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ANIMAL PRODUCTION

Does first and last stocking could "fits" Campos grassland structure to improve beef cattle production?

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ABSTRACT: *This study evaluated the structure of vegetation and the performance of rearing heifers and cull cows in Campos grasslands managed in the rotational stocking method with first-last stocking in the spring-summer period. The treatments were different rest intervals of 402 and 252 degrees-day, which favor the growth of different functional groups of grasses. A completely randomized block design with two treatments and three repetitions was used. The test animals were 24 heifers in the "first" group and 24 cows in the "last" group. In the stratum between tussock grasses, sward heights greater than 0.16 m were predominant in both treatments, it was 1.3 times more frequent in the 402 DD treatment compared to the 252 DD treatment. Average stocking rate was 22% higher in the 252 DD treatment. Although, no differences were observed for the average daily gain of heifers (0.227 kg.day^{-1}) and cows (0.336 kg.day^{-1}) between treatments, the weight gain per area in the experimental period was greater in the 252 DD treatment. Despite the management system with first and last stoking does not provide significant changes in the structure of the pasture, it allowed to achieve satisfactory performance goals in areas of Campos grassland.*
Key words: *daily weight gain, first and last grazing, herbage mass, Pampa biome.*

O método de pastoreio rotativo "ponta" e "rapador" pode moldar a estrutura das pastagens naturais para aumentar a produção de bovinos de corte?

RESUMO: *Este estudo teve como objetivo avaliar a estrutura da vegetação e o desempenho de novilhas em recria e vacas de descarte em pastagens naturais manejadas em sistema de pastejo rotacionado com lotes "ponta" e "rapador" no período primavera-verão. Os tratamentos foram diferentes intervalos de descanso de 402 e 252 graus-dia (GD), os quais favorecem o crescimento de gramíneas de diferentes grupos funcionais. O delineamento experimental foi em blocos ao acaso com dois tratamentos e três repetições. Os animais de teste foram 24 novilhas no grupo "ponta" e 24 vacas no grupo "rapador". No estrato entre touceiras, as alturas do pasto maiores que 16 cm foram predominantes em ambos os tratamentos, sendo 1.3 vezes mais frequente no tratamento 402 GD em relação ao tratamento 252 GD. A taxa de lotação média foi 22% maior no tratamento com 252 GD. Embora não tenham sido observadas diferenças para o ganho médio diário de novilhas (0,227 kg.dia^{-1}) e vacas (0,336 kg.dia^{-1}) entre os tratamentos, o ganho de peso por área no período experimental foi maior no tratamento 252 GD. Apesar do sistema de manejo com lotes "ponta" e "rapador" não proporcionar mudanças significativas na estrutura da pastagem, ele permite atingir metas de desempenho satisfatórias em áreas de pastagens naturais.*
Palavras-chave: *bioma Pampa, ganho médio diário, massa de forragem, ponta e rapador.*

INTRODUCTION

The South American Campos comprise an environmental group that extends through the central-eastern region of Argentina, the entire Uruguayan territory and the southern Brazil (JAURENA et al., 2021), and represent the main source of food for cattle and sheep. These areas are used mainly by cow-calf and heifers in breeding because they do not have immediate economic return when compared to animals in the finishing phase, however, future herds come from these areas. These high diversity natural resources

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provide various ecosystem services for humans, but are losing space mainly to annual crops. Thus, studying the potential use as a source of animal protein production is important both for maintaining biodiversity and for the safety of the food production chain.

Campos grassland are characterized by high floristic diversity, with around 65 to 80% of field biomass being composed of grasses (QUADROS et al., 2011). This grasslands are usually formed by a canopy with a double stratum, with the lower stratum being composed of prostrate-growing grasses, such as *Paspalum notatum* and *Axonopus Affinis*, which are usually grazed by animals, and the upper one by tussock-forming grasses, like *Andropogon lateralis* and *Aristida laevis* (JOCHIMS et al., 2020). The floristic and structural heterogeneity of these environments makes management complex, representing a challenge to farmers. In this sense, CRUZ et al. (2010) proposed a functional grouping of native grasses based on leaf characteristics to simplify the management of these areas. Through the classification by functional types, it was suggested to use time of leaf elongation of the main native grasses as a basis for establishing the resting time (in degrees-day) between grazing in the rotational stocking method to benefit different groups of plants (QUADROS et al., 2011).

These environments, when subjected to long rest periods or low stocking rate, develop a gross structure with high contributions of tussocks in the forage mass, leading to consumption restrictions and low animal performance (BREMM et al., 2012; TRINDADE et al., 2016). Thus, it is necessary to search for alternatives to shape pasture structures more favorable to animal production.

The use of "first" and "last" stocking represents an alternative to traditional rotational grazing capable of increasing the productive efficiency of Campos grassland areas (PEREIRA NETO et al., 1999). This method consisted of the use of two groups of animals with different nutritional requirements, grazing the same area sequentially (ALLEN et al., 2011). This management method produced different forage allowance, which allows the "first" group, to be more selective with the available forage (BLASER, 1982).

Thus, the use of "first" group with rearing heifers and the "last" group with cull cows can promote better use of pasture, allowing the reduction of the height and frequency of tussock and shaping a more uniform structure. Moreover, it can promote different performances between groups of animals by offering different opportunities for forage selection.

Therefore, this study evaluated the dynamics of the sward structure and the productive performance of rearing heifers and cull cows, both managed in the rotational grazing system with "first" and "last" stocking and using different rest intervals between grazings according to leaf elongation of different functional types of grasses abundant in the Campos grasslands of the Central Depression of Rio Grande do Sul.

MATERIALS AND METHODS

The experiment was in an area of 22.5 ha of Campos grassland belonging to the Natural grassland Ecology Laboratory (*Laboratório de Ecologia de Pastagens Naturais* - LEPAN) at the Federal University of Santa Maria, located in the region of Central Depression of Rio Grande do Sul, with geographic coordinates 29º43 'S, 53º42' W and an altitude of 95 m above sea level. The region's climate is Cfa, humid subtropical, according to the Köppen classification with an average annual rainfall of 1769 mm and annual average temperature of 19.2 °C. The average daily temperature and total precipitation accumulated during the experimental period were 23 °C and 560 mm, respectively. These data were obtained daily from the National Institute of Meteorology (Instituto Nacional de Meteorologia - INMET), from a meteorological station located 3.8 km from the experimental area.

From 2010 to 2017, the Campos grassland of the experimental area was managed in the rotational grazing system (BARBIERI et al., 2014), with rest intervals between grazing of 375 and 750 degrees-day (DD) based on the thermal sum (sum of the average daily temperature) required for elongating 2.5 and 1.5 leaves of resource-capture and resource-conservation native grasses, respectively (QUADROS et al., 2011; MACHADO et al., 2013).

The Campos grassland of the experimental area is characterized by double stratum formation with the contribution of upright (tussock) and prostrate (between tussocks) grasses in the forage mass (JOCHIMS et al., 2020), characteristics of the region of Central Depression of Rio Grande do Sul. The composition of the herbaceous vegetation in the experimental area (composition in total green forage mass) was described by JOCHIMS et al. (2020) as *Andropogon lateralis* was the grass that mostly contributed to the forage mass in both treatments (± 37%) followed by *Aristida laevis* (± 14%), *Paspalum notatum* (± 9%), *Saccharum trinii* (± 6%), *Shorgastrum nutans* (± 6%), *Axonopus affinis* (± 6%), *Paspalum plicatulum* (± 3%), and other species of plants representing ± 16%.

The present experiment was carried out from October 25, 2017 to March 23, 2018 for 148 days in the rotational stocking method with two groups of cattle. The "first" group was composed of heifers and the "last" group was composed of cull cows. The treatments consisted of two different rest intervals between grazing for determining the thermal time required for leaf elongation of native grasses. A shorter rest interval, of approximately 252 DD, corresponds to elongation of 1.6 leaves of resource-capture grasses and a greater rest interval of 402 DD was associated with leaf elongation of 0.8 leaves of resource-conservation grasses.

The treatments were arranged in a completely randomized block design with three repetitions. The blocking factor was the topography of the experimental area (top, slope, and valley). In each topography, 252 DD treatment had 3.5 ha subdivided into 7 paddocks, and 402 DD treatment had 4.0 ha subdivided into 8 paddocks. The paddocks measured 0.5 ha on average, and the animals had unrestricted access to water in circular drinking fountains with an automatic float for refueling.

The period of occupation of the paddocks was chosen based on the historical average of occupation of three and five days in the spring-summer period for the 375 DD and 750 DD treatments, respectively, obtained in previous experiments carried out in the same experimental area (BARBIERI et al., 2014; KUINCHTNER et al., 2021). Thus, in the present study, each group of animals occupied each paddock for half of the historical average of occupation, 1.5 days in the treatment with the shortest interval and 2.5 days in the treatment with the longest interval between grazing. As the period of occupation in the present experiment was fixed but with two paddocks occupied by the animals simultaneously, the rest interval between grazing was approximately 252 DD and 402 DD, respectively. Treatment 252 had 13 grazing cycles, while treatment 402 had eight grazing cycles.

The "first' group was composed of 24 Braford heifers aged 12 months at the beginning of the experiment and with an average body weight of 235 kg (± 32 kg). The "last group in turn, was composed of 24 crossbred cows over 60 months of age with an average body weight of 330 kg (± 50 kg). The coefficient of variation of weight of the animals distributed within and between the experimental units was 14% so that each experimental unit received four test animals from each category (first and last).

The pre-grazing forage mass (FM_{pre}) was estimated in a paddock representative of each experimental unit chosen before the beginning of the experiment. Eight evaluations of forage mass were made in each treatment, four in the spring period and four in the summer period, by comparing the patterns visually, which, in turn, were calibrated through double sampling (HAYDOCK & SHAW, 1975), using a 0.25 m² metal frame. Thirty visual estimates were made, of which 10 were cut at ground level and taken to a forced circulation oven at 55 ºC, until reaching constant weight, to determine the partially dry matter (DM). Post-grazing (FM_{post}) was estimated after the "last" group left the representative paddocks, using the same methodology used to evaluate FM_{pre}.

The sward height was taken at three points of each of the 30 forage mass estimates using a ruler, and classified according to the structure (tussock or non tussock). The points occupied with grasses belonging to the functional groups C and D, with height greater than 0.20 m, were classified as tussocks.

The average heights of the stratum between tussock (non tussock) were classified in ranges: < 0.08 m, 0.08 to 0.12 m, > 0.12 to 0.16 m and > 0.16 m. The frequency of each sward height range of the pasture at the pre and post grazing FM of the animals from the paddocks was calculated by dividing the number of samples of each range by the total number of estimates classified as stratum between tussocks. The frequency of tussocks was calculated by dividing the number of samples classified as tussocks in each evaluation by the number of estimates made per evaluation (30).

After each evaluation of FM_{pre}, three representative cuts of the forage mass were chosen and separated into leaves, grass stems dead material, and species from other families to determine the contribution of the structural components of the pasture. The density of forage was calculated by dividing FM_{pre} by the average sward height. The daily forage accumulation rate was estimated only in the stratum between tussocks. It was evaluated at five points in each experimental unit and was calculated by the difference in dry weight between the cuts made at 0.05 m from the ground in an area of 0.25 m² divided by the number of days between cuts. The evaluations were carried out in the paddocks during rest periods between grazing.

Neutral detergent fiber (NDF), *in situ* organic matter digestibility (ISOMD), and crude protein (CP) of the forage was taken with the hand-plucking method, carried out only in the last experimental period because it shows the quality and structural composition of the forage at the end of the experiment. The evaluations were carried out according to the protocol described by BARBIERI et al. (2014).

The stocking rate was adjusted using the "put and take" method (MOTT & LUCAS, 1952). A variable number of heifers in the "first" group was used to adjust the stocking density, while four cows were used to compose the "last" group during the experimental period. Stocking density (SD) was adjusted to consume 70% of the leaf mass of a FM_{pre} above 1000 kg ha^{-1} during the occupation period of each paddock (3 or 5 days), considering the disappearance of forage corresponding to 4.5% of body weight (BW) per day (HERINGER & CARVALHO, 2002). Thus, the following equation was used:

$$SD = \frac{\frac{(FMpre-1000)*(\%leaves*0.7)}{occupation\ period\ (in\ days)}}{0{,}045}$$

The stocking rate (SR) was obtained by dividing SD by the total paddock area (3.5 or 4 ha). The total forage allowance (FA_T) was calculated by dividing the total forage mass by the occupation period of each paddock (3 days in 252 DD treatment and 5 days in 402 DD treatment) divided by the SD. The forage allowance of the non-tussock stratum (FA_{NT}) was calculated in the same way, using only the non-tussock forage mass. FA_T was multiplied by the percentage of leaf blades to calculate leaf allowance (FA_{leaf}). These operations were done in order to be comparable to FA already published in South American natural grasslands. In order to standardize with time-independent estimations of forage allowance, it was also calculated according to what was proposed by SOLLENBERGER et al. (2005).

The removal forage by animals during the occupation period was estimated by the difference in the height of the lower stratum (samples without tussocks) between pre and post grazing forage mass multiplied by the average density of this stratum. The forage mass that removed in the period was divided by the number of days of occupation in each treatment and the FM removed per day. This value was divided by the average stocking density (SD) resulting in the disappearance of forage (kg body weight $^{-1}$ day $^{-1}$).

The animals were weighed periodically on average every 28 days. The spring period evaluations were carried out on 10/25/2017, 11/22/2017 and 12/21/2017, and the summer evaluations were carried out on 1/19/2018, 2/21/2018 and 3/22/2018. Average daily gain (ADG) was obtained by the difference in weight of the test animals divided by the number of days between weighings. The animals did not eat or drink water for at least 12 hours before weighing. Endo and ectoparasite control were performed when necessary. The live weight gain per area (LWG; kg ha^{-1}) was obtained by dividing the SR by the average weight of the test animals in each sample unit and then multiplying it by the ADG of the test animals in each category and the number of days of the experiment.

The analysis of variance was performed using the MIXED procedure of SAS University Studio, including the block effects, treatment, seasons, and treatment x season interaction in the model. The values were subjected to analysis of variance and F test. The averages were compared with the LSMEANS, using a 5% level of significance. Results were tested for normality and, when necessary, transformed by the square root or logarithm.

RESULTS

Sward structure of Campos grassland

The variables describing the sward structure of pastures considered the total forage and the forage of the lower stratum (stratum between tussocks). No variable related to the total forage showed interaction between treatment (T) and season (S) of the year (Table 1).

In the total forage, FM_{pre} was similar between the treatments and seasons evaluated (4915 kg ha^{-1}). The average sward height of the pasture was 0.048 m higher in the 402 DD treatment compared to the 252 DD treatment (Table 1), and it was similar between the seasons evaluated. The forage density was similar between treatments and seasons (17.6 Mg m^{-1} ha^{-1}). The composition of leaves, stems and dead material of FM_{pre} did not differ between treatments and evaluated seasons (Table1). FM_{pre} consisted of 37% leaves, 10% stems, and 51% dead material, on average. Other non-grass species accounted for only 2% of the FM in the 402DD treatment and 4% in the 252DD.

In the stratum between tussocks, sward height of FM_{pre} were similar between treatments and seasons (3502 kg ha^{-1} and 0.19 m, respectively) (Table 1). Average density was 20.8 Mg m^{-1} ha^{-1} of treatments and seasons. The composition of leaves, stems dead material on FM_{pre} did not differ between treatments and seasons with averages of 40% of leaves, 7% of stems, 49% of dead material, non-grass species represented only 6% of FM in the 250DD and 3% in the 402 DD treatment.

The sward height observed in the stratum between tussocks of FM_{pre} were mostly above 0.16 m (Figure 1). The frequency of sward heights above 0.16 m was 1.3 times higher in the 402 DD treatment

Table 1 - Structural and qualitative attributes of pasture and animal performance in a natural grassland under "first" and "last" stocking with two rest intervals (252 and 402 DD) between grazings in the spring-summer period.

Variables	Units	---Treatments (T)---		-----Seasons (S)------		--------------P values-----------			CV (%)
		252 DD	402 DD	Spring	Summer	T	S	T*S	
Total forage									
FM_{pre}	kg ha^{-1}	4837	4994	5067	4763	0.657	0.400	0.602	11
AH	m	0.27	0.32	0.29	0.31	0.019	0.553	0.350	12
Density	Mg m^{-1} ha^{-1}	17.8	15.6	17.7	15.7	0.142	0.184	0.274	16
Leaves	%	36	38	35	39	0.614	0.114	0.578	13
Stems	%	10	10	9	11	0.852	0.450	0.410	43
Non-grass	%	4	2	3	2	0.010	0.050	0.117	6
DM	%	51	50	54	48	0.875	0.225	0.194	15
Tussoock frequency	%	56	50	52	55	0.042	0.434	0.8552	10
Between tussock									
FM	kg ha^{-1}	3588	3713	3720	3581	0.480	0.434	0.216	8
AH	m	0.18	0.21	0.19	0.21	0.071	0.285	0.500	13
Density	Mg m^{-1} ha^{-1}	22.4	19.2	22.4	19.2	0.196	0.210	0.309	21
Leaves	%	38	42	38	42	0.301	0.284	0.339	17
Stems	%	7	7	5	9	0.929	0.064	0.095	63
Non-grass	%	6	3	6	3	0.011	0.009	0.078	8
DM	%	50	48	54	45	0.636	0.081	0.053	18
Accumulation rate	kg ha^{-1} day^{-1}	19.5	19.1	16.8	22.2	0.814	0.019	0.053	26
Qualitative attributes of pasture									
NDF	g kg^{-1}	780	768	-	-	0.126	-	-	3
CP	g kg^{-1}	77.1	77.2	-	-	0.088	-	-	8
ISOMD	g kg^{-1}	548	553	-	-	0.608	-	-	4
Animal performance									
SD	kg ha^{-1}	2966	2758	2890	2843	0.310	0.817	0.870	18
SR	kg ha^{-1}	847	690	776	763	0.006	0.826	0.857	20
FA_T	%	54	37	47	44	0.014	0.638	0.798	26
FA Sollemberger	kg forage kg^{-1}LW	1.5	1.6	1.6	1.5	0.531	0.718	0.902	23
FA_{NT}	%	40	28	35	33	0.004	0.687	0.605	24
FA_{leaf}	%	15	12	13	14	0.085	0.55	0.333	25
ADG_H	kg day^{-1}	0.206	0.254	0.204	0.247	0.311	0.373	0.677	58
ADG_C	kg day^{-1}	0.351	0.321	0.334	0.338	0.774	0.964	0.242	71
LWG	kg ha^{-1}	130	80	-	-	0.039	-	-	27

DD= Degree days; CV= Coefficient of variation; FM_{pre} = Pre-grazing forage mass; AH=Average sward height; DM= Dead material; NDF= Neutral detergent fiber; ISOMD= "in situ" organic matter digestibility; CP= crude protein; SD= Stoking density; SR= Stocking rate; FA_T= Total forage allowance; FA Sollemberger = Total forage allowance calculated by Sollemberger et al. (2005) method; LW=live weight; FA_{NT}= Forage allowance in the stratum between tussocks; FA_{leaf}= Forage allowance of leaves; ADG_H= Average daily

compared to 252 DD (P = 0.012), without differences between seasons (P = 0.964). The frequency of sward heights between > 0.12 and 0.16 m was similar between treatments (P = 0.599), and these sward heights were 1.4 times more frequent in the spring than in the summer (P = 0.037). The sward heights between 0.08 and 0.12 m were 2.1 and 2.5 times more frequent in the 252 DD treatment (P = 0.010) and the summer (P = 0.006) compared to the 402 DD treatment and spring season, respectively. Sward Heights <0.08 m were 3.5 times more frequent in 252 DD treatment (P = 0.005), regardless of the season evaluated (P = 0.276).

Lowest sward heights were observed in the stratum between tussocks after the animals left (post-grazing) (Figure 1). Sward heights > 0.16 m were 1.7 times more frequent in the 402 DD treatment (P = 0.008) and did not differ between seasons (P = 0.999). The frequency of sward heights between > 0.12 and 0.16 m was similar between treatments (29%; P = 0.475), and these sward heights were 1.4 times more frequent in summer compared to spring (P = 0.007).

The frequency of sward heights between 0.08 and 0.12 m was the one that most increased from pre- to post-grazing. The 0.08 and 0.12 m sward height range was 1.9 times more frequent in 252 DD treatment compared to 402 DD treatment (P = 0.010) and 1.25 times more frequent in spring compared to summer (P = 0.006). Sward heights < 0.08 m were two times more frequent in the 252 DD treatment compared to 402 DD treatment (P = 0.006), when the animals left the paddocks. The frequency of sward heights <0.08 m did not differ between seasons (P = 0.276).

Tussock frequency, accumulation rate, and qualitative attributes of pasture

The frequency of tussocks in pasture was higher (P = 0.042) in the 402 DD treatment (56%) compared to the 252 DD treatment (50%), and there was no difference between seasons (P = 0.4340). The average sward height of tussocks at FM_{pre} was similar between treatments (P = 0.188) and seasons (0.38 m; P = 0.283). On FM_{post} the average tussocks height was 0.36 m, being similar between treatments and seasons.

The average forage accumulation rate in the stratum between tussock of pasture was 21.5 kg ha^{-1} day ^{1} in both rest intervals between grazing (P = 0.814); however, it increased from 16.8 kg ha^{-1} day^{-1} in the spring to 22 kg ha^{-1} day^{-1} in the summer (P = 0.019). Also in the stratum between tussocks of pasture, the disappearance of forage corresponded on average to 8.5% body weight day^{-1} of grazing, being similar between treatments (P = 0.118).

Neutral detergent fiber (NDF), "in situ" organic matter digestibility (ISOMD) and crude protein (CP), variables related to the quality of forage ingested by the animals, were similar in both animal categories (heifers × cows) and treatments (272 DD × 402 DD; P>0,05). The average NDF was 782 g kg^{-1} (± 22.6), ISOMD 548 g kg^{-1} (± 22.8) and CP 77.1 g kg^{-1} (± 9.9).

Animal production

SD was similar between treatments and seasons (2864 kg ha $^{-1}$) (Table 1), and SR was 22% higher in the 252 DD treatment (Table 1). Cows represented an average of 45% of the SD in both treatments. FA_T was 1.4 times higher in the 252 DD treatment compared to the 402 DD treatment. However, no difference was observed between seasons, with average of 45.5% (P=0.638). FA_{NT} was different between treatments, where in the treatment 252 DD it was 40% and in the 402DD treatment 28%, but did not present difference between seasons (34%; P=0.687). FA_{leaf} was similar between treatments (P= 0.085), and seasons (P=0.55), with average of 13.5%. When forage allowance was calculated using the method proposed by SOLLENBERGER et al. (2005), where the days of occupation of the paddock are not considered, no difference was observed between seasons (P = 0.718) and treatments (P = 0.531), with an average of 1.6 kg forage kg^{-1} of live weight, ranging from 1.3 to 2.3 kg forage kg^{-1} of live weight. The average daily gain of heifers (ADG_H) and cows (ADG_C) was similar between treatments and seasons. However, when comparing the ADG of the categories, cows showed significantly higher gains than heifers (P = 0.013), with averages of 0.336 kg day^{-1} and 0.227 kg day^{-1}, respectively (Table 1). The final average weight of the cows was 370 kg in both treatments (P = 0.249), and the final average weight of the heifers was 262 kg (P = 0.054). In 148 days of the experiment, the live weight gain per area (LWG) was 38% higher (P = 0.039) in the 252 DD treatment compared to 402 DD treatment (Table 1). Cows represented 56% of the production in 252 DD, and 46% in 402DD.

DISCUSSION

The different rest intervals between grazing (252 and 402 DD) showed highly similar total pre-grazing forage masses and strata between tussocks, not resulting in different pasture structures (Table 1). The only parameter that showed a difference between treatments was the average sward height of total pre-grazing forage mass. The 402 DD treatment resulted in an average sward height greater than that of the 252 DD due to the longer interval between grazing and the lower SR used, being more favorable to the growth of resource conservation species, corresponding to functional groups C and D, as predicted by the rotating grazing system methodology (QUADROS et al., 2011; CRUZ et al., 2010).

Sward height changes are observed in the frequency of distribution of ranges (Figure 1), both at the pre grazing and mainly at the post grazing FM, showing that most of the sward heights observed at an interval between grazing of 252 DD were close to those recommended (0.08 to 0.12 m) to maximize the instantaneous intake rate (GONÇALVES et al., 2009). However, these changes in sward height and frequency of sward heights promoted by the intervals between grazing have not allowed yet changes in the botanical composition of the grassland or the average frequency and heights of tussocks, even with a 7-year history of rotational grazing. This may be due to the predominance of *Andropogon lateralis*, providing the pasture with phenotypic plasticity and resilience to grazing (TRINDADE & ROCHA, 2002). When a high animal stocking rate is used, this grass changes the structure forming smaller tussocks (ZANELLA e al., 2021), more consumed by the animals. Therefore, the stocking rate used in the present study was not able to change the structure of the pasture definitively.

The use of two group of animals can lead to lower sward height ranges of the stratum between pasture tussocks throughout the seasons, since there was an increase from spring to summer in the frequency of sward heights between 0.08 and 0.12 m (Figure 1) and a reduction in the frequency of sward heights between 0.12 and 0.16 m (Figure 1) in the pre-grazing forage mass. However, the evaluated period was not enough to allow changes in the total forage mass, the stratum between tussock, and the contribution of tussocks during the seasons and ADG. This is because; although, the “last” group had fewer opportunities for selection compared to the “first” group, cows still have highly selective grazing habits (GREGORINI et al., 2016), making them preferentially consume the stratum between tussocks.

The quicker return with fewer days of pasture rest in the 252 DD interval (11 days) seems to favor a stratum structure between tussocks more suitable for grazing than the 402DD (21 days), with a higher frequency of heights between 0.08 and 0.12 m after the exit of the animals from the paddocks (Figure 1). This is the sward height range that ensure maximum efficiency of instantaneous forage intake in Campos grasslands (GONÇALVES et al., 2009). There are recommendations for lowering 40% of the sward height at the entrance of the animals to the paddocks in rotational stocking with cultivated species and natural grassland (CARVALHO, 2013; SCHMITT et al., 2019). Therefore, considering the previous recommendation of GONÇALVES et al. (2009) and this one, stratum between 0.14 m at the entrance and 0.08 m at the exit of the animals from the paddocks are the ideal. These values are the lower limit of the stratum of 0.08 to 0.12 m and the average of the stratum of 0.12 to 0.16 m in figure 1. The 252 DD treatment would lead to about 42% of this sward height range at the entrance of the animals against 31% of the 402 DD treatment. Both treatments allow reducing areas above 0.16 m in sward height between the FM_{pre} and FM_{post} (Figure1). However, this reduction can lower the performance of the animals, especially the most demanding ones, such as heifers. Although, differences were observed in the frequency of sward heights of stratum between tussocks, this not led to different performances between treatments. A perspective to be explored in these pastures would be the mechanical removal of this stratum above 0.16 m with the use of mowing to avoid the drop in the performance of the animals.

The similar ADG between the grazing intervals of 252 DD and 402 DD in both categories used, is the result of similar pasture conditions in the treatments (Table 1), which had limiting structures, such as sward height, forage mass, and contribution of tussocks higher than those considered ideal to ensure maximum consumption (BREMM et al., 2012; TRINDADE et al., 2016). Moreover, the low quality of the forage consumed contributed to the low performance, with high % of dead material, which resulted in high contents of NDF (780 g kg^{-1}), low digestibility (540 g kg^{-1}), and low crude protein, which is similar to the 70 g kg^{-1} considered limiting for ruminal functioning (VAN SOEST, 1994). According to VAN SOEST (1994), NDF levels above 550 g kg^{-1} lead to a reduction in pasture consumption. This reinforces the idea that the individual performance of the animals is the result of a set of interactions between pasture and forage consumption and is determined by variables such as structure, quality of forage, and allowance (TRINDADE et al., 2012).

The ADG of the heifers in the present study was lower than that observed by BARBIERI et al. (2014) using rest intervals of 375 DD and 750 DD, 0.410 kg day^{-1} and 0.314 kg day^{-1}, respectively. These results were similar to the result of 0.231 kg day^{-1} reported by MEZZALIRA et al. (2012) from October to March in a continuous grazing system with an FA of 12%. However, when compared to the data presented by SOARES et al. (2005), the ADG values were below those observed in the FA 12%. The superior performance of cows in the “last” group compared to the heifers of the “first” group is mainly due to the lower nutritional requirements of cows compared to that of growing heifers (NRC, 2000) and greater ingestive capacity of the animals. According to CARVALHO et al. (2007), larger animals have a greater capacity to eat poorer quality food, besides that, they select less and consume more forage, which influences the amount of food consumed.

The LWG of 130 kg ha^{-1} obtained in the rest interval of 252 DD in the spring-summer period is considered satisfactory when compared to the annual average obtained in Campos grasslands in southern Brazil, which rarely exceeds 70 kg ha^{-1} (JAURENA et al., 2021). At the end of the experiment, heifers had an average weight of 262 kg. Following the recommendation of mating heifers with 65% of adult weight, and considering that adult Braford females have an average of 450 kg (PATTERSON et al., 1991), heifers would reach this

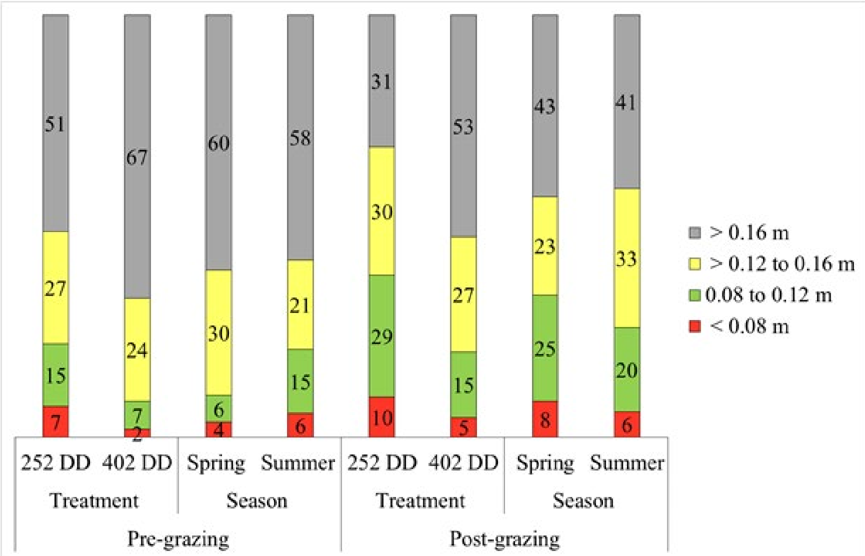

Figure 1 - Frequency of sward height ranges of stratum between pasture tussocks on pre-grazing and post-grazing forage mass.

goal with 292 kg, thus, these animals evaluated would still not be able to mate at 18 months.

However, to ensure that the animals reach the target weight until this age thus being able to mate at 24 months, they must have performances that allow a gain of 30 kg until the beginning of the mating period. Thus, rotational management with "first" and "last" stocking can be used as a management option for the Campos grasslands with double strata in the Central Depression of Southern Brazil to increase productivity and ensure the conservation of Campos grasslands with animal protein production.

CONCLUSION

The management does not allow changes in the structure of the Campos grassland during the spring-summer period. However, the use of rotational grazing with rest intervals based on the leaf elongation duration of native grasses belonging to the functional groups of conservation and capture, with the rotational stocking method with "first" and "last" stocking achieved satisfactory performance goals, proving to be a useful tool in the rearing of heifers for mating at 24 months and slaughtering cull cows.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

The authors contributed equally to the manuscript.

BIOETHICS AND BIOSSECURITY COMMITTEE APPROVAL

The experiment was approved by the Ethics Committee on the use of animals at UFSM, protocol number CEUA nº 6762160916.

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