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Marandu grass pastures with the same average height and different horizontal structures change the feeding behavior of grazing sheep?

[*Pastos de capim-marandu com mesma altura média e diferentes estruturas horizontais alteram o comportamento ingestivo de ovinos em pastejo*?]

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ABSTRACT

The objective was to investigate the feeding behavior of sheep in marandu grass (*Brachiaria brizantha* cv. Marandu) pastures under continuous stocking with the same average height and different horizontal structures. The treatments were composed of less heterogeneous pastures (P-H, 24% coefficient of variation of plant heights and more heterogeneous pastures (P+H, 46% coefficient of variation of plant heights) and the locations of the picket, front and back, were also evaluated. A randomized block design was used, with split plots in space and four replications in two years. Crossbred lambs were used, managed under continuous stocking and variable stocking rate, to maintain average height of pastures at 30 cm. Greater masses of total forage, live leaf, live stem and dead material, and greater time of sheep in rumination, occurred in the front, in relation to the paddock background. In P-H, grazing time (GT) did not vary between regions. In P+H, GT was lower at the front than at the background. Idle time (IT) was similar between P-H and P+H. However, the animals remained more IT in the front than in the background. The feeding behavior of grazing sheep is modified in marandu grass pastures under continuous stocking with the same average height, but with different spatial variability of the vegetation.

Keywords: coefficient of variation, forage mass, grazing, rumination, selectivity

RESUMO

Objetivou-se investigar o comportamento ingestivo de ovinos em pastos de capim-marandu (Brachiaria brizantha cv. Marandu) sob lotação contínua com mesma altura média e diferentes estruturas horizontais. Os tratamentos foram compostos de pastos menos heterogêneo (P-H, 24% de coeficiente de variação das alturas das plantas) e pastos mais heterogêneo (P+H, 46% de coeficiente de variação das alturas das plantas), também foi avaliado os locais do piquete, frente e fundo. O delineamento utilizado foi de blocos ao acaso, com parcelas subdivididas no espaço e quatro repetições em dois anos. Foram utilizadas borregas mestiças, manejadas sob lotação continua e com taxa de lotação variável, para manter altura média dos pastos em 30cm. Maiores massas de forragem total, folha viva, colmo vivo e material morto, e maior tempo dos ovinos em ruminação, ocorreram na frente, em relação ao fundo do piquete. No P-H, o tempo em pastejo (TP) não variou entre as regiões. No P+H, o TP foi menor na frente do que no fundo. O tempo em ócio (TO) foi semelhante entre os P-H e P+H. Porém, os animais permaneceram mais TO na frente que no fundo. O comportamento ingestivo de ovinos em pastejo é modificado em pastos de capim-marandu sob lotação contínua com mesma altura média, porém com diferentes variabilidades espaciais da vegetação.

Palavras-chave: coeficiente de variação, massa de forragem, pastejo, ruminação, seletividade

INTRODUCTION

Marandu grass (*Brachiaria brizantha* cv. Marandu syn. *Urochloa brizantha* cv. Marandu) stands out as one of the most used forage grasses in Brazil (Brachiaria…, 2021). In most pasture production systems in Brazil, continuous stocking is also widely used for grazing management.

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Under continuous stocking, animals remain in the same pasture area for long periods during the year (Silva *et al*., 2013). Continuous stocking management allows the animal to perform greater forage selection and generates a more uneven distribution of feces and urine in the pasture, which causes an increase in pasture heterogeneity (Santos *et al*., 2014).

The pasture heterogeneity or spatial variability of the vegetation is also called the horizontal structure of the pasture, is an important interfering factor at all scales of plant-animal interaction (Carvalho *et al*., 2001). Even so, the horizontal structure has been less studied in tropical pastures (Santos *et al*., 2014), given that studies on the vertical structure of tropical pastures predominate, that is, they characterize the way in which the pasture is made available to animals, from the upper to the lower strata (Souza *et al*., 2015; Zanini *et al*., 2012).

The vertical and horizontal structures of pasture are determinants of plant and animal's responses in a grazing. Therefore, understanding the relationships between the pasture structural characteristics and animal feeding behavior is essential to define pasture management strategies (Fonseca *et al*., 2012; Portugal *et al*., 2022).

Currently, grazing management in continuous stocking has been recommended based on the average height of tropical pastures (Silva *et al*., 2015). However, there is the possibility that pastures with same average height have different horizontal structures (Santos *et al*., 2014). If this occurs, the responses of grazing animals can vary, considering the cause-and-effect relationship between the pasture structure, feeding behavior, intake, and performance of grazing animals (Silva *et al*., 2013).
In this context, it is not known how sheep managed on pastures with the same average height, but with different horizontal structures, express their feeding behavior. It is possible that, in more heterogeneous pastures, the animal remains longer, selecting more nutritious parts of the plants, which would make it graze for a longer time, reducing the animals' rumination and idle time.

This work was carried out with objective of verifying whether there are variations in sheep feeding behavior in marandu grass pastures under continuous stocking at the same average height, but with different horizontal structures.

MATERIALS AND METHODS

The experiment was conducted for two years, from October 2013 to January 2014 (Year 1) and from October 2014 to January 2015 (Year 2), in the Sheep and Goat stable of the Fazenda Experimental Capim Branco, belonging to the Faculdade de Medicina Veterinária at the Universidade Federal de Uberlândia, located in Uberlândia, MG, (18 ^{o} 30' S; 47 ^{o} 50' W; 863 m altitude) in a pasture formed with *Urochloa brizantha* cv. Marandu syn. *Urochloa brizantha* cv. Marandu (marandu grass) and divided into twelve paddocks of 800 m^2 each. The climate of the region, according to the Köppen classification, is type Aw, tropical savanna (Alvares *et al*., 2013).

In early October 2013 and 2014, pastures were mowed at a height of 8 cm in all twelve paddocks in the experimental area. Subsequently, all pastures remained without animals, until they reached an average height of 30cm, which occurred in early November 2013. From then until the end of January 2014, all paddocks were managed with the same criteria: continuous stocking, with hairless sheep and with a variable stocking rate to keep the pasture height at approximately 30 cm (Silva *et al*., 2013). For this, weekly and in each paddock, the heights of the plants were measured with a graduated ruler, in 30 points, having as criterion the distance from the level of the soil surface to the living leaves located higher in the canopy. When the average height of the pasture was above the target (30 cm), more animals were placed in the paddock. On the other hand, if the average height of the pasture was below the target, animals were removed from the paddock. This management was carried out until January 2014 and 2015. In this period, the average stocking rate of the paddocks was 1.6 and 1.9 AU/ha in the first and second year, respectively, which corresponded to about two growing sheep per paddock.

Despite the same grazing management criterion adopted in spring and early summer, it was observed that, in early January 2014 (Year 1) and 2015 (Year 2), the pastures presented different spatial variability of vegetation, from so that in some paddocks, the pasture was less heterogeneous, while in other paddocks. Thus, to characterize the vegetation of the pastures, in each region of the paddock (front and back), the plants heights were measured at 60 points. Subsequently, the average height of the pasture in these locations was calculated. In order to quantify the spatial variability of vegetation, the coefficient of variation of plant heights was also calculated at each site of the paddocks, according to methodology described by Hirata (2002). The most heterogeneous pastures presented a coefficient of variation (CV) of the average height of pasture of 46%, while the less heterogeneous pastures presented a CV of average height of the pasture of 24%. In the more heterogeneous pastures, it was also verified that plants were higher in the front of the paddock, in relation to the back (Table 1).

As there was a great difference in height between marandu grass plants within the same paddock, in Year 2, all pastures (two less heterogeneous and two more heterogeneous) underwent a more detailed assessment of the height of the plants in their horizontal planes. For this, the paddocks were subdivided into 12 regions, with the aid of a nylon rope. These subdivisions occurred every 6.7 m along the length (40 m) of the paddock; and, in the width direction (20m), only one division was made in half. In each region delimited in the paddock, the height of the pasture was measured in 15 points. Afterwards, the average height values were calculated, and the results were expressed in the form of figures containing the gradient of these height values (Fig. 1).

Table 1. Average height of pastures (cm) in each region of the paddock (front and back)

Paddock location	Pasture	
	More Heterogeneous	Less Heterogeneous
Front	40.7	30.7
Back	19.9	29.8

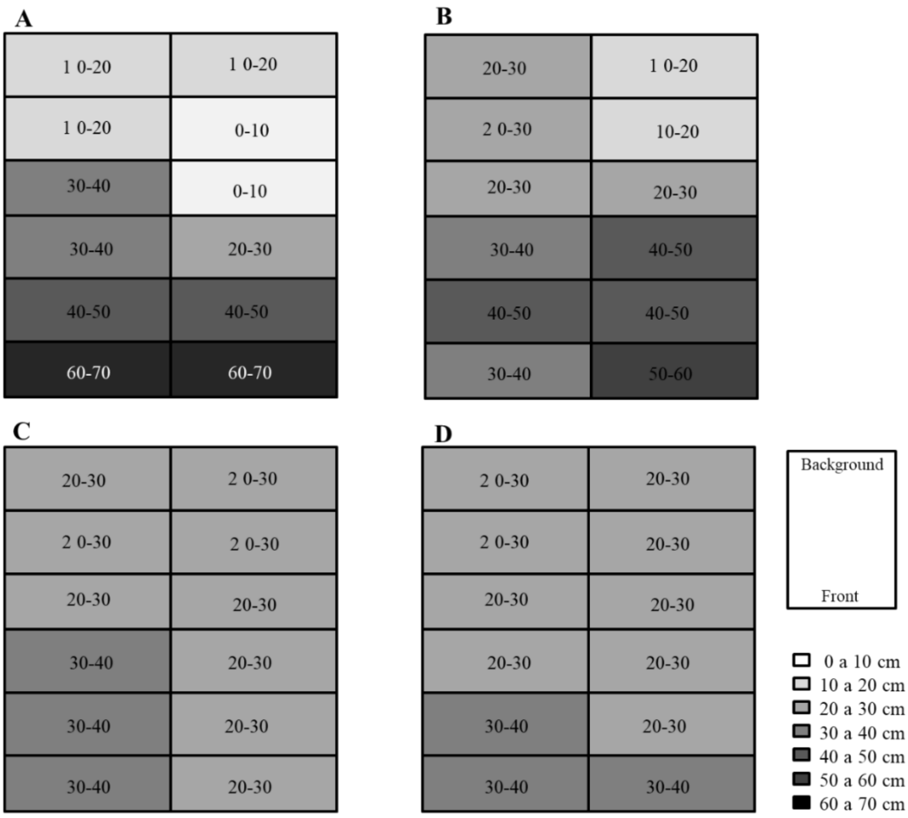

Figure 1. Plant heights between the areas of the paddocks with more heterogeneous (A and B) and less heterogeneous (C and D) pastures in the second experimental year.

In each experimental year, four paddocks were chosen for evaluations, two paddocks containing less heterogeneous pastures and the other two with more heterogeneous pastures. Each paddock chosen was demarcated in half, with the aid of a rope, so that the front and back of the paddock were easily delimited. The front of all paddocks contained a drinking fountain, as well as an area of 2.68 m² (1.1 m x 2.44 m) covered with asbestos tiles. In the center of this covered area, there was feed bunk for mineral salt (Figure 2).

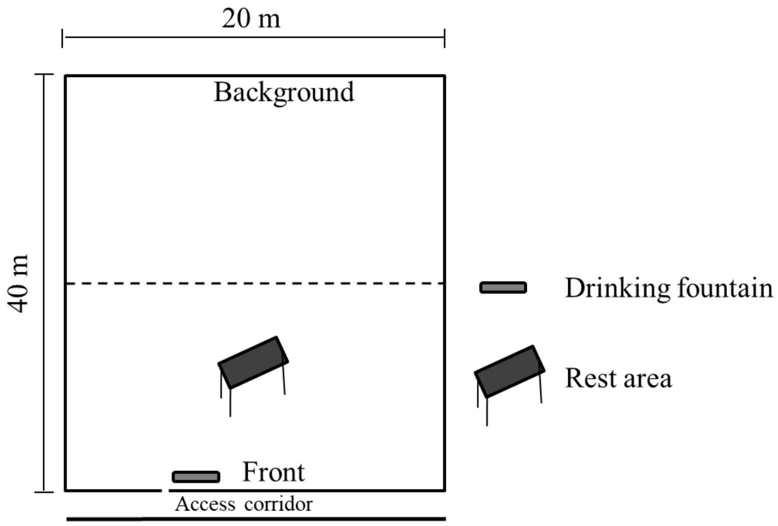

Figure 2. Sketch of the experimental area pickets, indicating the existing infrastructure, as well as the front and back of the paddock.

Therefore, in this work, two types of pastures were studied in a split plot scheme: one less heterogeneous and the other more heterogeneous, which corresponded to the experimental plots. In these, two areas of the paddock were also evaluated: front and back, which were experimental subplots. Each type of pasture was studied in two paddocks per year. Thus, in the two experimental years, it was possible to obtain four paddocks (replications) for each type of pasture evaluated. Due to the different climatic characteristics between the two experimental years, these were considered blocks, and, in fact, the experimental design used was randomized blocks.

All evaluations took place in January 2014 and 2015. The feeding behavior of sheep was evaluated on 01/26/2014 and 01/30/2015, from 06:30h to 20:00h, by recording the times in which the animals were in grazing, rumination, and other activities (idleness). Concomitantly, the location (front or back of the paddock) where each animal was also recorded. On 01/26/2014, the maximum, minimum and average temperatures were 30.9; 19.1 and 24.9°C; the solar radiation was 21.4 Mj/day and it did not rain. On 01/30/2015, the maximum, minimum and average temperatures were 33.0; 18.3 and 25.5°C; the solar radiation was 24.6 Mj/day and it didn't rain either.

The two animals in each paddock were Santa Inês x Dorper crossbred females, with about four months of age and an average weight of 32 kg. These animals were observed at ten-minute intervals by properly trained people. At the end, the measurements inherent to the activities (grazing, rumination, and leisure) and to the evaluated locations (front and back of the paddock) were added up and the time spent in each activity and paddock site was expressed as a percentage of the total observation time. By multiplying the total time of observation of the animals, in minutes, by the percentages of each activity evaluated, the times, in minutes, spent by the animals in grazing, rumination and leisure activities, performed in the paddocks front or back were obtained.

Data collection to quantify the time spent by each activity was done using spreadsheets, containing the identification of each animal, with squares next to the respective observation times and the region of the paddock where the animal was, for the treatments studied.

In each place (front and back) of the paddocks, all the tillers contained within a square of 0.25 m ^{2} and at three points where the plants were at the same height were cut at the level of the soil surface. At each point, a forage sample was collected, weighed, and subdivided into two subsamples. One of them was separated into live leaf, live stem, and dead material. The parts of the stem and leaf blade with yellowing and/or necrosis were incorporated into the dead material fraction. After separation, the components were weighed and dried in an oven with forced air circulation at 65°C for 72 hours. From these data, the percentages of each morphological component in the forage mass were estimated. The other subsample was weighed, dried under the same conditions as before and weighed again to estimate the total forage mass (TFM) of the pasture, in kg/ha of DM. By multiplying the TFM and the percentages of each morphological component, the masses of live leaf, live stem and dead material were obtained, in kg/ha of DM.

The data were first evaluated in terms of the model's assumptions, using tests of normality (Shapiro-wilk and Lillefors) and homogeneity of variances (Bartlett´s Test). Variables that did not violate the assumptions were evaluated by analysis of variance, while for those that violated the assumptions, data transformation was first attempted by means of logarithmic transformation. If, after this transformation, the assumptions were not violated, analysis of variance was performed. If, even after the transformation, the assumptions continued to be violated, a nonparametric analysis was performed.

The evaluated model that assumes the analysis of variance is a fixed effects model, according to a completely randomized design with a split-plot scheme where the pastures were allocated in the plot and the place allocated in the subplot. The model can be written as follows:

$y_{ijk} = \mu + p_i + e_{ij} + l_j + (pl)_{ij} + b_k + e_{ijk}$(i= 1, 2...,aej= 1, 2...,b and K= 1,2,...,r)
On what:

y_{ijk}= value observed in the experimental plot that received level i of factor a and level j of factor B in block k;
μ = overall mean of the experiment;
p_i= effect of level i of the pasture factor;
$e_{(i)j}$= effect of factor A level i on repetition k (residue a);
l_j= effect of level j of the local factor;
$(ab)_{ij}$= effect of the interaction between level i of factor a and level j of factor b;
b_k = effect of block k.
e_{ijk}= experimental error (residue b);
The only variable that was analyzed nonparametrically, using the Kruskal Wallis test, was rumination time. All other variables were parametrically evaluated (analysis of variance), adopting a 10% probability of type I error.

RESULTS

The mass of total forage, live leaf, live stem, and dead material, as well as the time of ruminating sheep were influenced by the paddock location. In front of the paddocks, greater masses of total forage, live leaf, live stem, and dead material were verified, as well as greater time spent on rumination (Table 2).

Table 2. Effect of paddock region (front and back) on the forage masses of marandu grass pastures and rumination time in sheep

Feature	Picket Location		P -value
	Front	Background	
Total forage mass (kg.ha $^{-1}$ of DM)	6.669a	4.929 b	0.0100
Live leaf mass (kg.ha $^{-1}$ of DM)	1941a	1536 b	0.0570
Live stem mass (kg.ha $^{-1}$ DM)	2692a	1781 b	0.0300
Mass of dead material (kg.ha $^{-1}$ of DM)	2036a	1612b	0.0680
Rumination time (minute)	127.7a	1.9b	<0.0001

For each characteristic, means followed by distinct letters, lower case in the line, differ statistically from each other by the SNK Test (P>0.10).

The grazing and idle times of sheep were influenced by interaction between pasture heterogeneity and paddock location. In the less heterogeneous pasture, the grazing time did not vary in relation to paddock region. On the other hand, in the more heterogeneous pasture, grazing time was shorter at front than at the paddock background (Table 3). The idle time was similar between the less heterogeneous and more heterogeneous pastures. However, the animals remained idle longer at the front than at the back of the paddock (Table 3).

Table 3. Effect of interaction between pasture heterogeneity and paddock region (front and back) on grazing and idle times in sheep

Paddock Location	Pasture		P-value
	More heterogeneous	Less heterogeneous	
	Grazing time (minute)		
Front	184aB	194aA	0.0490
Background	303aA	180bA	
	Idle time (minute)		
Front	146bA	231aA	0.0200
Background	93aB	8.7bB	

For each characteristic, means followed by the same letter, lower case in the line and capital in the column, do not differ statistically from each other by the SNK Test (P>0.10).

DISCUSSION

The spatial heterogeneity of vegetation, in which some places in the same pasture have taller plants than others, is called horizontal structure and is important at all scales of plant-animal interaction (Carvalho *et al*., 2001). The horizontal structure can be characterized by coefficient of variation of the pasture, such as plant height (Hirata, 2002; Santos *et al*., 2014, 2022).

In this context, in the present study, pasture heterogeneity was adequately quantified and characterized by measuring the coefficient of variation (CV) of plant heights in pastures. In fact, as expected, there was a higher CV of plant height in the more heterogeneous pastures, compared to the less heterogeneous. This result demonstrates that pastures with the same average height can have different horizontal structures.

The spatial variability of vegetation is a consequence of balance between the processes of intake and forage growth, which do not occur homogeneously, as they are determined, above all, by uneven grazing and by the heterogeneity of trophic resources, respectively. In this sense, several factors can cause the spatial variability of vegetation, such as selective defoliation of animals, climate, terrain relief, pasture management strategies and feces and urine´s deposition on the pasture by animals (Santos *et al*., 2014). Therefore, due to various interfering factors, the control of horizontal structure of the pasture is a challenge for the pasture manager. In this context, in the present work, it is possible that small variations in relief of the existing terrain between the experimental paddocks may have generated the difference in spatial variability of the vegetation.

The location of drinking troughs and shaded area for animals in front of the paddocks (Fig. 2) promoted greater permanence of animals in this area over the years of pasture use. This may have caused a large deposition of feces and urine by the animals in this region of the paddock, which may have increased the concentration of nutrients in the soil (Bretas *et al*., 2020) and, consequently, resulted in greater plant growth (Carvalho *et al*., 2016).

The likely greater plant growth in paddock front resulted in higher values of pasture height (Table 1), masses of total forage, live leaf, live stem and dead material (Table 2) when compared at the background.

The pasture with greater height has greater stem mass and percentage of dead material (Nantes *et al*., 2013), as well as tending to pass to the reproductive stage. Thus, this morphology of taller plants is less predisposing to grazing by animals (Afonso *et al*., 2018). For this reason, it is possible that sheep rejected more plants located in front of the paddock, which also contributes to the higher values of pasture height and forage masses in this region (Table 1 and 2).

Then, the elongation of the stem, to support the greater weight of the plant and also to arrange the seeds in the upper stratum of pasture in the reproductive stage, was the factor responsible for the greater mass of live stem observed in the front, in relation to the back of the paddock (Table 2).

In taller plants present in front of the paddocks, young leaves located in the upper stratum of the forage canopy intercept lighter and generate greater shading at the base of the canopy, accelerating the process of senescence of older leaves (Araújo *et al*., 2015). This process may have been responsible for the greater mass of dead material at the front than at the back of the paddock (Table 2).

The sheep had their feeding behavior altered, due to the heterogeneity of the pasture. In this context, in more heterogeneous pasture, the grazing time was shorter at the front than back of the paddock (Table 3), probably because the taller plants located in front of the paddock had greater stem and dead masses, morphological components that made it difficult to seizure and ingestion of forage by grazing animals (Afonso *et al*., 2018). As a result, the sheep grazed for less time in front of the paddock. On the other hand, at the paddock back the plants were lower and had a lower stem elongation, which facilitated the disposal of leaves for the animals and favored consumption. Therefore, the sheep preferred to graze at the paddock back.

Considering the lower height of plants at the paddock back (Table 1), it is possible that there has been a greater renewal of tiller population in this area of the pasture, since, in lower pastures, greater penetration of light occurs in the pasture canopy base, which stimulates the appearance of young tillers (Carvalho *et al*., 2021). The high appearance of new tillers reduces the average age of tillers in the pasture (Paiva *et al*., 2011), which is now made up of more young tillers. These are of better nutritional value compared to older tillers (Santos *et al*., 2006). This fact could also explain the longer grazing time of the animals at the paddock back in the more heterogeneous pasture (Table 3), selecting the youngest and most nutritious plants in the pasture.

These response patterns observed for the grazing time are in line with the fact that the pasture structure is both a cause and a consequence of the grazing process performed by the animals (Xiao *et al*., 2020). In this sense, it is possible that, since sheep are more selective than cattle, this association between pasture structure and the grazing process is even more pronounced.

The longer idle and rumination times of the animals in front of the paddock (Table 2 and 3) are justified by the presence of a drinking fountain and covered area (shade) in this region of the paddock, which results in greater comfort for the animals. Corroborating our results, Oliveira *et al*. (2013) also found that Santa Inês sheep look for shade to ruminate during periods of higher solar radiation.

The results presented demonstrate that the feeding behavior of grazing animals is modified by the spatial heterogeneity of the vegetation, even in pastures with the same average height. Thus, further scientific investigations into the effects of pastures with the same average height, but with different horizontal structures, on intake and animal performance still need to be carried out under grazing and tropical conditions.

CONCLUSION

The feeding behavior of grazing sheep is modified in marandu grass pastures under continuous stocking and with the same average height, but with different spatial variability of vegetation.

REFERENCES

AFONSO, L.E.F.; SANTOS, M.E.R.; SILVA, S.P. *et al*. O capim-marandu baixo no início do diferimento melhora a morfologia do pasto e aumenta o desempenho dos ovinos no inverno. *Arq. Bras. Med. Vet. Zootec*., v.70, p.1249-1256, 2018.

ALVARES, C.A.; STAPE, J.L.; SENTELHAS, P.C. *et al*. Köppen's climate classification map for Brazil. *Meteorol. Z.*, v.22, p.711-728, 2013.

ARAÚJO, D.L.C.; OLIVEIRA, M.E.; LOPES, J.B. *et al*. Características morfogênicas, estruturais e padrões demográficos de perfilhos em pastagem de capim-andropógon sob diferentes ofertas de forragem. *Semin. Ciênc. Agr*., v.36, p.3303-3314, 2015.

BRACHIARIA *brizantha* cv. Marandu. Campo Grande: Embrapa. Disponível em: https://www.embrapa.br/busca-de-solucoes-tecnologicas/-/produto-servico/863/brachiaria-brizanthacv-marandu. Acessado em: 26 jun. 2021.

BRETAS, I.L.; PACIULLO, D.S.C.; ALVES, B.J.R. *et al*. Nitrous oxide, methane, and ammonia emissions from cattle excreta on *Brachiaria decumbens* growing in monoculture or silvopasture with *Acacia mangium* and *Eucalyptus grandis*. *Agric. Ecosyst. Environ*., v.295, p.106896, 2020.

CARVALHO, B.H.R.; PEREIRA, L.E.T.; SBRISSIA, A.F. *et al*. Height and mowing of pasture at the end of winter modulate the tillering of Marandu palisadegrass in spring. *Trop. Grassl. Forrajes Trop*., v.9, p.13-22, 2021.

CARVALHO, P.C.F.; RIBEIRO, H.M.N.; POLI, C.H.E.C. *et al*. Importância da estrutura da pastagem na ingestão e seleção de dietas pelo animal em pastejo. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 38., 2001, Piracicaba. *Anais*... Piracicaba: ESALQ, p.883-871, 2001.

CARVALHO, R.M.; SANTOS, M.E.R.; CARVALHO, B.H.R. *et al*. Morphogenesis of marandu palisade grass next or distant from the catte feces during the seasons. *Semin. Ciênc. Agr*., v.37, p.3231-3242, 2016.

FONSECA, L.; MEZZALIRA, J.C.; BREMM, C. *et al*. Management targets for maximising the short-term herbage intake rate of cattle grazing in *Sorghum bicolor*. *Livest. Sci*., v.145, p.205-211, 2012.

HIRATA, M. Herbage availability and utilisation in small-scale patches in a bahia grass (*Paspalum notatum*) pasture under cattle grazing. *Trop. Grassl*., v.36, p.13-23, 2002.

NANTES, N.N.; EUCLIDES, V.P.B.; MONTAGNER, D.B. *et al*. Desempenho animal e características de pastos de capim piatã submetidos a diferentes intensidades de pastejo. *Pesqui. Agropecu. Bras*., v.48, p.114-121, 2013.

OLIVEIRA, F.A.; TURCO, S.H.N.; ARAÚJO, G.G.L. *et al*. Comportamento de ovinos da raça Santa Inês em ambientes com e sem disponibilidade de sombra. *Rev. Bras. Eng. Agríc. Ambient*., v.17, p.346-351, 2013.

PAIVA, A. J.; SILVA, S.C.; PEREIRA, L.E.T. *et al*. Morphogenesis on age categories of tillers in marandu palisadegrass. *Sci. Agr*., v.68, p.626-631, 2011.

PORTUGAL, T.B.; SZYMCZAK, L.S.; MORAES, A.L. *et al*. Low-intensity, high-frequency grazing strategy increases herbage production and beef cattle performance on sorghum pastures. *Animals*, v.12, p.13, 2022.

SANTOS, M.E.R.; GOMES, V.M.; FONSECA, D.M. Fatores causadores de variabilidade espacial do pasto de capim-braquiária: manejo do pastejo, estação do ano e topografia do terreno. *Biosci. J*., v.30, p.210-218, 2014.

SANTOS, M.E.R.; SILVEIRA, M.C.T.; FONSECA, D.M. *et al*. How do initial sward height and the grazing period influence the spatial variability of vegetation in deferred signal grass pastures? *Biosci. J*., v.38, p.e38019, 2022.

SANTOS, P.M.; CORSI, M.; PEDREIRA, C.G.S. Tiller cohort development and digestibilidade in Tanzania guinea grass (*Panicum maximum* cv Tanzania) under three levels of grazing intensity. *Trop. Grassl*., v.40, p.84-93, 2006.

SILVA, S.C.; GIMENES, F.M.A.; SARMENTO, D.O.L. *et al*. Grazing behaviour, herbage intake and animal performance of beef cattle heifers on marandu palisade grass subjected to intensities of continuous stocking management. *J. Agric. Sci*., v.151, p.727-739, 2013.

SILVA, S.C.; SBRISSIA, A.; PEREIRA, L. Ecophysiology of C4 forage grasses-understanding plant growth for optimising their use and management. *Agriculture*, v.5, p.598-625, 2015.

SOUZA, D.O.C.; FERNANDES, W.B.; FERNANDES, G. *et al*. A roçada do capim-marandu alto no fim do inverno melhora a estrutura do pasto no início do verão. *Encicl. Biosfera*, v.11, p.12-22, 2015.

XIAO, X.; ZHANG, T.; ANGERER, J.P. *et al*. Grazing seasons and stocking rates affects the relationship between herbage traits of alpine meadow and grazing behaviors of Tibetan sheep in the Qinghai–Tibetan plateau. *Animals*, v.10, p.488, 2020.

ZANINI, G.D.; SANTOS, G.T.; SCHMITT, D. *et al*. Distribuição de colmo na estrutura vertical de pastos de capim Aruana e azevém anual submetidos a pastejo intermitente por ovinos. *Cienc. Rural*, v.42, p.882-887, 2012.