing a high degree of resistance to the leaf spot caused by the fungus *Bipolaris maydis*, a disease which affects cultivar Tanzania in some farms and regions of the country. This disease appeared after about fifteen years that cultivar Tanzania was being used. *Brachiaria humidicola* cv. Tupi was developed as another option for temporarily flooded soils, showing superior animal performance and greater individual live weight gain than the common *B. humidicola*. However, research is still underway to find high-quality grasses to substitute *B. brizantha* cv. Marandu in the North of the country in soils under temporary flooding. After 20 years that this cultivar was extensively used in the country, a syndrome of death of Marandu occurred, since it started to die in many farms, thus affecting animal production in these properties (Barbosa, 2006). To select for increased yield and increased quality combined is not always an easy task, but it is easier if the germplasm bank is large enough and representative of the natural variability of the species. This was possible with the selection of *P. maximum* cv. BRS Zuri, which resulted in an increment of 10% live weight gain per area in relation to Tanzânia (Andrade et al., 2013) and Mombaça in the Amazon and Cerrado, respectively, while also presenting a high degree of resistance to the leaf spot mentioned earlier. Breeding for only increased quality is possible. In a two-year experiment under grazing, *P. maximum* cv. Tamani presented 20% higher crude protein than cultivar Massai in the rainy season and 6% higher in the dry season. In the third year, after alterations in the management strategy, Tamani presented 9 and 6% higher IVOMD n the rainy and dry seasons, respectively. This higher quality has a direct effect on average daily gain of the animals, 9.4% in the rainy season, and 5.6% in the dry season. However, liveweight gain per area was similar for both forages because Tamani is a lower producer than cv. Massai.

In fact, in the evaluation of 75 *P. maximum* hybrids, Braz et al. (2011), obtained negative correlations of -0.57 to -0.67 between yield (green matter yield, total, leaf and stem dry matter yields) and crude protein and of -0.44 to -0.46 between yield and IVOMD. Negative correlations were also found for 1415 *B. decumbens* hybrids for crude protein and fresh yield (-0.45) and dry matter yield (-0.50) and digestibility and fresh yield (-0.70) and dry matter yield (-0.72).

Despite tropical breeding being still at its infancy, nevertheless, reports on progress obtained from breeding and information of genetic parameters of selection traits are being generated (Batistoti et al., 2012; Braz et al., 2013; Fernandes et al., 2014; Figueiredo et al., 2012; Martuscello et al., 2015 a; 2015 b). The use of marker assisted selection to aid the breeding programs is slowly becoming more tangible, as new research in this area progress (Bluma-Marques et al., 2014; Toledo-Silva et al., 2013; Zorzatto et al., 2010).

New options of high-quality forage cultivars

Much progress has been obtained in the past years with the release of important high-quality cultivars. Higher animal gains have been obtained through the release of *Brachiaria brizantha* cvs. Piatã, Xaraés and Paiaguás, *Panicum maximum* cvs. Mombaça, Tanzânia, Massai, BRS Zuri and BRS Tamani, *Cajanus cajan* cv. BRS Mandarim and *Pennisetum purpureum* cv. Kurumi. These cultivars are briefly presented below and more information may be found on www.cnpgc.embrapa.br (*Brachiaria* and *P. maximum* cultivars) and www.cnpgl.embrapa.br (*Pennisetum* cultivar) and www.cppse.embrapa.br (*Cajanus* cultivar).

Pennisetum purpureum cv. Kurumi was released in 2012. It is a hybrid cultivar selected for its dwarf size, vigorous vegetative growth, rapid leaf expansion, and intense tillering. It presents high quality and ease of management and stands out for its high forage production with excellent nutritional characteristics (Gomide et al., 2015). In southern Brazil, BRS Kurumi produced almost twice as much cultivar Mott (Mittelmann et al., 2013).

Cajanus cajan cv. BRS Mandarin was released in 2007 for animal feed, green fertilization and recovery of degraded pastures. It is easy to establish and manage, even in low fertility soils. It can be used as a support in the sugar cane production process, as a recovery of degraded areas and for intercropping with corn and pasture.

Brachiaria brizantha cv. Xaraés was released in 2003. The main advantages are very high productivity, especially of leaves, rapid regrowth and extension of the grazing period into the dry season because it is late flowering. It also has high nutritional value and carrying capacity, resulting in higher animal productivity than the well-known cultivar Marandu.

Brachiaria brizantha cv. BRS Piatã, released in 2007, presents ease of management and high forage accumulation in the dry season and similar performance and productivity as cultivars Xaraès and Marandu. It is a good alternative for crop-livestock integration because it is easily dissected and shows slower initial growth than these two cultivars. It associates well with Stylosanthes Campo Grande, corn and sorghum.

Brachiaria brizantha cv. Paiaguás was released in 2013. It was selected for its productivity, vigor and seed production. Despite being susceptible to spittle-bugs, its great advantage is during the dry season, when it presents great accumulation of forage of better nutritional value, resulting in higher weight gain per animal and per area. It associates well with off-season maize in crop-livestock integration for the production of autumn-winter forage and/or substrate for direct seeding.

Brachiaria humidicola cv. BRS Tupi was released in 2011 and was selected for its higher leaf/stem ratio and digestibility than common B. humidicola. It showed a superior animal performance and greater indi-

vidual weight gain, especially in the dry season. It is earlier flowering than the common cultivar and an alternative pasture planted by seeds in moist areas subject to temporary flooding.

Panicum maximum cv. Massai was released in 2001. It is a short sized plant and was selected for its high forage production and regrowth. It is more adapted to conditions of low soil fertility and low rainfall than other *P. maximum* cultivars. Management is easy and covers well the soil.

Panicum maximum cv. BRS Zuri was released in 2014 due to its high yield, high nutritive value, resistance to spittle-bugs and high degree of resistance to leaf spot, caused by the fungus *Bipolaris maydis*. It is a tall plant with very wide leaves moderately tolerant to waterlogging of the soil, similar to Tanzania-1, but grows best in well-drained soils, and is an option for diversification of pastures in the Amazon and Cerrado biomes.

Panicum maximum cv. BRS Tamani was released in 2015. It is the first hybrid released by the program. Is a short plant with intense tillering and abundance of very high-quality leaves. It is easily managed and recommended for animal categories where rapid weight gain is sought.

References

ABIEC. 2015. Associação Brasileira das Indústrias Exportadoras de Carne. http://www.abiec.com.br/texto.asp?id=8

ANDRADE, C.M.S. de; FARINATTI, L.H.E.; NASCIMENTO, H.L.B. do; ABREU, A.D.Q, de; Jank, L.; ASSIS, G.M.L. de. 2013. Animal production from new *Panicum maximum* genotypes in the Amazon biome, Brazil. Tropical Grasslands – Forrajes Tropicales, v 1, p. 1−5.

BARBOSA, R.A. 2006. Morte de pastos de braquiárias. Editor técnico Barbosa, R.A. – Campo Grande, MS: Embrapa Gado de Corte, 206p.

BATISTOTI, C.; LEMPP, B.; JANK, L.; MORAIS, M. G.; GOMES, R. A.; FERREIRA, M. V. B. 2012. Correlations among anatomical, morphological, chemical and agronomic characteristics of leaf blade in *Panicum maximum* genotypes. Animal Feed Science and Technology (Print), v. 171, p. 173-180.

BLUMA-MARQUES, A.C.; CHIARI, L.; AGENS, D.C.; JANK, L.; PAGLIARINI, M.S. 2014. Molecular markers linked to apomixis in *Panicum maximum* Jacq. African Journal of Biotechnology, v.13, n.22, pp.2198-2202.

BRAZ, T.G.S.; JANK, L; FONSECA, D. M.; MORI, I.K.; MARCOS, M.F.; BEZERRA, J.D.C. 2011. Correlação entre caracteres agronômicos e de valor nutritivo em híbridos de *Panicum maximum*. In: IV Congresso de Forragicultura e Pastagens, Lavras. Anais do IV Congresso de Forragicultura e Pastagens.

BRAZ, T.G. dos S.; FONSECA, D.M. da; JANK, L.; RESENDE, M.D.V de; MARTUSCELLO, J.A.; SIMEÃO, R.M. 2013. Genetic parameters of agronomic characters in *Panicum maximum* hybrids Revista Brasileira de Zootecnia, v.42, n.4, p.231-237.

FERNANDES, F.D.; RAMOS, A.K.B.; JANK, L.; CARVALHO, M.A.; MARTHA Jr., G.B.; BRAGA, G.J. 2014. Forage yield and nutritive value of *Panicum maximum* genotypes in the Brazilian savannah. Scientia Agricola, v.71, n.1, p.23-29.

FIGUEIREDO, U. J. DE; NUNES, J. A. R.; VALLE, C. B. do. 2012. Estimation of genetic parameters and selection of *Brachiaria humidicola* progenies using a selection index. Crop Breeding and Applied Biotechnology, v. 12, p. 237-244.

GOMIDE, C. A. de M.; PACIULLO, D. S. C.; LEDO, F. J. da S.; PEREIRA, A. V.; MORENZ, M. J. F.; BRIGHENTI, A. M. 2015. Informações sobre a cultivar de capim-elefante BRS Kurumi. Comunicado Técnico 75, Embrapa Gado de Leite, 4p.

JANK, L.; VALLE, C. B. do; RESENDE, R. M. S. 2011. Breeding tropical forages. Crop Breeding and Applied Biotechnology, p. 27-34. Special Edition - S1, p. 27-34.

JANK, L; BARRIOS, S.C.L.; VALLE, C.B. do; SIMEÃO, R.M; ALVES, G.F. 2014. The value of improved pastures to Brazilian beef production. Crop and Pasture Science, http://dx.doi.org/10.1071/CP13319.

MARTUSCELLO, J. A., BRAZ, T. G. S.; JANK, L.; CUNHA, D. de N. F.; LIMA, B.P. da S.; OLIVEIRA, L.P. 2015a. Repeatability and phenotypic stabilization of *Panicum maximum* accessions, Acta Scientiarum. Animal Sciences, v. 37, n. 1, p. 15-21.

MARTUSCELLO, J. A., BRAZ, T. G. S.; JANK, L.; CUNHA, D. de N. F.; CARVALHO, A.L.S. SOUZA, M. W. M.; BRITO, G. F.; OLIVEIRA, L.P. 2015b. Identification of ideotypes by canonical analysis in *Panicum maximum.* Ciênc. Agrotec., Lavras, v.39, n.2, p.147-153.

MATIAS, F.I.; BARRIOS, S.C.L.; VALLE, C.B. do; MATEUS, R.G.; MARTINS, L.B.; MORO, G.V. 2015. Estimate of genetic parameters in *Brachiaria decumbens* hybrids. Crop Breeding and Applied Biotechnology, in press.

MITTELMANN, A.; BORTOLINI, F.; BITENCOURT, D.; BENDER, S. E. 2013. Capim-Elefante: BRS Kurumi. Embrapa Gado de Leite, folder.

TOLEDO-SILVA, G.; SILVA, C.B.V.; JANK, L.; SOUZA, A.P. 2013. De Novo Transcriptome Assembly for the Tropical Grass *Panicum maximum* Jacq. PLOS ONE, 2013, v. 8 , n.7.e70781. www.plosone.org.

ZORZATTO, C.; CHIARI, L.; BITENCOURT, G. DE A.; VALLE, C. B. DO; LEGUIZAMÓN, G. O. DE C.; SCHUSTER, I.; PAGLIARINI, M. S. 2010. Identification of a molecular marker linked to apomixis in (*Poaceae*). Plant Breeding, p. 734-736.