

Sward Structural Characteristics and Performance of Beef Heifers Reared under Rotational Grazing Management on Campos Grassland

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Received 22 January 2014; revised 25 February 2014; accepted 12 March 2014

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Abstract

This study aimed to evaluate the effect of two rest intervals on structural sward characteristics and productive performance of beef heifers reared on Campos grassland managed on rotational grazing. The treatments were two intervals between grazing of 375 and 750 DD (degree days), based on thermal cumulative sum for leaf expansion of native grasses belonging to two functional groups. The experimental design was a randomized complete block design with two treatments and three replications. The tested animals were beef heifers with initial age of 12 months and average weight of 185.2 ± 17.4 kg. Measures in the pasture were: herbage mass, mass of green leaf blades, stem mass, dead material mass and green leaf allowance. The 750 DD rest interval presented higher herbage mass (24%), higher green herbage mass and 19% more leaves in the canopy. This rest interval also presents a high proportion of dead material and stems in the sward structure. In the other way, the 375 DD rest interval presents better chemical characteristics, with 20% more crude protein in the hand plucking samples. Heifers' dry matter intake was similar between the rest intervals (2.04% of live weight) and the bite mass was also similar (0.22 g DM per bite) but the animal performance was higher in the 375 DD rest interval. The stocking density showed similarity between treatments with an average of 875 kg/LW/ha. The live weight gain per area was higher in 40 kg/LW/ha ($P = 0.117$) for 375 DD rest interval, reaching 251 kg/LW/ha produced over the 149 experimental days. Based on these results, we can conclude that the treatment of shortest interval between defoliation gave the highest gain individual animals in warm seasons.

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How to cite this paper: Barbieri, C.W., De Quadros, F.L.F., Jochims, F., Soares, É.M., De Oliveira, L.B., Carvalho, R.M.R., Dutra, G.M., De Lima, F.X. and Gusatto, F. (2014) Sward Structural Characteristics and Performance of Beef Heifers Reared under Rotational Grazing Management on Campos Grassland. *American Journal of Plant Sciences*, 5, 1020-1029.
<http://dx.doi.org/10.4236/ajps.2014.57114>

Keywords

Average Daily Gain; Duration of Leaf Expansion; Herbage Mass; Rotational Grazing; Stocking Rate

1. Introduction

The combination of high stocking rates and inappropriate management applied to the natural grasslands of the Pampa Biome, also known as Campos Grasslands [1], usually results in low animal performance rates. Those lower rates make beef cattle production activity less profitable than other production options however, beyond animal production, conservation of this biome is important due to its plant diversity and ecosystemic services provided. It could be considered as a suitable environment for sustainable animal production and includes many elements of a culture that goes beyond territorial borders [2].

According to reference [3], the Campos grasslands represent the major food source for Rio Grande do Sul's beef cattle systems (South Brazil). According to the same authors, heifers are the main livestock category reared in this forage resource. Although this category doesn't provide short term economic return, when compared to fattening steers or breeding cows, heifers need to receive appropriate attention to obtain suitable conditions to be mated. Reduction of age at first mating has positive impacts in the whole local production system [4].

Recent research results have shown that the potential productivity of the Campos grasslands goes far beyond of what is usually recorded at commercial farms, making possible to obtain mean daily weight gains of 0.6 kg per day depending on climatic season [5] [6] and increases the productivity per area to around 250 kg of live weight gains/ha. These gains per area are nearly four times higher than the average gains obtained by local farmers, with no inputs and applying a proper stocking rate adjustment only [3].

Campos grasslands are recognized by their great species diversity, due to this, the management of these areas becomes a challenge, mostly due to their high complexity. Grasses represents 65% to 80% of aboveground biomass of this natural grassland. Due to that, as a way to simplify its management, grass species were grouped according to some leaf traits, as specific leaf area and dry matter content from leaves [7]. According to these authors, native grasses could be classified into four functional groups, A, B, C and D. The first two include prostrate grasses of the "lower strata" and the C and D groups present tussock species from the "upper strata".

In this sense, authors from reference [2] proposed to consider morphological and physiological characteristics of the native grasses to management the Campos grasslands. Using the morphogenesis traits of species which composed that four functional groups [8] [9], the authors proposed life elongation duration as a determinant time (in degrees sum) in order to quantify the rest intervals between grazing for benefit specific different groups of plants [10]. To make easier to use those plant characteristics or to explore those characteristics, rotational grazing should be used, mostly due to its control over the time that the plants will be grazed and the time that they are in "rest".

The objective of this article was to evaluate Campos grassland management using different rest intervals in a rotational grazing, considering plant traits as criterion for these intervals, and its effects on sward characteristics and in heifers' performance during its rearing phase.

2. Material and Methods

The experiment was conducted in a natural grassland area, with double strata structure, at Universidade Federal de Santa Maria (UFSM), situated at Depressão Central region (RS), with 29°43'30"S, 53°45'33"W coordinates. The climate is humid subtropical (Cfa), with mean temperature of 19.2°C and annual 1770 mm mean precipitation. The experimental area soils were classified as Ultisoil and Hapludalf in the upper and low slope landscape topographic position, respectively.

The experiment was carried out from Nov 7th, 2011 to Apr 3rd 2012, totalizing 149 consecutive days, divided in 5 periods of approximately 28 days each. The first period was from Nov/07 to Dec/06, the second from Dec/06 to Jan/04, the third from Jan/04 to Feb/02, the fourth from Feb/02 to Mar/03 and the fifth and last period from Mar/03 to Apr/03.

The experiment was conducted with rotational management grazing system. To define the rest intervals in the rotational grazing it was used the accumulated thermal sum to match the mean leaf elongation duration of two

functional grass groups, classified according to the functional types proposed by reference [7]. These criteria determinate the following two treatments: rest period between occupations of 375 and 750 degree day (DD). The 375 DD treatment is based on the time (in degrees-sum) for elongation of 2.5 leaves per tiller of functional groups A and B species (*Axonopus affinis*, *Paspalum notatum*) [8]. The 750 DD treatment is based on the time (degrees-sum) for elongation of 1.5 leaves per tiller of functional groups C and D species (*Aristida laevis*, *Saccharum trinitii*) [9]. So, we multiplied each group average phyllocron by the above number of leaves. The numbers of expanding leaves in the functional groups are intrinsic to genetic traits and define the time of rest intervals (in degrees). The occupation period was defined by the division of the thermal sum of each treatment by the paddocks subdivision number, resulting in the time, in Celsius degrees, of occupation of each subpaddock, which was on average 2.9 from 4.4 days, respectively for 375 and 750 DD treatments. Although 117 species were registered, being 33 grasses, the most abundant are from A and B functional groups that comprises 52% of average forage mass and from C and D groups comprising 24% of forage mass.

The accumulated thermal sum was calculated by the mean daily temperatures sum (MT), which was obtained this way: $MT = [(T^{\circ}Mx + T^{\circ}Mn)/2]$; where $T^{\circ}Mx$ is the daily maximum mean temperature and $T^{\circ}Mn$ is the daily minimum mean temperature. The climatic data was obtained with the National Meteorological Institute (INMET), in the automatic meteorological station of Santa Maria, RS, three km from the experimental area.

The experimental area had 22.5 ha where the two treatments and three area replicates were distributed, totalizing six experimental units (paddocks). The experimental units of the 375 DD had seven subdivisions and the 750 DD treatments had eight subdivisions. Each subdivision had 0.5 ha where water and mineral supplements were provided ad libitum. Previously to the starting of the trial, six subdivisions, one by replicate, were elected as representatives of all paddock's area. Herbage evaluations were realized in those subdivisions.

Tester animals were 24 Angus beef heifers, with initial mean age of 12 months and mean initial weight of 185.2 ± 17.4 kg. The heifers were arranged in six groups of similar weight and body condition score and then randomly distributed in the treatments with four heifers in each replicate. In addition to the tester animals a variable number of "put-and-take" animals, with the same age and sex of the test-animals was used to adjust the stocking rate (SR). The natural grassland was managed with rotational grazing method and variable stocking rate, using the accumulated thermal sum as an occupation and rest period parameter.

The herbage mass (HM) was measured using a visual standard comparison, calibrated with double sampling technique [11], with 20 visual estimative and six cuts at ground level, using a 0.25 m^2 quadrat. All regression equations derived from visual assessments are above 0.7 of determination coefficient (R²), indicating evaluators' skill. In each cut two sub samples were separated, one to determinate the dry matter (DM) content and other to determinate leaves, stems (of grass), dead material and other species (than grass) dry matter contribution in the canopy. In each evaluation sward height was measured with a sward stick.

Instantaneous stocking rate (ISR) (stocking during grazing days in the subdivisions of 0.5 ha) was adjusted using grasses leaves proportion of the sward, in a way that the calculated SR could remove 70% of the leaves mass and keeping a residual mass of 1500 kg DM/ha, using the following equation: $ISR = ((\text{Herbage mass} - 1500) \times (\% \text{ green leaf} \times 0.7 \text{ (or } 1))) / 0.045$ (herbage disappearing of 4.5% of live weight). This residual mass was used considering a "La Niña drought" forecast for the experimental period (Figure 1). Besides that, for SR calculating it was considered herbage disappearing of 4.5% of live weight [12]. From 02/02 until the end of the trial, the protocol was changed, mostly due to more favorable precipitation conditions. In this occasion the leaf offer goes from removal of 70% to 100%. Mean stocking rate (MSR) was calculated by dividing ISR by all paddock area (3.5 or 4.0 ha).

The mean daily weight gain (DWG) was obtained by the difference of the animal's weight among the weightings, divided by the day number among the weightings. Animals had a 12 hours total fasting period approximately each 28 days. Along with the weighting, the Body Condition Score (BCS) of the animal was assessed and classified from 1 to 5, being 1 very thin and 5 very obese [13]. Endo and ectoparasites were controlled when needed.

For herbage allowance estimations it was used a mean growth herbage rate value, mostly due to high variation of data. Herbage allowance was calculated adding the mean growth rate to the mean HM in the occupation days. The relations between these values with the stocking rate are the actual herbage allowance (HA), in percentage of live weight (kg DM/100 kg LW). The leaf HA was calculated in the same way.

The herbage intake was measured in two occasions (Nov 12th 2011 and Mar 12th 2012), using two animals by replicate, with Cr₂O₃ (chromium oxide). The dosage period to adaptation and faeces samples collection comprised

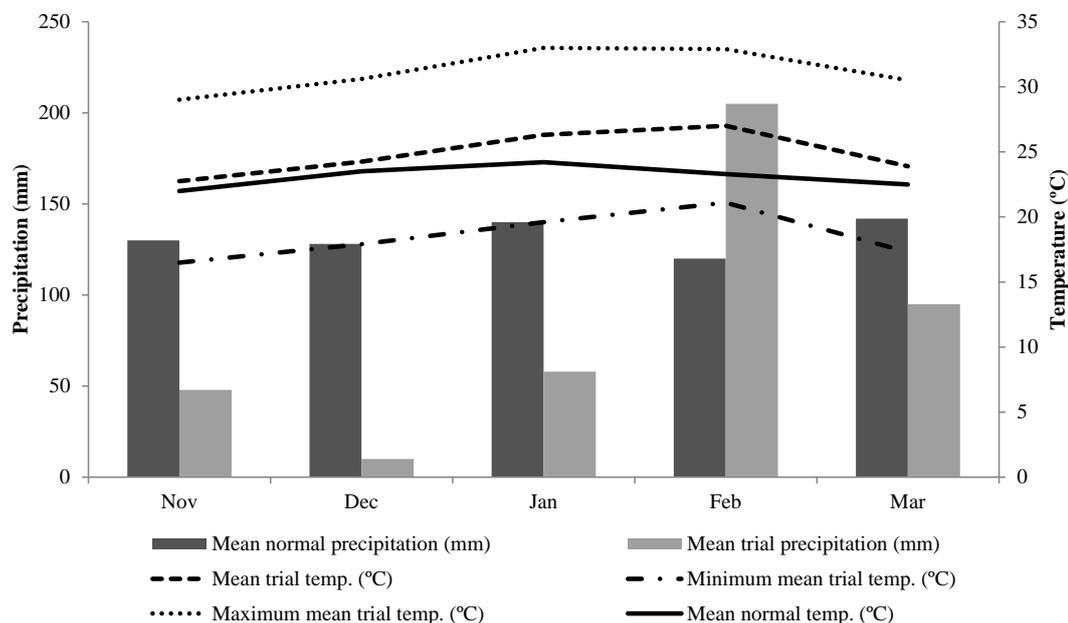


Figure 1. Historic normal mean precipitation and temperature and mean precipitation, mean temperature and mean maximum and minimum temperature during the experimental period. Data from INMET (Santa Maria, RS, Brazil).

10 consecutive days. Chromium oxide was provided orally, one time by day [14], in the morning (7:30 h), together with a polyethylene external marker, with different colors for each animal to identify the faeces in the paddocks along the collection period.

Animals received for nine consecutive days five grams of Cr_2O_3 , daily, and in the last three days the fecal samples were collected at the grassland. For these collections daily “sweeps” were realized in the paddocks, with an examination of all found faeces. If the polyethylene marker was present, samples were collected. After the “sweeps”, all faeces founded were spread out. The collected samples were allocated into aluminum recipients and dry until constant weight, macerated to remove the polyethylene markers and grounded for laboratory analysis.

Samples of 0.5 g was weighted for Cr_2O_3 determination and then burned in a 550°C oven for three hours. After, a Cr_2O_3 digestion solution of 5 ml was added, according to [15] and placed in a hot plate at 220°C . After the sample changes color (green to yellow), the content was filtered and transferred to a 100 ml volumetric balloon, completing the volume with distillate water to measure the Cr_2O_3 concentration by atomic absorption spectrophotometry. The standard curve was prepared with 100 mg of Cr_2O_3 . Fecal production (FP) was estimated as follows: $\text{FP} = \text{supplied } \text{Cr}_2\text{O}_3 \text{ (g/day)}/\text{faeces } \text{Cr}_2\text{O}_3 \text{ (g/kg of DM)}$. Then, the intake estimation was calculated as follows: $\text{Intake (g/day)} = \text{FP (g/day)}/(1-\text{digestibility})$. The digestibility in situ of samples of herbage apparently collected by the animals was determined according to reference [16]. The bite mass was calculated dividing the total bite number (bite rate \times grazing time) by the daily DM intake.

Together with the intake evaluations was performed grazing behavior assessments in order to obtain the grazing time and the bite rate. The grazing time was assessed by visual observations each 10 minutes. The bite rate was measures using the bite number in 20 seconds periods, at least 9 times by animal within repetitions.

Herbage apparently collected by the animals was obtained using a hand plucking sampling of the tester animals [17]. These assessments were made when the animals were in the second day of occupation, in three periods, prior, in-between and after grazing behavior assessments. Collected samples were dried in a 65°C oven until constant weight and grounded in a Willey mill with 1 mm sieve. The hand plucking samples were analyzed for total DM, in an oven at 105°C , total nitrogen (N; $\text{N} \times 6.25 = \text{crude protein}$; [18]) and neutral detergent fiber [19].

The experimental design was a randomized block design, with repeated measures in time, two treatments and three replicates. The blocking criterion is the relief slope. Values were submitted to a variance analysis and F test. Analysis of variance was performed using SAS 9.2 software’s MIXED procedure, including in the model

the effects of block, treatments, periods and the treatment \times period interaction. The means were compared with LSMEANS, with 10% of significance level and using the CS covariance structure (Compound Symmetry), chosen by the lower AIC (Akaike's information criteria) among other structures. All variables presents normal statistical distribution tested using UNIVARIATE NORMAL procedure from SAS 9.2 software.

3. Results

All sward or animal production variables did not present any rest interval \times periods interaction ($P > 0.10$). Herbage mass (HM) differed among the rest periods tested ($P = 0.01$) being 24% higher in the paddocks managed with 750 DD interval. The HM did not present significant differences over the periods (**Table 1**). Grasses contribution for A and B groups were also similar for both treatments, being 52% and 51% of HM, respectively for 375 and 750 DD. Although no differences in HM and A plus B groups, 750 DD treatment presented 27% of HM of C and D grasses groups while 375 DD only 23% ($P = 0.06$).

Green herbage mass (GHM; all green material, including leaves, stems and other species than grass) differed among the rest intervals and over the periods. The GHM was 27% higher in the 750 DD rest interval. Besides, the GHM in the first period presents the lower quantity and an increase of 63.7% was observed until the last period.

The stem mass was also 67% higher in the 750 DD rest interval when compared with the stem mass from 375 DD rest interval. The stem mass did not present significant differences over the evaluation periods.

The leaf mass (LM) was higher in the 750 DD rest intervals ($P = 0.06$), with 19% more leaves than the 375 DD rest interval. Furthermore, LM also differed over the evaluation periods, with the lower amount of leaves in the third period and the higher amount of leaves in the last period.

There are differences ($P < 0.1$) to stem mass (Stem) and dead material (Dead M.) in the sward to the different rest intervals and both characteristics are similar over the periods ($P > 0.1$). The 750 DD rest interval presented 40.4% more stem mass and 27% more dead material than the 375 DD rest interval. The "other species" mass did not present differences to the rest intervals and over periods, with a mean of 72 kg DM/ha during all over the trial.

The CP content in the hand plucking samples was different among the rest intervals and similar over the assessments (**Table 2**). The 375 DD rest interval presented 20% more CP content in the hand plucking samples than the 750 DD rest interval. Despite the change in the CP content, the herbage ISOMD (in situ OM digestibility) was similar among the rest intervals and only presented significant differences over the assessments. The lower ISOMD was observed in the second assessment and the higher in the third assessment. Anyway, those changes in the chemical characteristics did not change the total digestible nutrients (TDN) in the samples to the rest intervals or assessments ($P > 0.10$).

The mean herbage intake represents 2.04% of the heifers live weight and is similar for both rest intervals and among the assessments. The bite mass was also similar between the rest intervals and periods, with a mean of 0.22 g DM/bite (**Table 3**).

Considering heifers performance, when natural grassland was managed with 375 DD rest interval, the DWG was higher ($P < 0.1$). Furthermore, there was a significant difference over the periods as well (**Table 4**). In the 375 DD heifers gain about 0.100 kg more than the heifers in the 750 DD.

For BCS, the rest intervals presented similar results and the BCS only varies over the periods. The mean BCS was 2.69 to the rest intervals and, over the periods, was higher in the three last periods.

The ISR (instantaneous stocking rate) and the MSR (mean stocking rate) were similar among the rest intervals, with a mean of 3288 and 875 kg/LW, respectively.

The leaf herbage allowance (LA) was similar over the periods but differed among the rest intervals, being 5.3% higher in the 375 DD. As a final result, the area LW gain (kg/ha) in the 149 experimental days was similar ($P > 0.10$) for the different rest interval used to manage the grassland. In total, the 375 DD rest interval produced 251 kg LW/ha and the 750 DD rest interval produced 211 Kg LW/ha.

4. Discussion

The higher HM observed in the 750 DD rest interval probably was caused by the higher rest interval applied in those paddocks. This higher lapse of time before the animal's entrance optimizes the condition to lower growing rate plants recovery, due to low frequency in which they were grazed, increasing their leaf proportion. The C

Table 1. Pre grazing herbage mass (HM), green herbage mass (GHM), green leaf mass (LM), stem mass and dead material quantity, in kg DM/ha, of a natural grassland managed with rotational grazing method using two rest intervals (375 and 750 degree-day, DD).

<i>Rest intervals</i>	HM	GHM	LM	Stem	Dead M.
375 DD	2687 ^B	1502 ^B	1149 ^B	276 ^B	1188 ^B
750 DD	3526 ^A	1909 ^A	1377 ^A	463 ^A	1630 ^A
SME [*]	214.6	109.7	81.4	39.1	121.9
<i>Periods (day/month)</i>					
07/11 a 06/12 (1)	2840	1391 ^C	1052 ^{BC}	254	1451
06/12 a 04/01 (2)	2823	1504 ^{BC}	1132 ^{BC}	293	1342
04/01 a 02/02 (3)	2928	1433 ^{BC}	954 ^C	425	1506
02/02 a 03/03 (4)	3535	1921 ^{AB}	1402 ^{AB}	427	1618
03/03 a 03/04 (5)	3404	2278 ^A	1775 ^A	446	1128
SME [*]	339.5	173.5	129.1	61.8	192.9
<i>Significance level (P =)</i>					
Rest intervals	0.012	0.010	0.063	0.003	0.019
Periods	0.438	0.007	0.001	0.128	0.468
Ri × P interaction ¹	0.650	0.444	0.474	0.449	0.524

Values with different uppercase letters in column differ by LSMEANS ($P < 0.10$). ¹Rest intervals × periods interaction, ^{*}Standard mean error.

Table 2. Crude protein content (CP), in situ organic matter digestibility (ISOMD) and total digestible nutrients (TDN) of the herbage apparently eaten by the animals in a natural grassland managed with rotational grazing method with two rest intervals (375 and 750 degree-day; DD).

	<i>Rest intervals</i>		<i>Assessments</i>			<i>Signif. (P =)</i>		<i>SME³</i>	
	375 DD	750 DD	23/11	20/01	30/03	Ri ¹	A ²	Ri ¹	A ²
CP (%)	9.6 ^A	8.0 ^B	9.3	8.4	8.8	0.001	0.246	0.26	0.33
ISOMD (%)	65.3	63.4	63.7 ^{AB}	62.4 ^B	67.0 ^A	0.170	0.034	0.86	1.20
TDN (%)	62.3	60.3	61.0	60.1	62.5	0.120	0.221	0.76	1.07

Values with different uppercase letters in line differ by LSMEANS ($P < 0.10$). ¹Rest intervals, ²Assessments, ³Standard mean error from Rest intervals (Ri) and Assessments (A).

Table 3. Herbage intake, in live weight percentage (% LW), and bite mass (B. Mass), in dry matter grams per bite, from beef heifers kept in a natural grassland managed with rotational grazing method with two rest intervals (375 and 750 degree-day; DD).

	<i>Rest intervals</i>		<i>Assessments</i>			<i>(P =)</i>		<i>SME³</i>	
	375 DD	750 DD	09/12	12/03	Ri ¹	A ²	Ri ¹	A ²	
Intake	1.94	2.14	2.15	1.94	0.246	0.222	0.15	0.21	
B. Mass	0.20	0.24	0.23	0.21	0.309	0.689	0.019	0.027	

¹Rest intervals, ²assessments, ³Standard mean error.

and D functional group plants present naturally slower growth rate, higher leaf dry matter proportion and high stem proportion, increasing the HM in this treatment. Despite that, higher rest interval of this treatment is favorable to the development of “tussock like” grass species, from functional types C and D [10] and 2.5 years of

Table 4. Daily weight gain (DWG; kg/live weight/day), body condition score (BCS), instantaneous stocking rate (ISR), mean stocking rate (MSR) and leaf allowance (LA), in % of live weight from beef heifers kept in a natural grassland managed with rotational grazing method with two rest intervals (375 and 750 degree-day; DD).

<i>Rest intervals</i>	DWG	BCS	ISR	MSR	LA
375 DD	0.410 ^A	2.79	3006	859	14.7 ^A
750 DD	0.314 ^B	2.75	3570	892	9.4 ^B
SME*	0.032	0.018	363.6	99.7	0.25
<i>Periods (day/month)</i>					
07/11 to 06/12 (1)	0.393 ^{BC}	2.69 ^B	2639 ^B	717 ^B	12.3
06/12 to 04/01 (2)	0.313 ^C	2.70 ^B	2710 ^B	725 ^B	12.2
04/01 to 02/02 (3)	-0.090 ^D	2.83 ^A	2179 ^B	577 ^B	12.8
02/02 to 03/03 (4)	0.714 ^A	2.80 ^A	3751 ^{AB}	1004 ^{AB}	11.6
03/03 to 03/04 (5)	0.480 ^B	2.85 ^A	5160 ^A	1353 ^A	11.3
SME*	0.049	0.029	575.1	157.7	0.60
<i>Significance level (P =)</i>					
Rest intervals	0.046	0.176	0.287	0.814	<0.001
Periods	<0.001	0.003	0.012	0.020	0.821
R × P interaction ¹	0.290	0.237	0.145	0.218	0.180

Values with different uppercase letter in column differ by LSMEANS ($P < 0.05$). ¹Rest intervals × periods interaction, *Standard mean error.

this management in the same area could be changing the sward structure in this way.

The observed HM of the present trial was higher than the observed HM in experiments using different herbage allowances in natural grassland (4, 8, 12 and 16 kg dry mass/100kg live weight; %LW), including the HM observed in the higher herbage allowance (16% LW), that varies from 1935 kg DM/ha [20] to 2087 kg DM/ha [21]. Probably the higher HM from the present trial was due the inclusion of the tussocks in herbage mass evaluations, given that, references [19] and [20] only evaluated the lower strata of the natural grassland. Higher GHM observed in the 750 DD rest interval are probably due the higher HM from this treatment.

The change in LM over the periods was caused mostly due to a shortage of rains in these periods (Figure 1). Plants did not produce sufficiently (new leaves) to compensate the tissue removal by animals intake in the previous period, reducing the LM, despite that this result cannot be observed in the HM. Anyway, those results match with the higher daily weight gains in the animals on those periods (Table 4), as well with the better herbage digestibility in the hand plucking samples (Table 2).

Differences observed in the stem mass and dead material mass, which was higher in the 750 DD rest interval, are due to plant functional group that are most present in the paddocks allocated to this treatment (750 DD). Those plants are classified as in functional groups C [7] and tend to form tussock-like structure in the sward, with high amount of dead material and high stem proportion [2].

The 375 DD rest interval presented 20% more CP content in the hand plucking samples than the 750 DD rest interval. This result was probably due to a higher participation of the lower strata at those paddocks, fostering animal's selective intake. In the lower strata were found plant species that present better nutritional characteristics and prevailing mostly by A and B functional groups [7] due to their lower leaf duration (more tender leaves), with higher leaf area index and lower DM content [9]. According to [22], ruminants prefer to select leaves in the canopy, mostly by nutrient concentrations in those tissues (leaves) being higher. The CP content was higher than 7% in both rest intervals and, according to [23], this is the minimum CP value to avoid losses in the fiber degradation capacity by the ruminal microorganisms. These results are also related to the characteristics of the structure of the sward (Table 1) and probably are the main reason for higher animal production in the 375 DD interval (Table 4).

Considering changes in the chemical characteristics over the assessments, those results could be attributed to

the lack of rain observed along the trial (**Figure 1**). If precipitations were normal, a reduction in the ISOMD was expected but, in the results, this is not observed. With the increase in the water availability at the end of the trial there was an increase in the leaf mass, fostering heifers' selective bites, increasing the quality of eaten herbage.

The ISR and MSR differed over the periods and this variation was linked with the experimental protocol for SR adjustment, according to the herbage mass and the residual HM of the trial. Despite the natural changes in the sward, a water storage deficit influenced as well the stocking rates. The MSR of the present trial was higher than the SR used in other natural grassland experiments, in treatments that presented the highest DWG [5] [21] [24], demonstrating a higher potential to manage natural grasslands with rotational grazing.

Anyway, the SR and the herbage allowance observed in the present trial, in this case the leaf allowance, of both rest intervals, was considered non limiting to the heifers herbage intake, being superior than 8% LW [25]. Natural grassland trials evaluating distinct herbage allowances (4% to 16% LW) demonstrate that the herbage allowance presenting better results in terms of DWG was situated from 11.5% to 13.5% LW [5] [26]. Nevertheless, it is important to know that, in those trials, herbage allowance refers to above ground mass mainly from the lower strata. In the present trial, stocking rates was adjusted using the green leaves mass, so the allowance was only from green leaves.

Reference [27] observed increasing values of herbage intake when the herbage allowance increases (from 4% to 16% of LW). Nevertheless, in the present trial, the DM intake was near to the values observed by [27] in the treatment with lower herbage allowance (4% LW), when the animals presented 2.1% LW of intake. This difference between the present work and [27] experiment probably can be linked with differences in intake estimates that used different methods, but also with grazing methods used in each trial. In [27] trial, authors utilize n-alkanes as indigestible markers, that had lower recuperation rates than chromium oxide and tend to overestimate intake values. In the present trial, the grazing period is short and the SR could be consider high so, over the occupation days, the HM declines quickly and the herbage intake could present a reduction.

Those higher DWG from the 375 DD rest interval probably was due to better chemical composition, mostly CP content, of the herbage eaten, since the herbage intake was similar among the rest intervals ($P > 0.10$; **Table 3**) and among the periods. However, despite the positive DGW of the heifers of both rest intervals, the individual animal performances were lower than the DWG of 0.600 kg/day observed by [5] [6]. Probably there is a strong influence of sex of tester animals (above trials used steers) and year (climate) over the results observed in the experiments. Considering the first assumption, [24], using the same experimental protocol than [6], but evaluating heifers instead of steers, found DGW lower than the observed on the present trial for DWG and area weight gains.

The negative DWG observed in period 3 (**Table 4**) can be linked to rain shortage of this part of experimental year (between second and third periods) and the higher temperatures observed. The leak of water to the plants causes a reduction in the LM and consequently decreasing the quality of the herbage consumed by the animals (**Table 2**) and so DWG in those periods was lower. Despite that, higher temperatures can cause changes in the animal's ingestive behaviour, inducing an intake reduction in up to 10% [28]. In period 4, when rainfall exceeds normal records, the LM increase 32%, turning easier leaf selection and increasing DWG. In this period the hand plucking samples presented higher herbage quality.

Britannic beef heifers reach the sexual maturity with 60% of their adult weight [29], with occurs around 270 kg LW in animals evaluated in the present trial. At the end of the trial, the heifers reach 237 kg LW (mean), representing 53% of their LW. To reach the 60% of the adult LW, the heifers need to gain about 0.160 kg/day until the mating season (from 18 to 24 months). This DWG are easily attained in natural grassland with moderate herbage allowances [6] [20]. So it could be possible to assure that both rest intervals would provide similar or even better animal performances and the choice to use one or another will depend on sward structure that are available at farm. Moreover, the minimum BCS of beef heifers to manifest puberty is around 3.0 [30], indicating that heifers of the present trial still needs to gain only 0.4 points in the BCS, in 6 months.

Considering LW gain per area, the observed results could be consider satisfactory, mostly if compared with Rio Grande do Sul historic mean area LW gains, that are 70 kg LW/ha per year [3]. Despite that, these results are similar to results observed in articles using different herbage allowances [6] [21] [31]. If we extrapolate the results to all growing season (around 210 days), the estimated LW gain per area become 328 kg LW/ha.

In a general way, the 375 DD rest interval provided better animal performance than the 750 DD rest interval. This response was, probably, due to changes caused by this management in the sward structure over the time. The 375 DD rest interval tends to favor the prostrate grass species, with usually presents a better chemical

composition (A and B functional groups) [7] [10] [27]. Nevertheless, considering the available publications, the 750 DD rest interval also provided satisfactory animal performance.

5. Conclusion

Campos grasslands structure provided by this rotational grazing scheme allows satisfactory and intended beef heifers' weight gains, regardless of the rest interval used in the management, showing a higher stocking capacity and performance per area that this environment can produce. However, in the warm season, the rest interval of 375 accumulated degree-days provide better chemical characteristics for the herbage eaten by heifers and thus better daily weight gains than the treatment with a rest interval of 750 degree-day.

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