BRS Quênia and BRS Tamani: new *Panicum maximum* Jacq. hybrid cultivars in Brazil

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Abstract

Since 1982 Embrapa Beef Catle in Campo Grande, MS, Brazil, develops a *Panicum maximum* Jacq. breeding program, based on the germplasm collected and assembled by IRD (Institut de Recherche pour le Developpment) and received through a cooperation-agreement with IRD. The germplasm was evaluated and four cultivars were released directly from the germplasm: cultivars Tanzania, Mombaça, Massai and BRS Zuri. Breeding began in 1990 and involved crosses between sexual plants and selected apomictic accessions. The program consists of evaluation followed by selection of hybrids in plots with replications, evaluation of the selected hybrids in national network experiments in diverse regions and then evaluation of the few selected hybrids under grazing. Hybrids are also evaluated for disease and insect resistances and abiotic stresses. Seeds are multiplied between each evaluation phase. The whole process takes from 10 to 20 years for the release of superior cultivars. Recently, Embrapa released two hybrid cultivars. BRS Tamani, a short, very leafy and high-tillering cultivar, and BRS Quênia, a medium height, very leafy productive cultivar. Both cultivars are recommended for medium to high fertility light soils, corrected for soil nutrients, and for rotationally grazed management. BRS Tamani, because of its short stature and quality is well indicated for cattle weaning. Both cultivars are tolerant to all the spittlebugs present in Brazil. They are not suited for waterlogged soils. Compared to the traditional cultivars in Brazil, these two cultivars showed improved digestibility and crude protein and greater animal daily gains and BRS Quênia also provided higher liveweight gain per area.

Introduction

Brazil maintains the largest cattle herd in the world, is the second largest meat producer and the world's leading meat exporter. The cattle herd with 213.68 million heads (Abiec 2020) is basically kept on pasture, since only 14% is finished in feedlot (Abiec 2020). This is the great differential of the meat produced in Brazil, which gives a competitive advantage to exports because it is less expensive, free from the risks associated with mad cow disease (bovine spongiform encephalopathy), in addition to providing greater animal welfare.

To maintain this entire herd (on 162.5 million hectares of pasture), several forages are part of the production systems, and the search for new, more adapted, productive and better-quality forages is constant. To meet the demand for improved cultivars, Embrapa Beef Cattle maintains programs for the development of cultivars of *Brachiaria* spp. (syn. *Urochloa* spp.) *Panicum maximum* (syn. *Megathyrsus maximus*) and *Stylosanthes* spp., to meet the demand for improved cultivars.

The *P. maximum* breeding program began in 1982 with the import from France of its entire germplasm collection representative of the species' natural variability (Savidan et al. 1989). French researchers from the IRD (Institut de Recherche pour le Développpment), formerly ORSTOM (Office de la Recherche Scientifique et Technique d'Outre-Mer) collected natural variability at their Centre of Origin in Kenya and Tanzania in 1967 and 1969 (Combes and Pernès 1970), and after thorough studies of variability, agronomic potential, reproductive mode and inheritance of the mode of reproduction, among others, the collection was made available to the tropical world.

In Brazil, the entire collection was evaluated agronomically and morphologically between 1984 and 1989 (Jank et al. 1997; Savidan et al. 1989) and the first crosses were carried out from 1990. At that time, the cultivar in use in Brazil was the widespread cv. Colonião. Approximately 50% of the accessions in the introduced collection were more productive than this cultivar (Jank 1995) and thus, after several studies, the cultivars Tanzania-1 in 1990, Mombaça in 1993 and Massai in 2001 were commercially released. These cultivars rapidly gained the preference of the cattle rearers in Brazil. The success of these cultivars was based on the fact that the plants have a larger number of leaves, a faster regrowth after grazing, and a better structure for grazing due to a greater proportion of leaves and less elongated stems, resulting on greater performance and animal productivity. All of this was combined with the fact that these cultivars had a good seed production, which enabled commercial production and distribution to ranchers.

Later, with the continuation of the improvement program, the released cultivars included BRS Zuri in 2014 and the hybrids BRS Tamani in 2015 and BRS Quênia in 2017, all registered and protected with the Ministry of Agriculture, Livestock and Supply in Brazil. The objectives of the present paper are to show the steps that were taken to the selection and release of the two hybrids developed and released in Brazil.

Methods and Study Site

The research was developed by Embrapa Beef Cattle in Campo Grande, Mato Grosso do Sul, Brazil, in partnership with various other Embrapa Units throughout the country. The *P. maximum* breeding program follows three phases: phase 1 - evaluation of many accessions and/or hybrids in small plots; phase 2 - evaluation of the selected ones in network trials in different regions; phase 3 – evaluation under grazing.

Crosses between a selected sexual plant and two distinct apomictic accessions were carried out in 1990 at Embrapa Beef Cattle. All hybrids obtained from these crosses were planted in 1991 in the field at 1 m spacing between plants. A visual selection was carried out with 10% selection pressure and the best 79 hybrids were evaluated in phase 1 in 1995. Plots consisted of two lines of five plants each, spaced 0.50 m between lines and plants, with two replications under cuts every 35 days in the rainy season and one cut at the end of the dry season (Jank et al. 2001; Resende et al. 2004).

Four selected hybrids, accessions from the germplasm bank and standards in a total of 23 genotypes were evaluated in network trials (phase 2) in six states in Brazil: Acre, Rondônia, Federal District, Mato Grosso do Sul, Rio de Janeiro and Rio Grande do Sul (Jank et al. 2004; Ledo et al. 2005; Valentim et al. 2006; Montardo et al. 2010; Fernandes et al. 2014). Experiments consisted of 23 genotypes evaluated on 6 x 4 m plots, with three replicates in a randomized block design.

Hybrid H46 (BRS Tamani) was evaluated for animal performance (phase 3) in the Cerrado Biome (Maciel et al., 2018) in comparison to cv. Massai in an experiment under rotational grazing system with 56 days grazing cycle (28 days of grazing and 28 days of rest).

Also, in phase 3, hybrid H64 (BRS Quênia) was evaluated for animal performance in the Amazon Biome in Rio Branco, AC, from 2010 to 2012, with cv. Tanzania as standard. It was also evaluated in the Cerrado Biome in Campo Grande, MS, from 2011 to 2014, with cv. Mombaça as standard. At each location, cv. BRS Quênia and the standard were planted on 3 hectares (2 replications of 1.5 ha each).

Other evaluations were also done leading to the selection of the cultivars, such as tolerance to spittlebugs, resistance to diseases (viruses, leaf spot and seed fungi occurrences), seed production, fertilization responses, and tolerances to poorly drained soils, shade and frost.

Results

BRS Tamani

In phase 1, cv. Tamani presented 18 t/ha of total dry matter yield and 15 t/ha of leaf dry matter yield, while in the dry season its production was 10% of the annual production.

In the phase 2, in the mean of the five evaluation experiments, cv. BRS Tamani produced 11.2 t/ha and 1.24 t/ha leaf dry matter yields in the rainy and dry seasons, respectively, with a crude protein content of 12.4% and 10%, respectively. Leaf digetibility was 60% in all seasons.

In phase 3 under grazing evaluating Nelore young bulls, with no supplementation, in the Cerrado Biome, BRS Tamani resulted in gains of 791 g/animal/day in the rainy season and 311 g/animal/day in the dry season. The liveweight gain per area was 2.28 kg/ha/day.

BRS Quênia

In phase 1, cv. BRS Quênia showed a production of 19 t/ha of total dry matter and 14 t/ha of leaf dry matter , and in the dry season its production corresponded to 14.7% of the annual production.

In phase 2, in the mean of the five evaluation experiments, cv. BRS Quênia produced 13.2 and 1.41 t/ha with 11.8% and 10.6% crude protein and 60 and 64% digestibility in the rainy and dry seasons, respectively.

In phase 3 under grazing, in the Cerrado Biome, BRS Quênia resulted in 554 kg/animal/ha gain in the rainy season and 258 kg/animal/ha in the dry season and a gain of 975 kg/ha. Mean crude protein and digestibility were 11.7% and 54.4%. In the Amazon Biome, BRS Quênia resulted in 700 g/animal/day gain in the rainy season and 643 g/animal/day in the dry season. This resulted in an animal gain of 862 kg/ha. Mean crude protein and digestibility were 13.6% and 63.5%, respectively.

Discussion [Conclusions/Implications]

BRS Tamani

BRS Tamani was selected in the first phase because of its short size, quality, agreeable visual appearance due to abundance of soft leaves, high tillering capacity, rapid regrowth after cuts and seed production. It is not as productive as cv. Massai, the commercial wide-spread cultivar of the same stature. In phase 2, in the mean of the five network experiments, it was 12 to 18% less productive, but presented 4 to 7% higher leaf percentage, 6 to 13% more crude protein and 3 to 7% more digestibility than cv. Massai (unpublished data).

These characteristics were ascertained under grazing, where BRS Tamani showed an 8 to 9% lower carrying capacity than cv. Massai, but a 11 to 18% higher liveweight gain per animal. Gains per area were very similar for both cultivars (Maciel et al. 2018; Braga et al. 2019). Thus, the high quality of cv. BRS Tamani was fundamental for this high gain per animal. In the rainy season, crude protein and digestibility were 20% and 9% higher for BRS Tamani, respectively, while in the dry season they were 9% and 6% higher.

BRS Tamani also showed an important advantage. Since it is early-flowering (it flowers in February during the rainy season), the animals control flowering through grazing, and so it enters the autumn-winter season with still a high-quality forage (Braga et al. 2019). In June, its digestibility was 66%, 9% higher than cv. Massai which flowers in April-May in the beginning of the dry season and loses much of its quality.

Another advantage is its short size which, together with the high leaf percentage and short abundant stems, permit an ease of management and greater flexibility of use, which is very important for cultivars of this species, which are usually difficult to manage. For *P. maximum* cultivars, rotational grazing is recommended, with entry of animals at 50 cm of canopy height and exit at 25 cm from the soil (Pasto Certo 2020) or entry 35 cm and exit 25 cm as suggested by Tesk et al. (2019). BRS Tamani also shows a good ground cover. It is, however, not adapted to waterlogged soils (Andrade and Valentim 2009).

BRS Quênia

BRS Quênia was selected in the first phase because of its visual appearance, medium-high stature, abundance of soft leaves, thin abundant stems, quality and productivity. In the mean of the five network trials in phase 2, BRS Quênia was from 3% to 9% more productive than cv. Mombaça in the rainy and dry seasons, respectively. Cv. Mombaça is the most planted cultivar in Brazil, and is slightly taller than BRS Quênia. Its quality was greatly superior than that of cv. Mombaça in the dry season, 19% and 15% greater crude protein and digestibility, respectively. In the rainy season, the superiority was 10% and 5%, respectively (Jank et al. 2017).

These positive characteristics were also ascertained in the grazing experiments (Andrade et al. 2013; Jank et al. 2017). In the Cerrado Biome, BRS Quênia presented a 17% higher animal gain/ha than cv. Mombaça (Jank et al. 2017). The carrying capacity was similar between cultivars, regardless of the season, thus, the superiority was due to a better individual performance. This gain was mainly due to its high quality, 7% and 14% higher crude protein and 4% and 8% higher digestibility in the rainy and dry seasons, respectively.

In the Amazon Biome, carrying capacity of cv. BRS Quênia was lower than cv. Tanzania during the rainy season, as a result of the soil waterlogging in the experimental area in the months of January and February, in the two years of study, a situation that most affected cv. BRS Quênia than cv. Tanzania, which has a higher tolerance to soil waterlogging (Andrade and Valentim 2009). Even so, the greater weight gain per animal offset the lower carrying capacity of the pastures of cv. BRS Quênia, resulting in a liveweight productivity 8% higher than for cv. Tanzânia.

BRS Quênia shows similar advantages as BRS Tamani of the high quality in autumn-winter, because it is also early flowering. Despite its taller stature, it is easier and more flexible to manage than Tanzânia and Mombaça. It is recommended for rotational grazing, with entry canopy height of 70 cm from the soil and exit 35 cm from the soil (Jank et al. 2017) or even entry height 55 cm and exit height 35 cm from the soil (Tesk et al. 2019).

Summarizing, BRS Quênia is a grass with high forage quality and high yield potential when cultivated on well-drained soils, being especially suitable for intensive animal production systems. The main differential of this cultivar in relation to the traditional cultivars Tanzania and Mombaça is the best plant architecture, with smaller clumps, higher density of soft green leaves and tillers, tender stems and lower percentages of dead material, facilitating grazing management and maintenance of the pasture structure more favourable to the high consumption of forage by cattle.

BRS Tamani is a short grass with a high forage quality when cultivated on well-drained soils, provides for an excellent ground cover conferring ease and greater flexibility of management. It is an option for high-input pasture systems concerning cattle growing and fattening. There are also reports from farmers of its suitability for sheep and horse grazing.

Both cultivars are resistant to the Brazilian spittlebugs and are indicated for use in well-drained soils of medium to high fertility, with more than 800 mm of annual rainfall and up to six months of dry season. However, they do not tolerate waterlogged soils.

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