Effect of Native Grassland Intensification over Cattle Performance

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Abstract
The objective was to evaluate the effect of different levels of intensification in native grassland over cattle live weight gain (LWG), stocking rate (SR) and average daily gain (ADG) in Uruguay. The study was carried out in 7.8 ha in Paysandú, between winter 2015 and autumn 2019. Experiment was a randomized complete block design, with 4 replicates. The four treatments applied were native grassland (NG), NG overseeded with *Trifolium pratense* (6 kg.ha^{-1}) and *Lotus tenuis* (6 kg.ha^{-1}) + 40 kg.ha^{-1} of P_2O_5 (NGO), NG fertilized with 60 kg.ha^{-1} of N + 40 kg.ha^{-1} of P_2O_5 (N60) and NG fertilized with 120 kg.ha^{-1} of N + 40 kg.ha^{-1} of P_2O_5 (N120). Fertilizers used were urea and a blend of 7-40/40-0-4. Animals were growing Holstein steers, with initial live weight of 180 ± 22 kg. Treatments management consisted of rotational stocking system, subdivided in 4 plots, according to blocks. Grazing periods were 14 ±1 day, and rest periods were 45 ±2 days, totaling a grazing cycle of 60 days. The average area of the plots of NG and NGO treatments was 0.72 ha while the treatments of N60 and N120 was 0.26 ha. The SR was significantly different between treatments (P = 0.066). The SR in N60 was 868 ±85 kg LW.ha^{-1}, in N120 was 856 ±124 kg LW.ha^{-1}, in NGO was 583 ±91 kg LW.ha^{-1} and in NG 544 ±40 kg LW.ha^{-1}. The ADG was not different between treatments (P = 0.372), averaging 0.472 kg LW.animal^{-1}.day^{-1}. The LWG was different between treatments (P = 0.050). The LWG was higher in N60 (432 ±107 kg LW.ha^{-1}.year^{-1}), intermediate in N120 (391 ±91 kg LW.ha^{-1}.year^{-1}) and NGO (306 ±148 kg LW.ha^{-1}.year^{-1}) and lower in NG (206 ±63 kg LW.ha-1.year-1). Increasing levels of intensification in native grassland allow higher ADG and SR, determining higher LWG.

Introduction
Managements practices such the use of herbage allowance (HA), which relates the herbage mass and the stocking rate, determines the paddock herbage mass and intake rate for its effect in the bite mass (Carvalho et al. 2015). Furthermore, the HA affects the ingestive behaviour through the grazing and rumination time (Scarlato, 2011), and the forage chemical composition harvested by animals (Piaggio et al. 1996) and so through energetic cost, detetermines the average daily gain (Carvalho et al. 2015). The high vegetation heterogeneity on native pastures (Villalba et al. 2002) maintained at intermediate and high herbage allowance (i.e. not under or overgrazed, 8 and 12%), allows for greater selectivity (Mezzalira et al. 2012), resulting in a better quality diet than the average of pasture (Piaggio et al., 1996). Using variable HA throughout the year as a zero-cost practice management, allowed to express the potential productivity of the grazing native systems, which triplicates the live weight gain productivity, from 70 to 200 kg LW.ha^{-1}.year^{-1} (Nabinger and Carvalho, 2009).

The next step of increasing intensification practices are introduction of exotic species and fertilization, which cause important changes in native pastures productivity and community dynamics. Nitrogen and phosphorus fertilization and the incorporation of non-native, cool-season legumes, usually named pasture improvements, increase annual forage production and shifts seasonal patterns (Ayala and Carambula, 1994; Zanoniani et al. 2011). These interventions determine variations in the botanical composition, pasture structure (Boggiano, 2000), and the overall nutritive value also increases (Bemhaja, 1994). Additionally, in mixed pastures, animals tend to have greater selectivity towards legumes, spending more time searching and selecting (Chapman et al., 2007).

Based on background research in south Brazil and north and east Uruguay, we hypothesized that the use of practice managements as HA and the introduction of legumes and fertilization in a western Uruguay Campos, determine an increase in forage production, allowing an increase in stocking rate. Additionally, these interventions determine an increase in nutritive value which implies an increase in daily gain. Both an increase in stocking rate and animal performance determines an increase in annual live weight gain. Therefore, the objective of the study was to evaluate the effect of different levels of intensification in native grassland over cattle live weight gain (LWG), stocking rate (SR) and average daily gain (ADG) in western Uruguay Campos.

Methods and Study Site

The study was carried out in 7.8 ha at the Experimental Station "Mario A. Cassinoni" (EEMAC), Faculty of Agronomy, Paysandú (32 ° 23'55,67"S and 58 ° 2'42,34"W), Uruguay, between winter 2015 and autumn 2019. Historical annual average rainfall and temperature (1980-2009) are 1238 mm and 18.1 °C, respectively. The soil types of the study area were Lithic Hapludolls (28%), Natruaqolls (26%), Argialbolls (23%) and Argiudolls (22%) (Duran et al., 2005). The vegetation was a native grassland dominated by species of Poaceae family in low stratum (< 25 cm) like *Axonopus affinis* Chase*, Bromus auleticus* Trinius*, Mnesithea selloana* (Hack.) de Koning & Sosef*, Nassella mucronata* (Kunth) R. W. Pohl, *Paspalum dilatatum* Poir. and *Paspalum notatum* Flüggé*.* Species in medium stratum (25 – 70 cm) were shrubs like *Baccharis coridifolia* DC. and *Eryngium horridum* Malme, and in high stratum (> 70 cm) were trees species like *Acacia caven* Molina and *Prosopis affinis* Spreng.

The experiment was arranged in a randomized complete block design, with four replicates. Blocks were defined according to the topographic position in experimental area. The four treatments applied were native grassland (NG), NG overseeded with *Trifolium pratense* (6 kg/ha) and *Lotus tenuis* (6 kg/ha) + 40 kg/ha of P_20_5 (NGO), NG fertilized with 60 kg/ha of N + 40 kg/ha of P_20_5 (N60) and NG fertilized with 120 kg/ha of N + 40 kg/ha of $P0_5$ (N120). Fertilizers applied were urea (0-46/46-0-0, N-P-K-S) and a blend of 7-40/40-0-4. The animals utilized in the experiment were growing Holstein steers, with initial live weight of 180 ± 22 kg. Animals were randomly allocated to each treatment. The steers were weighted every 30 days with a 12-hour fast. The average area of the plots of NG and NGO+P40 treatments was 0.72 ha while the treatments of N60 and N120 was 0.26 ha. Treatments management consisted of rotational stocking system, subdivided in 4 plots, according to blocks. Grazing periods were 14 ±1 day, and rest periods were 45 ±2 days, totaling a grazing cycle of 60 days. The pasture management was based on the herbage allowance, managing during autumn and winter 7-9% of herbage allowance, and 10-12% during spring and summer.

A variance analysis was performed to determine differences between treatments in relations to stocking rate, average daily gain and live weight gain, where blocks, animals and years were used a repeated measure using R Development Core Team (2018).

Results

The annual real herbage allowance between treatments was between 8 and 12 kg DM. kg LW^{-1}. These management allowed that the residual average pasture height was at least 7 cm. We observed an effect of the native grassland intensification over stocking rate and live weight gain per area but not over animal daily gain. The stocking rate was significantly different between treatments (P= 0.066). Increasing levels of intensification in the native grassland allowed higher stocking rate. The SR in N60 was 868 ±85 kg $LW.ha^{-1}$, in N120 was 856 ±124 kg $LW.ha^{-1}$, in NGO was 583 ±91 kg $LW.ha^{-1}$ and in NG 544 ±40 kg $LW.ha^{-1}$ (Table 1).

Conversely, we did not observe and effect of the native grassland intensification over the animal daily gain. The ADG was not different between treatments (P = 0.372), averaging 0.472 kg $LW.animal^{-1}.day^{-1}$ in all treatments. Finally, the we observed an effect of the intensification over the live weight gain per area (P = 0.050). The LWG was higher in N60 (432 ±107 kg $LW.ha^{-1}.year^{-1}$), intermediate in N120 (391 ±91 kg $LW.ha^{-1}.year^{-1}$) and NGO (306 ±148 kg $LW.ha^{-1}.year^{-1}$) and lower in NG (206 ±63 kg LW.ha-1.year-1).

Table 1 Mean treatment effect (NG: native grassland, NGO: overseeded native grassland, N60 and N120: fertilized native grassland with 60 and 120 $kg.ha^{-1}$ of N, respectively) and standard error (SE) on stocking rate (SR), average daily gain (ADG) and live weight gain (LWG)

	NG	NGO	N60	N120	SE	P-value
SR (kg $LW.ha^{-1}$)	544	583	868	856	98	0.066
ADG (kg $LW.animal^{-1}.day^{-1}$)	0.374	0.523	0.521	0.471	0.065	0.372
LWG (kg $LW.ha^{-1}.year^{-1}$)	206^{a}	306^{ab}	432^{b}	391^{ab}	54	0.050

Different letters following means in rows indicate statistical significance at $P < 0.05$.

Discussion

Our results showed that a grazing pasture system under non-limiting pasture quantity and nutritive value with intermediate herbage allowance (8 to 12%) it is possible to triple the annual live weight gain per area as other authors showed in other Campos regions (Nabinger and Carvalho, 2009). The residual average height was at least 7 cm in all treatments and years. Therefore, we confirm that conducting different native pastures over the Campos region with intermediate HA and pasture height at least 7 cm and zero cost we could obtained 200 kg LW.ha.year (Rodriguez Palma and Rodriguez, 2017).

The higher stocking rate with higher levels of intensification is due to the higher pasture growth rate, which at the same herbage allowance allowed higher stocking rate. Other authors found an effect of direct introduction of N as urea and indirect introduction as biological nitrogen fixation over the growth rate (Zanoniani et al. 2011).

On the other hand, the native grassland fertilized and the overseeded with legumes allowed greater diet quality, basically on the effect over crude protein in pasture and diet (Piaggio et al. 1996). Furthermore, our results showed that managing native grasslands with optimal herbage allowance (8 – 12 %), enable higher SR than classical management and in fact, tripled the LWG obtained with classical management in the region as Uruguay, northern Argentina, and southern Brazil.

Therefore, we found that managing native grassland under optimal herbage allowance and zero costs, we could triple the LWG per area. If we overseed with legumes and fertilized with nitrogen and phosphorus we can obtain higher LWG per area as a result of an increase in SR and animal performance. Finally, we observed an effect of nitrogen fertilization up to 60 units per area per year. Considering economical, and basically ecological sustainability, the use of 120 units of nitrogen per area per area, does not seem to be recommended.

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