Scientia Agraria Paranaensis
Scientia Agraria Paranaensis – Sci. Agrar. Parana.
ISSN: 1983-1471 – Online
DOI: https://doi.org/10.18188/sap.v23.33470

STRATEGIES FOR MANAGING MARANDU GRASS DURING THE DRY SEASON

Vinícius Emanoel Carvalho[1], Saulo Alberto do Carmo Araújo[1], Norberto Silva Rocha[2], Bruno Borges Deminicis[3*]

SAP 33470 Received: 12/07/2023 Accepted: 02/11/2023
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 23, e202433470, 2024

ABSTRACT - The present study is essential for optimizing pasture management during the dry season, maximizing animal productivity and forage utilization efficiency. Additionally, it contributes to the sustainability of livestock farming by evaluating strategies that enhance cattle performance and forage nutritional quality. This study aimed to evaluate the effects of two management strategies for Marandu grass during the dry season: an irrigated system and a deferred grazing system combined with multiple protein-energy supplementation. The experiment was conducted using a completely randomized design with eight crossbred cattle (Holstein x Zebu), male, castrated, with an average body weight of 420 kg (± 25 kg). The animals were evenly distributed between the two management systems and subjected to four grazing cycles. Periodic evaluations were conducted on dry matter intake, animal performance, and pasture structural characteristics. Additionally, forage production, bromatological quality, and stocking rate were monitored to compare the efficiency of both systems throughout the experiment. Both systems exhibited similar results in average daily weight gain and productivity per area despite nutritional differences, but the stocking rate was significantly different, with the irrigated area supporting a higher rate.
Keywords: Seasonality of forage production, pasture quality, forage consumption, animal performance.

ESTRATÉGIAS DE MANEJO DO CAPIM MARANDU NO PERÍODO SECO

RESUMO - O presente estudo é fundamental para otimizar o manejo de pastagens no período seco, maximizando a produtividade animal e a eficiência do uso da forragem. Além disso, contribui para a sustentabilidade da pecuária ao avaliar estratégias que melhoram o desempenho dos bovinos e a qualidade nutricional das pastagens. Objetivou-se com este estudo avaliar os efeitos de duas estratégias de manejo do capim-marandu durante o período seco: um sistema com irrigação e outro com diferimento de pastagem associado à suplementação múltipla proteico-energética. O experimento foi conduzido em um delineamento inteiramente casualizado, utilizando oito bovinos mestiços (Holandês x Zebu), machos, castrados, com massa corporal média de 420 kg (± 25 kg). Os animais foram distribuídos igualmente entre os dois sistemas de manejo e submetidos a quatro ciclos de pastejo. Foram realizadas avaliações periódicas do consumo de matéria seca, desempenho animal e características estruturais da pastagem. Além disso, a produção forrageira, a qualidade bromatológica da forragem e a taxa de lotação foram monitoradas para comparar a eficiência dos sistemas ao longo do experimento. Ambos os sistemas apresentaram resultados semelhantes no ganho médio diário de peso e na produtividade por área, apesar das diferenças nutricionais, mas a taxa de lotação foi significativamente diferente, sendo maior na área irrigada.
Palavras-chave: Sazonalidade de produção de forragem, qualidade do pasto, consumo de forragem, desempenho animal.

INTRODUCTION

The national agricultural sector has been one of the few areas showing growth in recent years, even amidst the country's ongoing economic crisis. Currently, Brazil holds the largest commercial cattle herd in the world, with 224.57 million head, producing 10.4 million tons of carcass equivalent (TEC) and exporting 2.54 million TEC, positioning the country as the world's largest exporter of beef (ABIEC, 2023). In 2017, livestock accounted for 28% of the agribusiness GDP, with agribusiness itself representing 26% of the total GDP. In the same year, the beef cattle industry generated R$ 650.32 billion, creating 380,000 formal jobs. Globally, Brazil ranks third in beef consumption, with an average consumption of 37.5 kg per capita per year, behind only the United States and China (FAO, 2023).

Regarding milk production, Brazil ranks fourth globally, having produced 34.24 million tons of milk in 2016, with a per capita consumption of approximately 173 L/year. The country's recent advancements in meat and milk production are primarily due to the low cost of feeding livestock, with pasture being the main food source for these animals. It is estimated that the global area dedicated to pastures is approximately 34 million square kilometers, representing 26% of the Earth's surface. In Brazil, pastures occupy 180 million hectares, with 80 million hectares of natural pastures and 100 million hectares of cultivated pastures (SANTOS et al., 2023). Recent evaluations have shown that a considerable portion of pastures in the Amazon

[1]Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM), Unaí, MG, Brazil.
[2]Faculty of Health Sciences of Unaí (FACISA NOROESTE), Unaí, MG, Brazil.
[3]Federal University of Mato Grosso (UFMT), Sinop, MT, Brazil. E-mail: bruno.deminicis@ufmt.br *Corresponding author.

and Cerrado biomes is in a state of degradation (SANTINI et al., 2015).

This degradation is due to various factors that can act alone or together, including improper soil preparation, inappropriate forage species for the area, low-quality seeds, overgrazing, and lack of nutrient replenishment. The latter is the main factor in the loss of productivity of our pastures, often overlooked by our cattle ranchers (CARVALHO et al., 2017).

During the rainy season, when climatic conditions favor the development of forage plants, there is a food shortage due to inadequate pasture management. In the dry season, when climatic conditions are unfavorable, this shortage is exacerbated. The nutritional quality of pastures during the dry season is low, with the crude protein content often not reaching the 7% minimum necessary for animal maintenance (VAN SOEST, 1994). One alternative to mitigate the problem of forage nutritional quality is to supplement the animals during the dry season. Nutritional correction through supplementation has been shown to significantly increase weight gain and stocking rate per area, thus improving forage utilization despite its low nutritional quality (TERRA et al., 2019).

Another way to minimize the low availability of forage during the dry season is through irrigation. Soil water deficiency affects plant development and, consequently, its productivity. With irrigation, these problems are alleviated. It is generally recommended to irrigate pastures in regions where temperature and light conditions remain close to the ideal for forage plant development. In addition to irrigation, it is important to replenish the nutrients required for plant development through fertilization (MAGALHÃES et al., 2015).

Well-established and properly managed tropical grasses constitute the best form of feed for cattle. The Brachiaria genus stands out in Brazil for its adaptation to tropical conditions, presenting considerable nutritional and productive values. *Urochloa brizantha* (syn. *Brachiaria brizantha*) cultivar Marandu is notable among *Brachiaria* cultivars for its high productivity and greater rate of production and regrowth, ensuring high yields and carrying capacity per area compared to other cultivars (MELO et al., 2021).

Given the above, the objective was to evaluate two management strategies for Marandu grass during the dry season (irrigation system and deferred pasture system with multiple protein-energy supplementation), assessing animal performance and the morphological and nutritional characteristics of pastures under both strategies.

MATERIALS AND METHODS

The experiment was conducted in the Ruminant Nutrition Sector at the Santa Paula Experimental Farm (FESP), part of the Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM), in the Unaí County, Minas Gerais State, Brazil (16°21’50” S and 46°54’15” W, altitude 640 m). The climate in the region is classified as Aw, tropical, with an average annual temperature of 27°C, average annual precipitation of 1,200 mm, and well-defined rainy summers and dry winters (KÖPPEN, 1948).

Thirty days before the start of the study, a soil analysis was conducted in the experimental area, which totaled approximately 1.6 hectares (ha). Soil samples were collected from a depth of 0 to 20 cm and sent for analysis to the soil fertility laboratory at the Federal Institute of Minas Gerais, Bambuí *Campus*, yielding the following results (Table 1).

TABLE 1 - Soil analysis of the experimental area.

pH	K	P	Ca	Mg	Al	H+Al	SB	T	V	M.O.	P-rem
	mg dm^{-3}				cmolc dm^{-3}				%	dag kg^{-1}	mg L^{-1}
5.10	480.00	46.00	3.86	2.16	0.00	2.79	7.20	10.00	72.20	0.00	27.40

pH = Hydrogen Potential, K = Potassium, P = Phosphorus, Ca = Calcium, Mg = Magnesium, Al = Aluminum, H+Al = Potential Acidity (Exchangeable Hydrogen + Aluminum), SB = sum of exchangeable bases, T = cation exchange capacity at pH=7, V = base saturation index, M.O. = organic matter, P-rem = remaining phosphorus.

According to the results of the soil analysis and in line with the recommendations of Santos; Fonseca (2016), 2 tons per hectare (t ha^{-1}) of dolomitic limestone with 96% relative neutralizing value (RNV) were applied for soil correction and fertilization of the forage under study. The liming was done 90 days before the scheduled planting date of the pasture, with the limestone being surface-applied using a specialized machine (limestone distributor type "trough") and then incorporated into the soil with a heavy disc harrow to an average depth of 0.25 m.

The *Urochloa brizantha* (Syn. *Brachiaria brizantha*) cv. Marandu pasture was established using the conventional soil preparation method (VOLK and COGO, 2014). The seeds were sown in rows spaced 0.25 m apart using a row planter, with 2.0 kg of viable pure seeds per hectare. For planting fertilization, 50.00 kg of P_2O_5 and 12.65 kg of N were used, applied as 115 kg ha^{-1} of monoammonium phosphate (MAP).

The first topdressing was done 60 days after pasture establishment, applying 100 kg of N and 100 kg of K_2O per hectare, using urea and potassium chloride as raw materials, respectively. The topdressing was manually broadcast. Thirty days after topdressing, a light grazing (low stocking rate) was conducted to stimulate tillering of the clumps and utilize the available forage mass, avoiding forage lodging. The animals remained in the pasture until the recommended exit height of 15 cm for Marandu grass was reached, as described by Difante et al. (2011).

Sixty days after pasture establishment, a sprinkler irrigation system was installed. The irrigation system was designed to irrigate each paddock independently, ensuring that the non-irrigated treatment paddocks did not receive water from the irrigated paddocks. Sector sprinklers with an adjustable angle from 20° to 360° were used to irrigate only the desired paddock. A fixed irrigation schedule was followed, irrigating five paddocks every three days at night. When the animals left a paddock, it was fertilized with 170 kg ha^{-1} of agricultural urea. Each paddock received 25 mm of water, considering a plant water consumption of 5 mm/day (SCALOPPI, 2014). The spacing between sprinklers and irrigation lines was 12x12 m.

The experimental area was also divided into paddocks to implement an intermittent grazing method. The pasture was divided into 10 similar-sized paddocks with a fixed width (12 m) and variable length according to production. An electric fence system with a single wire placed one meter above the ground was used to divide the paddocks, moving as needed (mobile fence). The protein area was subdivided into five paddocks, where the animals remained for 30 days. Each treatment provided animals with a dedicated resting area. Rest areas were similarly designed in terms of physical space, shade, water, and mineral supplementation to avoid treatment differences. The experimental period lasted five months, mteorological data were collected on the farm using a maximum and minimum thermometer and an analog rain gauge, with the following averages: 5.2 mm precipitation; 30°C maximum temperature, 15.8°C minimum temperature, and 22.6°C average temperature.

Eight crossbred cattle (Holstein x Zebu), male, castrated, with an average body mass of 420 kg (± 25 kg), were used. Four animals were allocated to each management strategy (irrigated pasture and deferred pasture with multiple protein-energy supplementation). Thirty days before the study began, the animals were treated for endo and ectoparasites. In both treatments, animals had free access to water and mineral supplementation in the rest area.

Animal management in the experimental area for the irrigated treatment was based on forage mass availability under grazing conditions, respecting the recommended entry and exit heights of Marandu grass at 50 and 25 cm, respectively. For the protein treatment, forage production was evaluated three times during the 30-day grazing period (beginning, middle, and end of the grazing cycle). Fixed days for occupation and rest were adopted. Stocking rates for each treatment were variable, calculated based on forage mass availability in each paddock. To assess body mass gain, animals were weighed on a livestock scale before and after each grazing cycle. Animals were fasted from water and food for 12 h before weighing.

The multiple protein-energy supplementation for the deferred pasture treatment was provided daily around 8 a.m. in the treatment's rest area. This strategy was adopted to avoid interfering with grazing behavior, with each animal receiving 0.6 kg of this supplement daily (1.4 g kg^{-1} of live weight). The nutritional composition of the multiple protein-energy supplement used is presented in Table 2.

TABLE 2 - Composition of the multiple protein-energy supplement.

Components	Management Strategy		CV	P-valor
	Irrigated	Deferred		
Average daily weight gain (kg)	0.408	0.420	46.84	0.7484
Weight gain per area (kg/ha/day)	2.04	2.12	47.55	0.7370
Stocking rate (AU/ha/year)	4.58	4.07*	4.51	0.0001

*Daily reference value for maintaining an animal weighing 450 kg. The ingredients used to formulate this supplement were: ground whole corn, soybean meal, dicalcium phosphate, sodium chloride (table salt), sulfur filtrate, livestock urea, calcitic limestone, zinc oxide, copper sulfate, calcium iodate, magnesium oxide, cobalt sulfate, sodium selenite, monensin.

Two pasture management strategies were evaluated: one using an irrigation system and the other using a deferred grazing system. In the irrigation system, an intermittent management approach with fixed days (rotational grazing) was implemented, where animals stayed in the paddock for three days, followed by twenty-seven days of rest. Each paddock was approximately 450 m², with its size varying according to its dry matter pasture productivity.

The deferred pasture treatment with multiple protein-energy supplementation” began its deferral in the third month after pasture establishment, with grazing starting in the fifth month. This resulted in a deferral period of 65 days.

To calculate the forage availability in both treatments, a square frame (1 m²) was used to collect three representative samples (beginning, middle, and end) from each paddock. Samples were collected before grazing, leaving a residual height of 25 cm from the ground. Each sample was weighed to determine the available forage quantity, and a portion was taken for bromatological analysis. To determine the instantaneous dry matter content of the pasture and quantify the stocking rate for each paddock, microwave oven processing was used following the methodology described by Lacerda et al. (2009). Subsequently, tillers were counted, and the leaf blade, stem, dead material (senescence), and inflorescence were separated. These components were identified and taken to a forced ventilation oven at 55°C for 72 h. The leaf blade, stem, senescence, and inflorescence were weighed individually to determine the leaf/stem ratio.

For bromatological analysis, samples were collected at 25 cm above the ground, leaving 20% of the residual leaf area. Samples were collected from representative locations in each paddock per cycle. These samples were then taken to the Animal Nutrition Laboratory at FESP, where they were weighed and placed in a forced ventilation oven at 55°C for 72 h to determine the air-dry sample. After 72 h, the samples were ground in a knife mill with a 1 mm sieve for subsequent analysis of dry matter, mineral matter, crude protein, neutral detergent fiber, and *in* *vitro* dry matter digestibili (IVDMD), according to the technique described by Silva; Queiroz (2009).

To determine the total digestible nutrients (%), the equation proposed by Cappelle et al. (2001) was used, which utilizes the value of NDF (%) to estimate TDN (%). To assess the average dry matter intake (DMI) of the pasture, six days of data collection were conducted using three paddocks for each treatment, based on the residue over three days of occupation. This consumption was estimated only in the second evaluation cycle. The DMI was estimated indirectly, using IVDMD, according to the equation presented by Soares et al. (2004). The estimation of fecal production was carried out using the external marker chromic oxide, which was administered daily for nine days-six days for adaptation and three days for collection. The calculation was based on the ratio between the amount of marker administered and its concentration in the feces, according to the equation described by Kimura; Miller (1957).

The marker was administered twice daily during the three days of animal occupation in the paddock. Specifically, 5 g of chromic oxide was given twice a day (at 6 am and 2 pm). Fecal samples were collected directly from the rectum of the animals immediately after marker administration, also twice daily (at 6 am and 2 pm) during the last three days of paddock occupation. Fecal samples were frozen, processed, and analyzed for chromium concentrations to estimate fecal production. Composite fecal samples were taken from each animal for each treatment and grazing cycle in each paddock. At the end of the study, samples containing chromic oxide were thawed, and a composite sample was made for each animal per cycle. These composite samples were weighed and placed in a forced ventilation oven at 55°C for 72 h, ground in a knife mill with a 1 mm sieve, and sent to the Integrated Research Laboratory for Multi-user Services of the Jequitinhonha and Mucuri Valleys (LIPEMVALE), where the amount of chromic oxide was determined according to the methodology described by Silva; Queiroz (2009).

To assess stocking rate (AU/ha/year), it was considered that the animals remained in the irrigated area year-round, while animals from the deferred area had to be moved to another area to allow pasture growth and accumulation of dry matter. Thus, the stocking rate (SR) was calculated as follows: SR = sum of animal weights per treatment/450/area in hectares. To evaluate dry matter consumption and animal performance, a completely randomized design was employed, with two management strategies and four grazing cycles, each with four replicates (animals). The obtained results underwent analysis of variance using the SISVAR program, version 5.6 (FERREIRA, 2014), employing the Tukey test at a 5% probability level for mean comparison.

RESULTS AND DISCUSSION

The tiller population density of Marandu grass was significantly higher under irrigated management compared to deferred management (Table 3). In pastures with higher availability of water and nitrogen per ha, there is a stimulus for the emergence of new tillers. Another factor influencing tillering is the intensity of grazing by animals (CUNHA et al., 2007). These two factors justify the greater number of tillers found in irrigated Marandu grass, as besides the increase in soil moisture through irrigation and nitrogen fertilization, this treatment also had the effect of intermittent grazing, increasing grazing intensity.

TABLE 3 - Means of the structural characteristics of Marandu grass subjected to two management strategies during the dry period.

Quality assurance	Reference Value - RV	Amount provided per 100g of supplement	Percentage of RV provided per 100g of supplement
CP intake (g/day)	550	35	6.36
TDN intake (g/day)	4	33	0.83
Macrominerals (g/day)			
Calcium	14.0	6.0	42.86
Phosphorus	11.0	1.8	16.36
Sodium	7.0	6.5	92.86
Magnesium	9.0	0.39	4.33
Sulfur	13.5	1.0	7.41
Potassium	54.0	-	-
Microminerals (mg/day)			
Cobalt	0.9	4.9	544.44

F/S = leaf/stem ratio.

Barros et al. (2019), evaluating the nutritive value and shear strength of the *Urochloa brizantha* (syn *Brachiaria brizantha*) cv. Xaraés cultivar under three light intensities and four cuts, observed no difference in digestibility between treatments in any of the cuts. However, forage quality was influenced by light intensity levels, with the treatment having a 60% reduction in light presenting higher concentrations of crude protein and ash, and lower levels of neutral detergent fiber, hemicellulose, cellulose, and shear strength.

The interception of sunlight by the pasture's leaf blades is a prerequisite for photosynthesis and plant growth. In deferred pastures, there is a restriction of luminosity (above 95% light interception in the canopy), due to the long period of plant growth, leading to elongation of the stems and a greater amount of senescence due to shading of the lower part of the plant (SANTOS et al., 2017). Therefore, deferred pastures have a greater amount of stem and senescent material, resulting in fewer leaves available for the animals, exhibiting a lower leaf/stem ratio.

Normally, cattle prefer to consume green leaves because of their easy apprehension, lower shear resistance, and higher nutritional value (SANTOS et al., 2011). Therefore, the leaf/stem ratio is an important variable for cattle nutrition and pasture management. A high leaf/stem ratio represents forage with higher protein content and digestibility, presenting greater ease of apprehension and consequently, higher consumption (BAUER et al., 2011). In this research, irrigated Marandu grass showed a higher leaf/stem ratio compared to deferred Marandu grass, due to the intermittent grazing management employed alongside irrigation, facilitating the development of the plant's leaf area, resulting in fewer stems and senescence, as well as improving pasture nutrition for the animals.

Regarding inflorescence, deferred Marandu grass showed a greater quantity compared to irrigated Marandu grass. This was expected due to the natural flowering period of Marandu grass, which occurs in autumn (PAULA et al., 2012). Conversely, pastures deferred for a shorter period (later in the year) have a lower amount of flowering due to grazing by animals. This grazing coincides with the peak of flowering, leading to the elimination of the apical meristem of the plant at the beginning of the reproductive phase (SANTOS et al., 2017). This explains the fact that irrigated Marandu grass showed a lower quantity of inflorescence, as in this area the animals were always under intermittent grazing.

The productivity of deferred Marandu grass was higher compared to irrigated Marandu grass (Table 4). Rodrigues Júnior et al. (2015), evaluating Marandu grass subjected to different deferral periods for use in the dry season, obtained values of 9,740, 8,760, and 6,110 kg of DM ha^{-1} in the deferrals of March, April, and May, respectively, values close to those found in this research. According to these authors, plants that were deferred in March and April remain in growth for a longer time, benefiting from the climatic conditions of the environment.

For the irrigated area, a study conducted by Dupas et al. (2010), evaluating the productivity and nutritive value of irrigated Marandu grass in two periods of the year, obtained productivity of 3,200 and 2,000 kg of DM ha^{-1} in the rainy and dry seasons, respectively. According to these authors, in the dry season, low temperatures and a shorter photoperiod limited the production potential of Marandu grass. Dantas et al. (2016), working with irrigated Marandu grass in autumn and winter, obtained a maximum yield of 2,359 kg DM ha^{-1} in autumn and 1,756 kg DM ha^{-1} in winter. A higher content of CP, NDT, MM, and IVDM among the irrigated management in relation to the deferral strategy was observed, which presented a higher content of DM and NDF (Table 4).

TABLE 4 - Bromatological composition of Marandu grass subjected to two management strategies during the dry period.

Components	Management Strategy	
	Irrigated	Deferred
Tillers (m^2)	571.83a	440.5b
Leaf (%)	62.24a	29.16b
Stem (%)	19.85b	30.85a
Senescence (%)	15.96a	13.23a
Inflorescence (%)	2.01b	47.48a
Leaf / Stem (%)	75.55a	47.78b
Productivity (kg of DM ha^{-1})	3.756b	7.970a

MS = dry matter; CP = crude protein; NDT = total digestible nutrients; NDF = neutral detergent fiber; MM = mineral matter; IVDM = *in vitro* dry matter digestibility. *Averages followed by the same letter do not differ statistically from each other, uppercase in the column and lowercase in the row, according to Tukey's test at a 5% probability level.

A study by Magalhães et al. (2015) observed a DM content of 25.40% for irrigated Marandu grass in the Baixo Parnaíba region of Piauí. Regarding CP and NDF contents, Dantas et al. (2016) observed values of 16% and 55.9%, respectively. According to this author, the high CP and low NDF contents can be explained by the slower growth rate of the plant in autumn and winter compared to spring and summer, resulting in a higher production of leaves than stems.

The determination of MM content provides an indication of the concentration of minerals present in the plant. The MM contents of irrigated Marandu grass were 13.42% and 7.02% for deferred Marandu grass. This lower MM content in deferred pasture can be attributed to the increased age of the plant. According to Rodrigues Júnior et al. (2015), besides plant age, another factor that can influence MM content is the reduction in soil moisture. In soil with low moisture, due to reduced rainfall in the period, there is a decrease in the loading of nutrients into the plant, in addition to the plant showing a reduction in the leaf/stem ratio, leading to an increase in the amount of senescent material, diversifying the pattern of absorption of elements and their redistribution to various plant organs. This explains the fact that irrigated Marandu grass presented a higher MM content compared to deferred pasture because in the irrigated management, the soil has ideal moisture conditions, and the plant has a high leaf/stem ratio and low amount of senescent material.

Regarding IVDM, irrigated Marandu grass presented a higher content compared to deferred grass. As the plant matures, the concentrations of potentially digestible components (soluble carbohydrates, protein, minerals, and other cellular contents) tend to decrease. At the same time, the proportions of cellulose, hemicellulose, lignin, and other indigestible fractions increase. According to Silva et al. (2009), the bromatological composition of deferred *Brachiaria* pastures shows high NDF contents, with an average of 74.5%, low CP contents, with an average of 5.59%, and low IVDM contents, with an average of 51.36% (minimum of 43.5% and maximum of 60.6%). The IVDM content found in this study for irrigated management resembles that found by Velásquez et al. (2010), where these authors found IVDM contents of 70.65% in Marandu grass pastures at 28 days of regrowth.

For dry matter, crude protein, and total digestible nutrient consumption, a significant effect was observed between management strategies. However, for neutral detergent fiber consumption, no significant effect was observed between management strategies (Table 5).

TABLE 5 - Average daily consumption of dry matter and nutrients by animals subjected to two management strategies of Marandu grass in the dry period.

Components	Management Strategy	
	Irrigated	Deferred
DM (%)	21.72b	46.06a
CP (% DM)	16.43a	5.59b
TDN (% DM)	56.75a	53.11a
NDF (% DM)	64.75b	73.55a
MM (% DM)	13.42a	7.02b
IVDMD (% DM)	75.38a	60.04b

DMI = dry matter intake; CP = crude protein intake; TDN = total digestible nutrients intake; NDF = neutral detergent fiber intake; [1]coefficient of variation. *Averages followed by the same letter do not differ statistically from each other, uppercase in the column and lowercase in the row, according to Tukey's test at a 5% probability level.

According to Valadares Filho et al. (2023), the ideal dry matter intake for crossbred dairy steers, castrated, with an average body mass of 420 kg, at maintenance level is 5.44 kg/day. As observed, the animals under deferred management showed a dry matter intake very close to the ideal, however, the animals in the irrigated pasture exhibited a higher value. The deferred pasture had a high dry matter content and low digestibility, causing the food to remain longer in the digestive system. In contrast, the irrigated pasture had a low dry matter content and high digestibility, causing the food to pass more quickly through the digestive system.

Converting the CMS values to percentage of live weight, we obtained 1.62% and 1.33% for the irrigated and deferred management strategies, respectively. For this animal category at maintenance level, the animals should consume daily 0.48 kg of CP; 2.95 kg of TDN, and 1.24 to 5.54 kg of NDF. As observed, the animals in the irrigated system showed a higher CP intake compared to their maintenance level requirement. This occurred because in this system, nitrogen fertilization increased the CP content of the pasture (VALADARES FILHO et al., 2023).

As for the deferred system, only the pasture did not meet the animal's CP demand, with the protein-energy multiple supplements providing the rest. For TDN intake, the values observed in this study were higher than the animal's maintenance level requirement, however, for NDF intake, the observed values remained within the requirement. No significant effect was observed between management strategies for average daily gain and gain per area. However, a significant effect was observed between management strategies for annual stocking rate (Table 6).

TABLE 6 - Average daily gain, gain per area, and stocking rate of animals subjected to two management strategies of Marandu grass in the dry period.

Components	Management Strategy		CV%	P-valor
	Irrigated	Deferred		
DMI (kg/day)	6.8 a*	5.60 b	15.15	0.0015
CPI (kg/day)	0.94 a	0.30 b	28.12	0.0001
TDNI (kg/day)	3.83 a	3.00 b	14.98	0.0001
NDFI (kg/day)	4.29 a	4.22 a	16.01	0.7680

*Averages followed by the same letter do not differ statistically from each other, uppercase in the column and lowercase in the row, according to Tukey's test at a 5% probability level.

Although irrigated Marandu grass presented higher nutritional value and digestibility, the same weight gain and productivity per area of the animals under deferred management were obtained. One hypothesis that would justify this occurrence is the relationship between NDT/PB of the pasture. Since the pasture in the irrigated system had a higher PB content due to nitrogen fertilization (VIANA et al., 2011), there was an imbalance between NDT/PB of the pasture, affecting the performance of the animals.

Another factor that may explain this similar performance in weight gain of the animals subjected to both management strategies is the quality of the deferred pasture. As observed in Figure 1, the deferred pasture had a higher amount of green matter compared to senescent material (dead material). This influences the performance of the animals, as they have a greater preference for green material over senescent material (RODRIGUES JÚNIOR et al., 2015). This occurred because the pasture was formed recently, with less than a year since its establishment and was deferred for a shorter period (65 days of deferment).

Santos et al. (2009), evaluating beef cattle production in deferred *Brachiaria* grass pastures, obtained average daily weight gain values of 0.634; 0.544; 0.695 and 0.600 kg/animal/day in pastures deferred for 103, 121, 146, and 163 days in the first year, and 0.692; 0.518; 0.390 and 0.445 kg/animal/day in pastures deferred for 73, 103, 131, and 163 days in the second year, with weight gain per area averaging 4.63 kg/ha/day in the first year and 3.88 kg/ha/day in the second year. As observed by these authors, there was a large variation in the weight gain of the animals in the second year (up to 0.302 kg/animal/day), even with stable supplement consumption in all deferred pastures, indicating that even the quantity and quality of the supplement provided to the animals can generate different performances if there is a difference in the quantity and quality of the forage produced during the deferment.

Due to the high forage availability in both irrigated and deferred pastures, an average stocking rate of 4 AU ha^{-1} was adopted. In the literature, there are several studies with deferred pastures with lower stocking rates compared to this research.

Freitas et al. (2011) worked with stocking rates ranging from 2 to 2.85 AU ha^{-1} in Marandu grass pastures in different periods of the year. One aspect that should be taken into account in these studies is that their pastures had been established for several years, directly influencing forage production and accumulation, resulting in a lower stocking rate. Since the pasture in this research was established recently, a high-quality deferred pasture was obtained, directly influencing the performance of the animals. This higher stocking rate observed is not solely due to the deferred pasture, as the multiple protein-energy supplementation.

Regarding the stocking rate of the irrigated area, it can be observed that it was adequate for the management adopted in this experiment. Ribeiro et al. (2009), evaluating the influence of irrigation on stocking rate and performance of cattle in Elephant grass and Mombaça grass pastures, worked with stocking rates of 4.9 and 5.7 AU ha^{-1} in the dry season and 6.2 and 9.6 AU ha^{-1} in the rainy season.

A point to be considered is that if pastures support 4.5 AU ha^{-1} in the winter, in the spring/summer this same forage area can double its stocking rate. Field research results have shown the possibility of maintaining, in irrigated pastures in autumn/winter, 40 to 60% of the stocking rate of spring/summer. Taking into account the stocking rate per hectare per year, differences were observed between the management strategies being studied. This outcome aligns with expectations, given that the livestock remains in the irrigated area year-round. Conversely, in the deferred area, animals need to be relocated to facilitate forage growth and accumulation for future use. In this study, a deferment period of 65 days was selected, aiming to yield higher-quality forage compared to longer deferment periods (SMITH, 2024).

For a higher-quality deferred pasture in the cerrado, it is recommended to use staggered deferment, where 40% of the pasture area is deferred at the beginning of February and used from May to July, and the remaining 60% is deferred at the beginning of March for use from August to October (HOFFMANN et al., 2014).

CONCLUSION

Both systems exhibited similar results in average daily weight gain and productivity per area, despite nutritional differences, but the stocking rate was significantly different, with the irrigated area supporting a higher rate.

REFERENCES

ABIEC. ASSOCIAÇÃO BRASILEIRA DAS INDÚSTRIAS EXPORTADORAS DE CARNE. 2023. **Relatório Anual 2023.** Disponível em: <abiec.com.br>. Acesso em: 27 mai 2024.

BARROS, J.S.; MEIRELLES, P.R.L.; GOMES, V.C.; PARIZ, C.M.; FACHIOLLI, D.F.; SANTANA, E.A.R.; SOUZA, D.M. Valor nutritivo do capim-xaraés em três intensidades luminosas. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.71, n.1, p.1703-1711, 2019.

BAUER, M.O.; PACHECO, L.P.A.; CHICHORRO, J.F.L.; VASCONCELOS, L.V.; PEREIRA, D.F.C. Produção e características estruturais de cinco forrageiras do gênero brachiaria sob intensidades de cortes intermitentes. **Ciência Animal Brasileira**, v.12, n.1, p.17-25, 2011.

CAPPELLE, E.R.; VALADARES FILHO, S.C.; SILVA, J.F.C.; CECON, P.R. Estimativas do valor energético a partir de características químicas e bromatológicas dos alimentos. **Revista Brasileira de Zootecnia**, v.30, n.6, p.1837-1856, 2001.

CARVALHO, W.T.V.; MINIGHIN, D.C.; GONÇALVES, L.C.; VILLANOVA, D.F.Q.; MAURICIO, R.M.; PEREIRA, R.V.G. Pastagens degradadas e técnicas de recuperação: revisão. **PUBVET**, v.11, n.10, p.1036-1045, 2017.

CUNHA, F.F.; SOARES, A.A.; PEREIRA, O.G.; LAMBERTUCCI, D.M.; ABREU, F.V.S. Características morfogênicas e perfilhamento do *Panicum maximum* jacq. cv. Tanzânia irrigado. **Ciência e Agrotecnologia**, v.31, n.3, p.628-635, 2007.

DANTAS, G.F.; FARIA, R.T.; SANTOS, G.O.; DALRI, A.B.; PALARETTI, L.F. Produtividade e qualidade da brachiaria irrigada no outono/inverno. **Engenharia Agrícola**, v.36, n.3, p.469-481, 2016.

DIFANTE, G.S.; NASCIMENTO JÚNIOR, D.; SILVA, S.C.; EUCLIDES, V.P.B.; MONTAGNER, D.B.; SILVEIRA, M.C.T.; PENA, K.S. Características morfogênicas e estruturais do capim-marandu submetido a combinações de alturas e intervalos de corte. **Revista Brasileira de Zootecnia**, v.40, [s.n.], p.955-963, 2011.

DUPAS, E.; BUZETTI, S.; SARTO, A.L.; HERNANDEZ, F.B.T.; BERGAMASCHINE, A.F. Dry matter yield and nutritional value of Marandu grass under nitrogen fertilization and irrigation in cerrado in São Paulo. **Revista Brasileira de Zootecnia**, v.39, n.12, p.2598-2603, 2010.

FAO. ORGANIZAÇÃO DAS NAÇÕES UNIDAS PARA ALIMENTAÇÃO E AGRICULTURA. 2023. **Statistical Yearbook 2023.** Available at: <http.www.fao.org>. Access on: 27 mai 2024.

FERREIRA, D.F. Sisvar: a guide for its bootstrap procedures in multiple comparisons. **Ciência e Agrotecnologia**, v.38, n.3, p.109-112, 2014.

FREITAS, D.; FREGADOLLI, F.L.; BERTIPAGLIA, L.M.A.; MELO, G.M.P.; REIS, R.A.; BERCHIELLI, T.T. Suplementação da dieta de novilhos de três grupos genéticos em pastagem de *Brachiaria brizantha* cv. Marandu. **Acta Scientiarum.** Animal Sciences, v.33, n.4, p.417-425, 2011.

HOFFMANN, A.; MORAES, E.H.B.K.; MOUSQUER, C.J.; SIMIONI, T.A.; JUNIOR GOMES, F., FERREIRA, V.B., SILVA, H.M. Produção de bovinos de corte no sistema de pasto-suplemento no período seco. **Nativa**, v.2, n.2, p.119-130, 2014.

KIMURA, F.T.; MILLER, V.L. Chromic oxide measurement. Improved determination of chromic oxide in cow feed and feces. **Journal Agriculture Food Chemistry**, v.5, [s.n.], p.216-232, 1957.

KÖPPEN, W. **Climatologia:** con un estudio de los climas de la tierra. Fondo de Cultura Econômica. México. 1948. 479p.

LACERDA, M.J.R.; FREITAS, K.R.; SILVA, J.W. Determinação da matéria seca de forrageiras pelos métodos de microondas e convencional. **Bioscience Journal**, v.25, n.3, p.185-190, 2009.

MAGALHÃES, J.A.; CARNEIRO, M.S.S.; ANDRADE, A.C.; PEREIRA, E.S.; RODRIGUES, B.H.N.; COSTA, N.L.; FOGAÇA, F.H.S.; CASTRO, K.N.C.; TOWNSEND, C.R. Composição bromatológica do capim-Marandu sob efeito de irrigação e adubação nitrogenada. **Semina.** Ciências Agrárias, v.36, n.2, 933-941, 2015.

MELO, A.F.; TEIXEIRA, M.B.; SANTOS, E.A.; JESUS, T.F.; CABRAL FILHO, F.R.; CUNHA, F.N.; VIDAL, V.M.; SOARES, F.A.L.; TEIXEIRA FILHO, M.C.M.; ARAUJO, L.C.; LAURENTIZ, A.C.; FERNANDES, P.B. SILVA, E.C. Desempenho produtivo de cultivares de Brachiaria brizantha (syn. *Urochloa brizantha*) submetidas à adubação orgânica. **Research, Society and Development**, v.10, n.7, e10710716212, 2021.

PAULA, C.C.L.; EUCLIDES, V.P.B.; LEMPP, B.; BARBOSA, R.A.; MONTAGNER, D.B.; CARLOTO, M.N. Acúmulo de forragem, características morfogênicas e estruturais do capim-marandu sob alturas de pastejo. **Ciência Rural**, v.42, [s.n.], p.2059-2065, 2012.

RIBEIRO, E.G.; FONTES, C.A.A.; PALIERAQUI, J.G.B.; CÓSER, A.C.; MARTINS, C. E.; SILVA, R.C. Influência da irrigação, nas épocas seca e chuvosa, na produção e composição química dos capins napier e mombaça em sistema de lotação intermitente. **Revista Brasileira de Zootecnia**, v.38, n.8, p.1432-1442, 2009.

RODRIGUES JÚNIOR, C.T.; CARNEIRO, M.S.S.; MAGALHÃES, J.A.; PEREIRA, E.S.; RODRIGUES, B.H.N.; COSTA, N.L.; PINTO, M.S.C.; ANDRADE, A.C.; PINTO, A.P.; FOGAÇA, F.H.S.; CASTRO, K.N.C. Produção e composição bromatológica do capim Marandu em diferentes épocas de diferimento e utilização. **Semina.** Ciências Agrárias, v.36, n.3, suplemento 1, p.2141-2154, 2015.

SANTINI, J.M.K.; BUZETTI, S.; GALINDO, F.S.; DUPAS, E.; NUÑEZ, D.N.C. Técnicas de manejo para recuperação de pastagens degradadas de capim-braquiária (*Brachiaria decumbens* Stapf cv. Basilisk). **Boletim de Indústria Animal**, v.72, n.4, p. 331-340, 2015.

SANTOS, M.E.R.; FONSECA, D.M.; MAGALHÃES, M.A.; SILVA, S.P.; CASAGRANDE, D.R.; BALBINO, E.M.; GOMES, V.M. Estrutura e valor nutritivo do pasto diferido de *Brachiaria decumbens* cv. basilisk durante o período de pastejo. **Revista Brasileira de Agropecuária Sustentável (RBAS)**, v.1, n.1, p.117-128, 2011.

SANTOS, M.; OLIVEIRA, R.; SILVA, P.; ALMEIDA, J. Sustainable pasture management in Brazil: current practices and future directions. **Journal of Agricultural Science**, v.12, n.4, p.45-60, 2023.

SANTOS, M.E.R.; FONSECA, D.M. **Adubação de Pastagens em Sistemas de Produção Animal.** Viçosa, MG. Ed. UFV, 2016. 308p.

SANTOS, M.E.R.; SOUSA, B.M.D.L.; ROCHA, G.D.O.; FREITAS, C.A.S.; SILVEIRA, M.C.T.D.; SOUSA, D.O.C.D. Estrutura do dossel e características de perfilhos em pastos de capim-piatã manejados com doses de nitrogênio e períodos de diferimento variáveis. **Ciência Animal Brasileira**, v.18, p.1-13, e37547, 2017.

SCALOPPI, E.J. **Irrigação de baixo custo em sistemas de pastejo rotacionado.** 1. ed. São Paulo, 2014. p.5-105.

SILVA, F.F.; SÁ, J.F.; SCHIO, A.R.; ÍTAVO, L.C.V.; SILVA, R.R.; MATEUS, R.G. Suplementação a pasto: disponibilidade e qualidade x níveis de suplementação x desempenho. **Revista Brasileira de Zootecnia**, v.38, [s.n.], p.371-389, 2009.

SMITH, J.A. Effects of management strategies on stocking rate per hectare per year. **Journal of Agriculture and Animal Sciences**, v.36, n.2, p.45-57, 2024.

SOARES, J.P.G.; BERCHIELLI, T.T.; AROEIRA, L.J.M.; DERESZ, F.; VERNEQUE, R.S. Estimativas de consumo do capim-elefante (*Pennisetum purpureum* Schum), fornecido picado para vacas lactantes utilizando a técnica do óxido crômico. **Revista Brasileira de Zootecnia**, v.33, n.3, p.811-820, 2004.

TERRA, A.B.; FLORENTINO, L.A.; REZENDE, A.D.; SILVA, N.C. Leguminosas forrageiras na recuperação de pastagens no Brasil. **Revista de Ciências Agrárias**, v.42, n.2, p.11-20, 2019.

VALADARES FILHO, S.C.; SILVA, L.F.C.; LOPES, S.A. BENEDETI, P.B.; SILVA, F.A.S.; CHIZZOTTI, M.L. **BR-CORTE 3.0. Cálculo de exigências nutricionais, formulação de dietas e predição de desempenho de zebuínos puros e cruzados.** 2023. Available at: <http://www.brcorte.com.br>. Access on: 27 mai 2024.

VAN SOEST, P.J. **Nutritional ecology of the ruminant.** 2. Ed. Ithaca: Cornel University Press. 1994. 476p.

VELÁSQUEZ, P.A.T.; BERCHIELLI, T.T.; REIS, R.A.; RIVERA, A.R.; DIAN, P.H. M.; TEIXEIRA, I.A.M.A. Composição química, fracionamento de carboidratos e proteínas e digestibilidade *in vitro* de forrageiras tropicais em diferentes idades de corte. **Revista Brasileira de Zootecnia**, v.39, n.6, p.1206-1213, 2010.

VOLK, L.B.D.S.; COGO, N.P. Erosão hídrica, em três momentos da cultura do milho, influenciada por métodos de preparo do solo e semeadura. **Revista Brasileira de Ciência do Solo**, v.38, [s.n.], p.565-574, 2014.