Bioagro 37(1): 135-142. 2025 doi: http://www.doi.org/10.51372/bioagro371.12

PRODUCTIVITY AND NUTRITIVE VALUE OF ELEPHANT GRASS (CV. BRS CAPIAÇU) AT DIFFERENT CUTTING AGES AFTER PLANTING

Leticia Carolina Vieira[1], Emerson Silva Miranda[2], Junio César Martinez[3], Lucien Bissi Da Freiria[1], Luciano Da Silva Cabral [2] and Fagton De Mattos Negrão[1]

ABSTRACT

Due to their high dry matter production and balanced nutritive value per unit area, Elephant grass cultivars are excellent for bulky supplementation during the dry season. The objective was to evaluate the productivity and nutritive value of the BRS Capiaçu cultivar through different cutting ages after planting. The experimental design was conducted in completely randomized blocks, with four cutting ages: 60, 90, 120, and 150 days, each with five replications (blocks), totaling 20 experimental units, covering a total area of 12 m². As age advanced, linear increases in productivity were observed ($p \leq 0.01$), reaching an average height of 4.60 m, a green matter productivity of 252.60 t·ha^{-1}, and a dry matter productivity of 67.36 t·ha^{-1} at 150 days after planting. Regarding nutritional value, linear increments ($p \leq 0.01$) were found in dry matter, organic matter, and neutral detergent fiber levels, while mineral matter and crude protein exhibited a linear reduction ($p \leq 0.01$). However, no effects ($p > 0.17$) were observed with advancing cutting age after planting for acid detergent fiber, and hemicellulose variables. It is concluded that increasing the cutting age reduces the forage's nutritional value. From this perspective, the 90-day age proved to be more suitable for cutting BRS Capiaçu elephant grass.

Additional keywords: Biomass production, *Cenchrus purpureus*, harvesting times

RESUMEN

Productividad y valor nutritivo del pasto elefante (cv. BRS Capiaçu) a diferentes edades de corte después de la siembra

Debido a su alta producción de materia seca y valor nutritivo equilibrado por unidad de área, los cultivares de pasto elefante son excelentes para una suplementación voluminosa durante la estación seca. El objetivo fue evaluar la productividad y el valor nutritivo del cultivar BRS Capiaçu a través de diferentes edades de corte después de la siembra. El diseño experimental se realizó en bloques completamente al azar, con cuatro edades de corte: 60, 90, 120 y 150 días, cada una con cinco repeticiones (bloques), totalizando 20 unidades experimentales, cubriendo un área total de 12 m². A medida que avanzaba la edad se observaron incrementos lineales en la productividad ($p \leq 0,01$), alcanzando una altura promedio de 4.60 m, una productividad de materia verde de 252.60 t·ha^{-1} y una productividad de materia seca de 67.36 t·ha^{-1} a los 150 años. días después de la siembra. En cuanto al valor nutricional, se encontraron incrementos lineales ($p \leq 0,01$) en los niveles de materia seca, materia orgánica y fibra detergente neutro, mientras que la materia mineral y la proteína cruda presentaron una reducción lineal ($p \leq 0,01$). Sin embargo, no se observaron efectos ($p > 0.17$) al avanzar la edad de corte después de la siembra para las variables fibra detergente ácido y hemicelulosa. Se concluye que aumentar la edad de corte reduce el valor nutricional del forraje. Desde esta perspectiva, la edad de 90 días resultó ser más adecuada para el corte de pasto elefante BRS Capiaçu.

Palabras clave adicionales: *Cenchrus purpureus*, épocas de cosecha, producción de biomasa

Asociate Editor Dr. Marie González

INTRODUCTION

Livestock farming developed on pasture in agricultural frontier areas in Brazil undergoes several transformations. Inadequate management is one of the leading causes of the degradation of these pastures, causing serious economic and environmental losses. It is estimated that around 80 % of the existing pasture area in Brazil is undergoing some degree of degradation, with more than half in the advanced stages of this process (EMBRAPA, 2011).

Received: March 27, 2024 Accepted: September 16, 2024

[1] Federal Institute of Rondônia (IFRO), Colorado do Oeste, RO, Brazil. e-mail: leticia_carolina_@hotmail.com; lucien.freiria@ifro.edu.br; fagton.negrao@ifro.edu.br (corresponding author)

[2] Federal University of Mato Grosso (UFMT), Cuiabá, MT, Brazil. e-mail: s.emersonmiranda@gmail.com; lucianoufmt@gmail.com

[3] State University of Mato Grosso (UNEMAT), Pontes e Lacerda, MT, Brazil. e-mail: martinez@unemat.br

Furthermore, variations in precipitation throughout the year cause seasonal variations in forage production and quality, further aggravating the challenges of grazing cattle production. During the rainy season, there is abundant production of high-quality pastures. However, in the dry season, the scarcity of forage associated with low nutritional value becomes a significant concern for livestock farmers. This lack of forage supply compromises the weight gain of the cattle herd and increases susceptibility to diseases and parasites, resulting in severe losses (Aguiar et al., 2006). One of the recommended alternatives to overcome this shortage is using weeds for bulk supplementation during the year's dry season.

According to Morenz (2016) elephant grass (*Cenchrus purpureus* (Schumach.) Morrone) stands out for presenting high production and having a suitable chemical composition, being used as a more economical alternative than other crops.

The use of areas for the production of Capiaçu is one of the most viable and efficient forms of land use for animal feed (Nascimento et al., 2024). For this purpose, the BRS Capiaçu cultivar stands out for having dense clumps, erect stalks that make harvesting easier, moderate tolerance to water stress, and high potential for biomass production (Silva et al., 2020; Siri et al., 2020; Moreno et al., 2022).

Additionally, Reis et al. (2001) reported that maintaining a supply of high-quality forage throughout the year guarantees that animal requirements are met and increases efficiency in the use of forage, reducing the risk of degradation of crop areas pasture as a result of overgrazing, often recorded during the period of restricted growth of forages in tropical climates.

According to Faria et al. (1995/96), around 80 % of the total forage produced occurs in the rainy season, leaving herds subject to food shortages in the dry season. Of African origin, elephant grass (*C. purpureus*), was introduced in Brazil in the early 1920s (Faria et al., 1998) and presents several characteristics that suit the needs of Brazilian livestock farming, such as rusticity, high production, diverse varieties and cultivars, adapted to various types of soil, certain resistance to drought, resistance to pests and diseases and adequate nutritional value.

Elephant grass is the most suitable forage for forming grasses for cutting and supplying chopped green forage in the trough. In addition to high productivity, it has advantages such as good nutritional value and fast regrowth speed. The main disadvantages of elephant grass are difficulties in implementation and rapid loss of nutritional value. For these reasons, it has been used in genetic improvement programs to develop new cultivars for cutting and grazing (Souza et al., 2005).

With technological advances, numerous varieties of elephant grass are released onto the market. EMBRAPA (2016) launched BRS Capiaçu, a very high dry mass productivity cultivar. According to them, the cultivar yields around 50 ton of dry matter per $ha.yr^{-1}$, an average of 30 % more than cultivars available. According to Morenz (2016), when the grass is cut after fifty days, it produces 50 t of dry matter, 10 % crude protein, a higher rate than corn silage, with around 8 %. The protein content reduces to 6.5 % when cut at 90 days and 5.5 % when cut at 110 days.

The cultivation of BRS capiaçu grass is widely known. It stands out as a forage crop cultivated in almost all regions with a tropical and subtropical climate (Rosa et al., 2019). Therefore, it is essential that in-depth studies be carried out on its productive and qualitative characteristics depending on the cutting age and its adaptation to different climatic and soil conditions.

Therefore, the objective was to evaluate the influence of diferente cutting ages after planting on the productivity and nutritional value of *C. purpureus* cv. BRS Capiaçu.

MATERIALS AND METHODS

The experiment was conducted in the Federal Institute of Education Science and Technology of Rondônia, Campus Colorado do Oeste, Rondônia State, Brazil, located at 11º43' S and 49º15' W, 460 masl. The hot and sub-humid tropical climate predominates, with a maximum temperature of 33ºC and a minimum of 22ºC and precipitation of 1270 mm (INMET, 2024). The experiment occurred under rain months between January and July 2018, without irrigation.

The grass used was *C. purpureus* cv. BRS Capiaçu. Before the experiment started, soil samples were collected from the 0-20 cm profile.

These samples were homogenized to obtain composite sample, which was packaged in a plastic bags and sent to a laboratory accredited by EMBRAPA for macro and micronutrient analysis and to particle size fraction.

The soil in the area had the following chemical and physical characteristics: pH: 6.4; Ca: 8.0 cmolc·dm^{-3}; Mg: 1.46 cmolc·dm^{-3}; organic matter: 18.3 g·dm^{-3}; P: 3.1 mg·dm^{-3}; K: 0.37 cmolc·dm^{-3}; CEC: 11.3 cmolc·dm^{-3}; base saturation: 86.7 %; clay: 24.1 % and sand 63.0 %.

The experimental design used was randomized blocks with four treatments (cutting ages) and five replications (blocks). Each plot consisted of four rows of elephant grass 3 m long, spaced 1.00 m apart, making up an area of 12.00 m². A border of 1.00 m was considered at the ends, with the useful area consisting of two central rows, with a useful area of 2.00 m². The grass was implemented on January 28, 2018, with soil preparation consisting of harrowing and furrows approximately 0-20 cm deep made manually, with the help of hoes. Stolons containing four buds with approximately 30 cm segments were used.

In the initial phase of crop establishment, mainly in the first month of planting and one month after each cut, manual weeding was carried out to reduce invasive plants and competition for nutrients, thus reducing productive losses of forage.

BRS Capiaçu grass was cut on March 27, April 26, May 26 and July 25, 2018, corresponding to 60, 90, 120 and 150 days of age, respectively. The cut was made 0.10 m from the ground with the help of a machete, collecting the biomass from the useful area of each plot. To carry out the analyses, only two linear meters of the two central lines of each plot were used. In these two linear meters, samples were taken to measure the height of the plant, which was defined as the measurement from the soil surface to the last fully expanded leaf and the production of green matter. The height of the plants was measured with the aid of a measuring tape.

Grass plantation fertilization was not carried out, however, maintenance fertilizations were carried out, the first being carried out when the grass was at an average height of 0.50 m and aged 60 days, using the application of 1,200 kg per hectare of NPK fertilizer (20-05-20). The source of nitrogen used was placed in a furrow at a distance of 10 cm from the plants and 0.05 m deep.

The aerial biomass samples from each experimental unit were weighed on an electronic scale, with an accuracy of 0.1 kg, obtaining the weight of the biomass to determine the amount of green matter per square meter. Subsequently, this result was converted into green matter productivity per hectare.

Dry matter productivity was estimated by the relationship between green matter productivity and the dry matter content of the forage. Thus, to determine the dry matter productivity per hectare, grass samples were pre-dried in a forced ventilation oven at 60±5 °C for 72 hours. Then, these value were multiplied by the green matter productivity.

Subsequently, the samples were ground in a Thomas-Willey mill, using sieves with 1 mm diameter screens. In the pre-dried forage samples, the definitive contents of dry matter (DM) were determined in a drying oven at 105 ºC, crude protein (CP) by the Kjedahl method, and mineral matter (MM) by incineration in a muffle furnace at 550 °C for 4 hours according to techniques described in AOAC (1995). Neutral detergent insoluble fiber (NDF) contents were obtained according to the method of Van Soest, Roberteson and Lewis (1991) and acid detergent insoluble fiber (ADF) according to Goering and Van Soest (1970). The difference between NDF and ADF determined hemicelulose (HEM).

The data collected for each variable were subjected to analysis of variance (ANOVA). When significance was observed ($p \leq 0.05$), the degrees of freedom of the treatments for all variables were broken down into regression analyses. In the tables, *p*-values were omitted as no significant quadratic or cubic effect was identified. In the equations, consider Y as the estimate of the variable and X as the cutting age (in days) after planting. The selection of the model that best describes the results was based on the *p*-values and the coefficient of determination. All statistical analyses were performed using the SAEG program (1999) version 8.1.

RESULTS AND DISCUSSION

For plant height, significant increases ($p \leq 0.01$) with cutting ages of 60, 90, 120 and 150 days after planting, respectively (Table 1). Plant height is a factor of great importance in the management of forage grasses, as it is related to the degree of advancement of the plants' physiological maturity and the quality of the forage (Pacheco et al., 2024).

Table 1. Height, green matter productivity (GMP) and dry matter productivity (DMP) of *Cenchrus purpureus* cultivar BRS Capiaçu at different cutting ages after planting

Variables	Cutting ages (days)				MSE	*p*-value	
	60	90	120	150		Linear	Treatment
Height (m)[1]	1.77	2.84	4.23	4.60	0.1636	≤0.01	≤0.01
GMP ($t \cdot ha^{-1}$)[2]	41.76	123.46	245.30	252.60	28328	≤0.01	≤0.01
DMP ($t \cdot ha^{-1}$)[3]	3.51	14.57	54.50	64.11	7903	≤0.01	≤0.01

[1]$\hat{Y}$= -0.0923 + 0.0328X (R^2=0.95); [2]$\hat{Y}$= -98296.666 + 2516.5555X (R^2=0.91); [3]$\hat{Y}$= -45274.1886 + 780.3602X (R^2=0.92); MSE: mean squared error.

These increases in plant height usually lead to an increase in the proportion of culms due to their formation and an increase in their diameter. Furthermore, the stem diameter is directly correlated with the production of dry matter and can favor the greater presence of stem in the material, in turn, has a positive correlation with biomass productivity (Pacheco et al., 2024).

Bircham and Hodgson (1983) described the forage plant growth curve and tissue flow and reported that leaves grow more initially. As the canopy develops, leaf blades are less accumulated, and pseudoculms and senescent material are more accumulated. According to these authors, net growth is also reduced due to increased losses due to senescence.

Thus, it can be inferred that longer cutting intervals underutilize the productive potential and quality of the forage. In addition to reducing the number of cuts, they promote self-shading of the crop and encourage an increase in the proportion of pseudoculm, material with low nutritional value.

It was observed that the productivity of green plant matter increased linearly ($p \leq 0.01$) as a function of the cutting age after planting (Table 1). Concerning the dry matter productivity of the forage, there was also a significant increase linearly ($p \leq 0.01$) with advancing cutting age after planting (Table 1), due to the development of the plant, demonstrated through cutting heights.

The edaphoclimatic conditions of the North region, a dry matter productivity of 28.22 % more was observed than the study carried out in the Southwest region of the country (Pereira et al., 2016), demonstrating that it is a potential and promising grass for feeding ruminant animals, both in quantity and quality of forage. The biomass production potential of BRS Capiaçu exceeds that of corn and sugar cane, reaching an average of 50 $t.ha^{-1}.year^{-1}$ of dry matter (Pereira et al., 2016) or more when harvested at 150 days, as shown in this work.

This result can be explained by the age of the grass, which increases the content of fibrous fractions (cellulose, lignin and hemicellulose) as it increases. It is also worth highlighting that the fibrous fractions are directly linked to the development of the cell wall and that with increasing cutting age, they are responsible for providing greater rigidity to the plants. When ingested in large quantities, it can reduce consumption by ruminant animals.

Therefore, the higher values found for plant height and green material productivity ($kg.ha^{-1}$) at more advanced cutting ages are justified because the plants had more time to accumulate biomass. Also, as the height of the forage canopy increases, tillers compete for light, which favors stem lengthening. This process is associated with the thickening of the plant cell wall, which provides resistance to the tiller and positions the leaves at the top of the canopy to favor light capture (Da Silva, 2004).

It was found that increasing the cutting age of capiaçu grass after planting increased linearly ($p \leq 0.01$) the dry matter (DM) (Table 2). According to Pereira et al. (2021), after 90 days of regrowth, the cultivar BRS Capiaçu tends to reach a DM content of 18 to 20 %.

Retore et al. (2021) found that the DM content of BRS Capiaçu grass increased with increasing cutting age because as the plant matures, there is a decrease in the proportion of leaves in relation to stalks and, consequently, an increase in DM content. In weed management, the cutting age influences the yield and quality. The longer the interval between cuts is, the greater the amount of DM, but the lower the nutritive value of the forage (Monção et al., 2019).

Table 2. Proximal analysis of *Cenchrus purpureus* cultivar BRS Capiaçu at different cutting ages after planting

Variables (%)	Cutting ages (days)				MSE	*p*-value	
	60	90	120	150		Linear	Treatment
DM[1]	8.41	11.80	22.22	25.38	0.5954	≤0.01	≤0.01
OM[2]	80.51	87.29	87.40	89.33	1.1820	≤0.01	≤0.01
MM[3]	19.48	12.70	12.59	10.66	1.1820	≤0.01	≤0.01
CP[4]	12.06	10.13	9.59	7.63	0,2465	≤0.01	≤0.01
NDF[5]	61.54	65.08	68.02	72.88	1.0197	≤0.01	≤0.01
ADF[6]	38.46	34.92	31.98	27.12	2.9661	-	0.19
HEM[7]	23.08	30.16	36.04	45.76	2.3885	-	0.17

DM: dry matter; OM: organic matter; MM: mineral matter; CP: crude protein; NDF: neutral detergent insoluble fiber; ADF: acid detergent insoluble fiber; HEM: hemicelulose; MSE: mean squared error.
[1]$\hat{Y}$= -4.5073 + 0.2044X (R^2=0.95); [2]$\hat{Y}$= 76.8383 + 0.0885X (R^2=0.79); [3]$\hat{Y}$= 23.1616 - 0.088X (R^2=0.79); [4]$\hat{Y}$= 14.6980 – 0.0461X (R^2=0.96); [5]$\hat{Y}$= 53.9443 + 0.1232X (R^2=0.98); [6]$\hat{Y}$= 33.12; [7]$\hat{Y}$= 33.76.

Increasing the cutting age results in increases in dry matter production; however, the nutritional value of the forage produced declines. The biggest changes in the chemical composition of forage plants are those that accompany their maturation. As the plant ages, the proportion of potentially digestible components tends to decrease, and the proportion of fiber tends to increase. According to Weiss (1993), as the plant ages, the forage quality decreases due to increased structural components such as lignin, hemicellulose, and cellulose, is the least digestible fraction of food.

Organic matter (OM) levels increased linearly (p≤0.01) (Table 2). At the same time, there was a linear reduction in the mineral matter (MM) (p≤0.01). This result can be explained by the increased deposition of structural carbohydrates in the plant wall at the expense of reducing the plants´s mineral fraction, as observed in the present work.

Reducing MM in forage plants is not attractive. According to Van Soest (1994), mineral deficiency in roughage can cause a reduction in animal performance and increase the incidence of health problems (Van Soest, 1994).

For crude protein (CP) levels, a reduction (p≤0.01) (Table 2). Martins et al. (2008) found more expressive results. They observed that the CP content in elephant grass fell from 17.14 % at 30 days to 8.73 % at 105 days of cutting age. This reduction is associated with advancing the plant´s maturation stage, which causes a decrease in cellular contente (the leading storage site for CP) in favor of an increase in the plant cell wall.

Therefore, it is important to highlight that the younger the grass, the higher the crude protein content and, consequently, the better its nutritional value. It is observed that even with the reduction in crude protein contents, according to the cutting ages, the values are in the acceptable range.

Minson (1990) report that a CP content of 7 % is necessary to maintain adequate rumen fermentation, allowing the microbial population to be active for using fibrous feeds. Furthermore, Van Soest (1994) report that CP levels below 7 % limit animal production, due to low voluntary consumption, lower digestibility coefficients and negative nitrogen balance.

Additionally, the most significant levels of crude protein and digestibility are allocated to the leaves. Thus, possibly, as the forage grows, the fiber content increases, thus, a large part of this crude protein may be in an unavailable form since the advancement in the cutting age of the elephant grass has reduced its nutritional value, characterized by the reduction of the soluble fractions of DM (Martins et al., 2008).

Harvesting younger forage will provide greater use of crude protein, due to the reduction of fibrous parts and increased digestibility of the material, however when the plant is harvested very young (60 days), it has a low amount of DM, resulting in a high consumption of this food, with the intake being limited by a restriction in the capacity of the digestive tract or by ruminal distension (Forbes, 1977), however diets that do not provide the necessary energy concentration can result in low animal performance.

Neutral detergent insoluble fiber (NDF) levels increased ($p \leq 0.01$), Table 2. These values can be explained according to the maturity of the grass, due to the increased concentration of cellulose, lignin and hemicellulose in the portion.

The increase in the percentage of insoluble fiber in neutral detergent demonstrates the reduction in the proportion of forage that the animal can digest, since NDF values above 60 % (Mertens, 1987; Van Soest, 1994) can make food digestion difficult by rumen microorganisms. Therefore, the later the grass is cut, the greater the participation of this fraction, contributing to the reduction in dry matter consumption by ruminants.

The content of NDF is related to the space occupied by the feed in the rumen. The current trend is to express the daily rumen filling capacity in neutral detergent insoluble fiber units, mainly when the diet consists of fresh forage or coarsely chopped (Van Soest, 1994). According to Mertens (1987), the NDF consumption capacity in Dairy cattle is 1.2 % of the animal's live weight.

Animals consume food to meet their energy, protein, mineral and vitamin needs requirements. However, if the roughage's nature restricts food consumption, it will also limit the animal's performance (Van Soest, 1994). Therefore, NDF in diets with a high proportion of fibrous fraction fills the rumen-reticle spaces, taking longer for the fraction fibrous to leave these compartments, limiting DM consumption and ingesting less energy.

The levels of acid detergent insoluble fiber (ADF) (p=0.19) and hemicellulose (HEM) (p=0.17) did not show a significant effect on the advancing cutting age of the cultivar after planting (Table 2). According to Mertens (1982), ADF (lignin and cellulose) is inversely correlated with the digestibility content of dry matter. Lignin is one of the main components of food that reduces digestibility, as rumen microorganisms cannot digested, preventing them from accessing the hemicellulose and cellulose fractions of the plant cell wall.

The increase in NDF in the present study probably occurred due to the plant's advancing age, which consequently increased the stem's participation since, as the plant ages, the proportion of potentially digestible components tends to decrease, and the proportion of fiber increases (Tables 1 and 2). The increase in the fibrous fraction causes the complexation of the crude protein to the plant cell wall components. Therefore, they cause a reduction in handling and the slow disappearance of digesta in the rumen (Van Soest, 1994).

Alves et al. (2022) related the plants managed with intervals between cuts of 120 days provided the highest yields of NDF and ADF per hectare.year^{-1}. In this sense, the potential of a forage plant should not be evaluated, taking only quantitative aspects into account. The data obtained in this work show that forage harvested at 150 days presented the highest total production of dry material. However, they had the lowest CP content and the highest NDF content, thus reducing the nutritional value of the forage.

In general, the results prove the great potential of capiaçu grass for conservation purposes. It is characterized as a good alternative for roughage supplementation for ruminants. However, although the intervals between cuts are a management factor that contributes to determining the nutritional value of the grass to be produced, the cutting age can vary according to the edaphoclimatic conditions pertinent to each region, which is extremely important, taking into account given that elephant grass presents a rapid accumulation of thatch, and consequently, a reduction in its nutritional value.

The chemical composition results may vary according to the experimental conditions in which these forages were grown, due to different factors, such as: soil conditions, climate and fertilization. In the present study, concerning climatic conditions, the month of July is considered a dry period in the state of Rondônia, in which there was probably less rainfall, possibly influencing the growth of grass and, consequently, affecting the chemical composition of the grass. Although a significant increase in productivity was found with increasing cutting age, there was a change in the nutritional value of BRS capiaçu elephant grass forage.

CONCLUSIONS

Cenchrus purpureus cv. BRS Capiaçu is characterized as a good alternative for the production of bulky foods. It is observed that at 90 days, there is a balance between productivity and chemical composition, making this age recommended for cutting this cultivar.

LITERATURE CITED

1. Alves, J.P., S.S. Mendes, E.S. Galeano, M.A.P. Orrico Junior, T. Fernandes, M. Retore et al. 2022. Forage Production and Quality of BRS Capiaçu as a Response of Cutting Age and Nitrogen Application. Tropical Animal Science Journal 45(2): 179-186.
2. AOAC, Association of Official Analytical Chemists. 1995. Official methods of analysis.14 ed. Washington.
3. Aguiar, E.M., G.F.C. Lima, M.V.F. Santos, F.F.R. Carvalho, A. Guim, H.R. Medeiros and A.Q. Borges. 2006. Rendimento e composição químico-bromatológica de fenos triturados de gramíneas tropicais. Revista Brasileira de Zootecnia 35(6): 2226-2233.
4. Bircham, J.S. and J. Hodgson. 1983. The influence of sward condition on rates of herbage growth and senescence in mixed swards under continuous stocking management. Grass and Forage Science 38(4): 323-331.
5. Da Silva, S.C. 2004. Understanding the dynamics of herbage accumulation in tropical grass species: the basis for planning efficient grazing management pratices. *In*: Simpósio em Ecofisiologia das Pastagens e Ecologia do Pastejo, 2., 2004, Curitiba. Curitiba: UFPR 1 CD-ROM.
6. Embrapa – Empresa Brasileira de Pesquisa Agropecuária. 2011. Centro Nacional de Pesquisas de Solos. Manual de métodos de análises de solos. 2.ed. Rio de Janeiro: Embrapa Solos. 230 p.
7. Embrapa - Empresa Brasileira de Pesquisa Agropecuária. 2016. Capim-elefante - BRS Capiaçu. Comunicado técnico 79. Juiz de Fora, MG.
8. Faria, E.F.S., L.C. Gonçalves and V.J. Andrade. 1995/96. Comparação de seis tratamentos empregados para melhorar a qualidade da silagem da capim-elefante (*Pennisetum purpureum* Schum.) em três idades de rebrota. I – 60 dias. Arquivo Escola de Medicina Veterinária da UFBA 18(1): 103-125.
9. Faria, V.P., S.C. Silva and M. Corsi. 1998. Potencial e perspectivas do pastejo em capim-elefante. Informe Agropecuário 19(192): 05-13.
10. Forbes, J.M. 1977. Developement of a model of voluntary food intake and energy balance in lactating cows. Animal Production 24: 203-214.
11. Goering, H.K. and P.J. Van Soest. 1970. Forage fiber analysis: apparatus reagents, procedures and some applications. Washington, D.C. Agricultural Handbook 379p.
12. INMET - Instituto Nacional de Meteorologia. 2024. Registered conditions. Brasília. https://tempo.inmet.gov.br/CondicoesRegistradas (retrieved Sept. 16, 2024).
13. Martins-Costa, R.H.A., L.S. Cabral, M. Bhering, J.G. Abreu, J.T. Zervoudakis, R.C. Rodrigues and I.S. Oliveira. 2008. Valor nutritivo do capim-elefante obtido em diferentes idades de corte. Revista Brasileira de Saúde e Produção Animal 9(3): 397-406.
14. Mertens, D.R. 1982. Using neutral detergent fiber to formulate dairy rations. In: Proceedings gainut conference for the Feed Industry. Athens University of Georgia pp. 116-126.
15. Mertens, D.R. 1987. Predicting intake and digestibility using mathematical models of ruminal function. Journal of Animal Science 64(5): 1548-1558.
16. Minson, D.J. 1990. Forage in ruminant nutrition. San Diego: Academic Press.

17. Monção, F.P., M.A.M.S. Costa, J.P.S. Rigueira, M.A. Moura, V.R.R. Rocha Junior, V.M. Gomes et al. 2019. Yield and nutritional value of BRS Capiaçu grass at different regrowth ages. Semina Ciências Agrárias, 41: 745-755.
18. Moreno, L., M. Cunha and L. Oiveira. 2022. Capim BRS Quênia: Produtividade de forragem sob diferentes estratégias de calagem e adubação no Tocantins. Tocantins, Embrapa Pesca e Aquicultura. v. 7 https://n9.cl/v25y2 (retrieved Sept. 16, 2024)
19. Morenz, M. 2016 Nova cultivar de capim-elefante apresenta produtividade 30% maior. Empresa Brasileira de Pesquisa Agropecuária
20. Nascimento, A., B.P.M. Oliveira, J. França, T. Silva Siqueira, M.F Andrade and J.N. Tabosa. 2024. A evolução genética do gênero sorghum e a importância do cereal para a economia mundial e a promoção da segurança alimentar a nível global: uma revisão integrativa. Revista de Gestão e Secretariado 15(2): e3552.
21. Pacheco, L.B., R.L. Machado, F.A.L. Soares, P.S.F. Silva, K.C.C. Rabelo and Â.A.L. 2024. Effects of biochar on soil fertility and the morphometry and production of elephant grass cultivars. Revista Caatinga, Mossoró 37: e11786.
22. Pereira, V., S.J.F. Ledo, B.L.J. Leite, B.M.A. Santos, E.C. Martins and C.J. Machado. 2016. BRS Capiaçu: cultivar de capim-elefante de alto rendimento para produção de silagem. Comunicado Técnico. Juiz de Fora - MG.
23. Pereira, A.V., A.M. Auad, A.M. Brighenti, A. Mittelmann, C.A.M. Gomide, C.E. Martins et al. 2021. BRS Capiaçu e BRS Kurumi: cultivo e uso. 1. ed. Brasília, DF: Embrapa 2021. 117 p.
24. Reis, R.A., A.L. Moreira and M.S. Pedreira. 2001. Técnicas para produção e conservação de fenos de alta qualidade. *In*: Jobim, Cloves Cabrera, Santos, Geraldo Tadeu dos Dasmaceno, Júlio César; Cecato, Ulysses. (Org.). Anais. Simpósio sobre Produção e Utilização de Forragens Conservadas. 1. ed. Maringá v.1 pp. 1-39.
25. Rosa, P.P., P.M. Silva, R.G. Chesini, A.P.T. Oliveira, P.A. Sedrez, M.R. Faria et al. 2019. Características do Capim Elefante *Pennisetum purpureum* (Schumach) e suas novas cultivares BRS Kurumi e BRS Capiaçu. Pesquisa Agropecuária Gaúcha 25: 70-84.
26. Retore, M., J.P. Alves, M.A. Orrico Junior and E.J. Galeano. Manejo do capim BRS Capiaçu para aliar produtividade à qualidade. 1. ed. Dourados, MS: Embrapa, 2021. 9 p. (Comunicado Técnico, 263).
27. Saeg. Sistema para Análises Estatísticas. 1999. Versão 8.1. Viçosa: Fundação Arthur Bernardes.
28. Silva, A.R.P., F.J. Dias, J.P.F. Rufino, E.S. Tanaka and M.M. Lopes. 2020. Effect of using inoculant on elephant grass silage with additives. Acta Scientiarum. Animal Sciences 42: 1-7.
29. Siri-Prieto, G., M. Bustamante, V. Picasso and O. Ernst. 2020. Impact of nitrogen and phosphorous on biomass yield, nitrogen efficiency, and nutrient removal of perennial grasses for bioenergy. Biomass and Bioenergy 136: 105526.
30. Souza Sobrinho, F., A.V. Pereira, F.J.S. Ledo, M.A. Botrel, J.S. Oliveira and D.S. Xavier. 2005. Avaliação agronômica de híbridos interespecíficos entre capim-elefante e milheto. Pesquisa Agropecuária Brasileira 40(9): 873-880.
31. Van Soest, P.J., J.B. Robertson and B.A. Lewis. 1991. Methods for Dietary Fiber, Neutral Detergent Fiber, and Nonstarch Polysaccharides in Relation to Animal Nutrition. Journal of Dairy Science 74: 3583-3597.
32. Van Soest, P.J. 1994. Nutritional ecology of the ruminant. Ithaca: Cornell University Press 476 p.
33. Weiss, W.P. 1993. Predicting energy values of feeds, Journal of Dairy Science 76: 1802.