An Ecophisiological Proposal to Manage Natural Grasslands: A Long Term Trial

F. L. F. de Quadros
Universidade Federal de Santa Maria, Brazil

D. Roberti
Universidade Federal de Santa Maria, Brazil

L. Marin
Universidade Federal de Santa Maria, Brazil

B. Kuinchtner
Universidade Federal de Santa Maria, Brazil

P. L. Nascimento
Universidade Federal de Santa Maria, Brazil

The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021.

Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress

Published by the Kenya Agricultural and Livestock Research Organization

An ecophisiological proposal to manage natural grasslands: a long term trial

Quadros, F.L.F. de*; Roberti, D. *; Marin, L. *; Kuinchtner, B. *,Nascimento, P.L. *
* Universidade Federal de Santa Maria

Key words: animal production; grasses functional groups; Pampa biome; rotational grazing

Abstract
Natural grasslands on Southern Brazil comprise the so called "Rio de La Plata Grasslands" in South America. They are an important fodder source for ruminant pastoral systems and contribute to regional ecosystem services. Strength of these grasslands is its floristic diversity that poses a dilemma to farmers: how to choose management protocols that could be applied for hundreds of species. We propose to use a functional ecophysiological approach based on groups of grasses, the most abundant on aerial biomass of this natural grasslands. We clustered the most frequent grasses in two groups based on its leaf traits (leaf dry matter content and specific leaf area). These traits are functional clues to growth rhythms and nutritive value that could separate grasses in "resource capture" and "resource conservation" groups, both important for forage production and ecosystem services. Evaluating the most frequent grasses in each group we found they have an average of 375 degree-days, for "resource capture" and 750 degree-day for "resource conservation" groups, as its leaf elongation duration. So we evaluated a rotational grazing system based on this morphogenic trait for beef heifers rearing on natural grasslands from 2010 to 2019. We chose these experimental animals, as a model by its nutrient requirements and relevance for regional rearing and breeding systems. Our results indicate an average daily gain that is adequate to reach mating age and weight targets (0,3 kg/heifer/day to mate at 24 months) and allowed a higher stocking rate and gain per area when compared to regional standards (1,100 kg of live weight/ha and 370 kg/ha versus 600 and 70 kg/ha). All this animal performance was obtained without changing floristic diversity and also enhancing ecosystem services as CO2 sequestration. We concluded that this approach could allow farmers to conciliate the dilemma of production and conservation in pastoral ecosystems.

Introduction

Natural grasslands on Southern Brazil are included in the so called "Rio de La Plata Grasslands" in South America. In Brazil, it is called the Pampa biome and presents a flora with great biodiversity, around 3 thousand vascular plant species, grasses being the most abundant and diverse family with about 450 species (Boldrini, 2009). There is also a great cultural national and regional heritage linked to this biodiversity. Since Iberian colonization, free-ranging livestock (cattle and sheep) on these natural grasslands had been the regional main economic activity. In addition to providing important economic results it has allowed natural grasslands conservation, and also developed the culture of a unique human type of transnational relevance, the so called "gaucho" (Suertegaray and Silva, 2009).The progressive introduction and expansion of crops and forests monocultures, mainly soybeans and eucalyptus, had greatly degraded and uncharacterized Pampa natural grasslands. Therefore, for the maintenance of livestock activity and the preservation of this biome, it is necessary to propose and use management practices appropriate for both conservation and animal production. One of the alternatives to support management is the functional approach (Cruz et al., 2010). These authors proposed the classification of the most abundant grasses in two large groups, the group of species that captures resources and that of resource conservators, which can also be subdivided into two others. As a consequence of the different leaf attributes, these groups present different rhythms of expansion of their tissues and formation of new organs (ecophysiological processes). The resource capture group has a shorter duration of leaf expansion, resulting from a shorter phyllochron. The resource conservation group recorded greater phyllochron and duration of leaf expansion. This work presents an ecophisiological approach, based on grasses functional groups, to manage natural grassland in a rotational grazing system in a long-term trial. Considering that, in this region, most of the breeding systems carry out the rearing of heifers until their mating in natural pastures, we choose them as our experimental animal units. For economic reasons in breeding, this mating must be done, on average, at 24 months of age.

Methods and Study Site:

The trial was carried out in an experimental area at the Federal University of Santa Maria, in the state of Rio Grande do Sul, southern Brazil, with geographic coordinates 29º43'S, 53º42' W. In Koeppen's classification, the region's climate corresponds to the mesothermal, humid subtropical type of Cfa class with an average annual rainfall of 1769 mm; annual average temperature of 19.2 ° C; maximum monthly temperatures of 30.2º C in January and minimum monthly temperatures of 9.3º C in June. The area received a management under the rotating grazing system over the period 2010 to 2019, with rest intervals of 375 and 750 degree-day (DD) based on the thermal sum required for leaf elongation of 2.5 and 1.5 leaves of grasses of resource use and conservation groups, respectively (Machado et al., 2013). The soil presents slightly wavy relief, with naturally acidic, deep soils and with sandy surface texture, classified as Arenic Red Dystrophic Argisoil in the hillside areas and Eutrophic Haplossol in the lowland areas. The experimental area had 22.5 ha where the two treatments and the three area repetitions were distributed according to the relief (top, slopes and lowland), totalling six experimental units. Each experimental unit in the 375 DD had 7 subdivisions (paddocks), while those in the 750 DD had 8 subdivisions. Each subdivision had 0.5 ha, where the animals had unrestricted access to water. The experimental animals were Angus and Braford heifers from 6 to 24 months of age, with average initial and final weights ranging between 160 and 300 kg live weight. The definition of instantaneous stocking rate to be used per paddock was calculated in order to achieve a forage disappearance of 4.5% of the live weight over 70% of the leaf blade forage mass. Forage disappearance accounts for intake and losses of forage mass. Forage mass and its components (leaf blades, pseudo stems, senescent material, and other components), as well as floristic composition, were evaluated by visual estimations calibrated by a double sampling procedure based on BOTANAL method (Tothill et al, 1992). A flow measurement tower was installed at the experimental site in 2013 to estimate the surface flows obtained by the Eddy Covariance technique over five years. Each paddock received a minimum of four tester heifers plus regulators to achieve the above disappearance rate, so that both treatments receive a similar grazing intensity, varying only grazing frequency. Heifers were weighed after a period of 12 hours of fasting every 28 days, approximately, to calculate the average daily gain, the average and instant stocking rates and the production per area. During the ten years of evaluations, the sampling of the warm season corresponded to an average of 210 days, while the cool season was 98 days. The data were analyzed in a randomized block design through analysis of variance.

Results

The annual carbon estimates, or Net Ecosystem Productivity (NEP), in the balance from January to December, for all years of analysis, showed a positive sign. The annual variability showed values varying between + 109.4 g C m^{-2} $year^{-1}$ (2014) and + 507.2 g C m^{-2} $year^{-1}$ (2015), with average annual value, for the complete five years analyzed, from + 349 g C m^{-2} $year^{-1}$. Over the ten years evaluated, the botanical composition did not show significant differences, maintaining a similar Shannon diversity index between treatments (H '= 2.2), with 57 species recorded. Considering that there were no significant differences when comparing long-term treatments, the animal production variables were presented as means of the two treatments in Table 1.

Table 1. Animal production variables (heifers' average daily gains; stocking rates and production per area) recorded by season (warm and cool season) and in an annual basis, indicating the range of best and worst years during 10 years of evaluation (Santa Maria site, Southern Brazil, 2010 to 2019).

Variable	Best year	Worst year	Average
Warm season (210 days)			
Average daily gain (kg/day)	0.5	0.2	0.3
Stocking rate (kg/ha)	1980	855	1350
Cool season (98 days)			
Average daily gain (kg/day)	0.5	0.1	0.3
Stocking rate (kg/ha)	945	378	562
Production per area			
Warm season (210 days) (kg/ha)	565	190	280
Cool season (98 days) (kg/ha)	193	35	90

Annual production per area (kg/ha)	758	225	370

Discussion and Conclusions

According to Table 1, we can see that the body development goal of heifers to achieve the recommended mating weight has been achieved. This statement can be confirmed by the pregnancy rates of heifers that varied between 75 and 100%, with an average of 86% (Soares et al., 2013). Greater efficiency in the use of natural grassland was achieved through the registered average stocking rates, both in the cool and warm seasons, as well as the annual average. The recorded values can be compared with the regional average stocking of 600 kg live weight / ha, in overgrazed areas on Southern Brazil (Carvalho et al., 2011). The same authors report that the annual production per area, in overgrazed natural grasslands is 70 kg / ha, which represents only 19% of the average values in our records. Even the worst year had an annual production three times higher. The production of this worst year was similar to the values registered in the best combination of forage on offer in continuous grazing proposed by Carvalho et al. (2011). NEP recorded along five years implies that the natural grassland ecosystem acts as an atmospheric carbon drain (Acosta, 2019). The biggest difference between the treatments was registered in relation to the pasture structure, which presented a higher frequency of the tussock stratum in the treatment of 750 DD, consequence of favouring the growth of resources' conservation grasses. In the long run, the increase in the tussock stratum may imply the need for mechanical mowing strategies to maintain a favourable structure for animal intake. We concluded that this approach could allow farmers to conciliate the dilemma of production and conservation in pastoral ecosystems.

Acknowledgements

The authors acknowledge CNPq , CAPES and UFSM for financial support and grants.

References

Acosta, R. 2019. Um entendimento entre as interações biosfera-atmosfera em cossistemas do bioma pampa / Thesis (doctorate) –Universidade Federal de Santa Maria, Programa de Pósgraduação em Meteorologia,Santa Maria, 82 p.

Boldrini, I. I. 2009. A flora dos Campos do Rio Grande do Sul. Pillar, V.D., Müller, S.C, Castilhos, Z.M.S. and Jacques A.V.A. (eds). *Campos Sulinos – Conservação e Uso Sustentável da Biodiversidade* Ministério do Meio Ambiente, Brasilia, chap. 4, pp.63-77.

Carvalho P.C.F., Bremm C., Mezzalira J.C., Da Trindade J.K. , Nascimento Jr D. 2011. How can grazing behavior research at the bite to patch scales contribute to enhance sustainability of rangeland livestock production systems? Proceedings of the IX International rangeland congress – Diverse rangelands for a sustainable society. Rosario, AR. pp. 565-571.

Cruz. P., Quadros, F. L. F. de , Theau, J.P, Frizzo, A., Jouany, C., Duru, M., Carvalho, P.C.F. 2010. Leaf Traits as Functional Descriptors of the Intensity of Continuous Grazing in Native Grasslands in the South of Brazil. *Rang. Ecol. & Manag.* , v.63, p.350 – 358.

Soares, É. M., Quadros, F.L.F., Kuinchtner, B.C., Oliveira, L.B., Dutra, G.M., Carvalho, T.H.N., ROCHA, M. G.
Taxas de prenhez em novilhas de corte recriadas em pastagem natural sob pastoreio rotativo In: VI Congreso Argentino de Pastizales Naturales, 2013, Santa Rosa -La Pampa-Argentina.

Suertegaray, D. M. A. and Silva, L.A.P. 2009. Tchê Pampa: histórias da natureza gaúcha. Pillar, V.D., Müller, S.C, Castilhos, Z.M.S. and Jacques A.V.A. (eds). *Campos Sulinos – Conservação e Uso Sustentável da Biodiversidade* Ministério do Meio Ambiente, Brasilia, chap. 3, pp.42-59, 2009.

Tothill, J. C. , Hargreaves, J.N.G., Jones, R. M., McDonald, C. 1992. BOTANAL - a comprehensive sampling and computing procedure for estimating pasture yield and composition. 1. Field sampling, *Trop. Agr. Tech. Mem*., v. 78, p. 1-24.