EDITORA VERDE
Revista Verde de Agroecologia e Desenvolvimento Sustentável
Green Journal of Agroecology and Sustainable Development
GVAA GRUPO VERDE DE AGROECOLOGIA E ABELHAS

# Influence of native pasture management in southern Brazil on dry mass production and forage protein content

# Influência do manejo do campo nativo do Sul do Brasil sobre a produção de massa seca e no teor de proteína da forragem

Luigildo Proner Junior[1], Henrique von Hertwig Bittencourt[2*], Juliano Cesar Dias[2], André Luís Finkler da Silveira[3], Lisandro Tomas da Silva Bonome[2]

[1]Master's in Agroecology and Sustainable Rural Development, Federal University of Fronteira Sul, Laranjeiras do Sul, Paraná, Brazil. [2]Professor, Federal University of Fronteira Sul, Laranjeiras do Sul, Paraná, Brazil. [3]Researcher, Rural Development Institute of Paraná, Pato Branco, Paraná, Brazil. [*]Corresponding author e-mail: henrique.bittencourt@uffs.edu.br

ARTICLE
Received: 03-10-2022
Accepted: 27-12-2022

*Key words:*
Crude protein
Forage
Leaf area index
Pasture

ABSTRACT

Grasslands in southern Brazil have inherent characteristics favorable to forage production for domestic herbivores, which can be impaired or enhanced by management. The aim of this study was to evaluate the influence of management on plant characteristics, comparing commonly used techniques. The experimental design was bifactorial, the first factor consisting of four managements: burning, oversowing with annual winter forages, mowing and absence of interference, and the second factor was the time elapsed between management and evaluation. The experiment was conducted under field conditions, in a complete randomized block design with four replications. The LAI (leaf area index), dry mass production and crude protein content of the pasture were evaluated. Pasture management with oversowing showed higher LAI growth rate, as well as higher pasture dry mass production than the other treatments. There was no effect of the different managements on the crude protein content of the pasture, but of the time, with the highest value on the 53rd day. The results suggest that the adoption of management with oversowing of annual winter forages should be emphasized for the productive improvement of native grasslands in southern Brazil.

*Palavras-chave:*
Forragem
Índice de área foliar
Pasto
Proteína bruta

RESUMO

Os campos do Sul do Brasil possuem características inerentes favoráveis à produção de forragem para herbívoros domésticos, que podem ser prejudicadas ou potencializadas pelo manejo. O objetivo do trabalho foi avaliar a influência do manejo nas características das plantas, comparando técnicas comumente utilizadas. O delineamento experimental foi bifatorial, sendo o primeiro fator composto por quatro manejos: queimada, sobressemeadura com forrageiras anuais de inverno, roçada e ausência de interferência, e o segundo fator foi o tempo decorrido entre manejo e avaliação. O experimento foi conduzido em condições de campo, em delineamento em blocos completos casualizados com quatro repetições. Foram avaliados o IAF (índice de área foliar), produção de massa seca e teor de proteína bruta da pastagem. O manejo da pastagem com sobressemeadura apresentou maior velocidade de crescimento do IAF, bem como maior produção de massa seca da pastagem que os demais tratamentos. Não houve efeito dos diferentes manejos sobre o teor de proteína bruta da pastagem, mas sim do tempo, com o maior valor no 53° dia. Os resultados sugerem que a sobressemeadura de forrageiras anuais de inverno deve ser enfatizada para a melhoria produtiva dos campos nativos do Sul do Brasil.

## INTRODUCTION

The native grassland is a biome found in 13.7 million hectares in southern Brazil (OVERBECK et al., 2007), characterized by a temperate and humid climate with well-distributed rainfall throughout the year and severe winters (PILLAR; VÉLEZ, 2010).

Although the native grassland has environmental, social, and economic importance, it has been replaced by other agricultural land use in last decades. Much of the change is due to the escalation of silviculture, monoculture of grains, and other short-term agricultural related activities (CÓRDOVA et al., 2012).

Where native grassland continues to be used for producing fodder for animal feed, fire is a common management practice. In addition, after the cold period of winter, fire is used by ranchers as a tool for pasture renovation. The practice aims renewing perennial plants after winter, improving the quality of the forage, and reducing the incidence of unwanted plants (ZANINI; SBRISSIA, 2013).

Another widely used context in favor of fire is the ash deposit on the soil surface. However, precipitation after the use of fire causes the ash to be easily carried away, acting in this case as a way of removing nutrients from the system, transporting them from the higher to the lower areas or the bodies of water. In addition, nitrogen is volatilized (BRINKMANN; NASCIMENTO, 1973), and the soil shows a decrease in the abundance of mycorrhizal fungi (BARRACLOUGH; OLSSON, 2018).

In addition to the effects on the production system, management methods can also impact the environment (BENGTSSON et al., 2019). Some result in landscape fragmentation, destruction of wetlands by drainage or damming, interrupting gene flow between natural populations and seed dispersal and pollination, and de-characterizing the habitat by over grazing and trampling by cattle, among others (FONTANA et al., 2003).

In recent years, some studies have been conducted to increase forage production and supply for animals in native grassland (DALMINA et al., 2021). Increasing the productive capacity for livestock activity can constitute a solution for altering the land use and the maintenance of the field areas. It is in this context that the improvement of the native field is found, which consists of several techniques that help the producer increase the productive potential of the pastures (PILLAR, 2009) and, thus, allow the maintenance of the use of the soil of the agroecosystem as a native field.

The objective of this work was to evaluate the effect of four managements of the native field, using fire, mowing, oversowing and fallow (absence of management) on forage characteristics: leaf area index, dry mass production, and protein content.

## MATERIAL AND METHODS

The experiment was carried out in an experimental field belonging to the Professor Jaldyr Bhering Faustino da Silva Professional Education Center -CEDUP. The ecosystem is called Palmas fields, of the “Palha Fina” physiognomic type (CÓRDOVA et al., 2012) in the municipality of Água Doce – SC. The experimental field has the prevalence of *Schizachyrium tenerum* Nees, a native plant with forage potential.

The region's climate is temperate (PANDOLFO et al., 2002), with average temperature and rainfall in the last ten years of 16.2 ºC and 1746 mm, respectively (EPAGRI, 2020). The predominant soil is classified as Humic Cambisol (EMBRAPA, 2004).

The total area used for the experiment was 2,025 m² in a randomized block experimental arrangement with four replications. The experimental design was bifactorial, with the first factor consisting of four managements: fire, overseed with black oats (*Avena strigosa* Schreb.) and ryegrass (*Lolium multiflorum* L.), mowing, and absence of interference, and the second factor was the elapsed time between management and the evaluation.

The interference simulating grazing using a mower started on the first spring day (September 22th). It was repeated four times throughout the experiment, with the cuts being carried out close to the soil at intervals of 35 days.

The leaf area index was estimated using below-canopy radiation (AccuPAR LP-80). At each point, five measurements were taken (perpendicular directions), leveling the device close to the ground, in a total of 15 radiation values collected per plot, consisting of reading above the canopy of the plants and close to the soil surface. All readings were performed between 10:00 and 11:00, and measurements were performed at 0, 3, 7, 14, 28, and 35 days after handling and repeated four times in the grazing simulation intervals.

The shoot mass and forage accumulation were determined by cutting the canopy at three random points per plot, using scissors and a 50 x 50 cm quadrat. Forage production was evaluated at 0, 3, 7, 14, 28, and 35 days after handling, and after that, mowing was performed to simulate grazing. The collected samples were composed of the shots (leaves, stems, and dead material) of all plants inside the quadrat, being stored in paper bags and immediately weighed to determine the natural mass. Afterward, they were dried in an oven with forced air circulation at 65 °C until constant weight and then weighed to determine the forage dry mass.

The canopy sampling was carried out using the same collection methodology to determine the forage mass at 35 days after management to determine the protein contents. Subsequently, they were ground in a Willey mill with a 1 mm mesh sieve to prepare the sample for the crude protein content determination (SILVA; QUEIROZ, 2002).

Data were subjected to analysis of variance, and when the F test indicated differences between treatments ($p<0.05$), the data were then subjected to multiple comparison of qualitative treatment means with Duncan’s test ($p<0.05$) or regression analysis for treatment data over time (STORCK et al., 2011). In the regression analysis, simpler models with a higher coefficient of determination ($R^2$) capable of representing the data were fitted.

## RESULTS AND DISCUSSION

### Leaf area index

The leaf area index was influenced by the interaction between management and time factors ($p<0.05$). Over time, there was an increase in the leaf area index, with the highest values recorded 35 days after cutting in the following decreasing order of management: oversowing, mowing, no management, and fire (Figure 1).

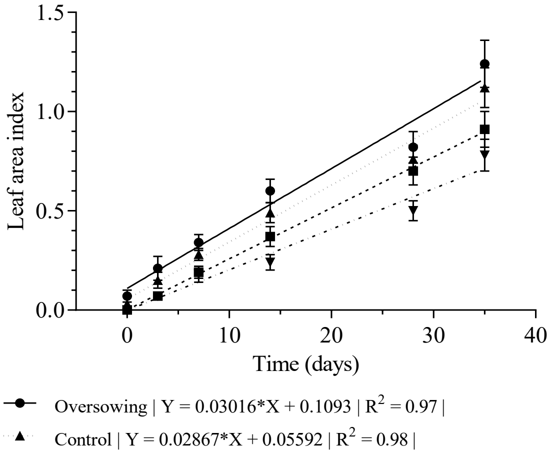


**Figure 1.** Leaf area index of forage from native pasture in southern Brazil as a function of time in each management. Symbols correspond to the mean and the bars to the standard error.

The leaf area index (LAI) refers to the area of leaves within a given area of soil occupied by the plant (leaves/m$^2$ of soil). Thus, the higher this index, which tends to increase with the age of the plant (GOMIDE, 1986), the greater its ability to intercept solar radiation and produce photoassimilates under ideal environmental conditions for development (MONTEIRO; MORAES, 1996; TAIZ et al., 2017).

Some plant characteristics such as leaf size, angle of insertion between leaf and stem, and leaf stiffness, among other variables, can affect its structure and, consequently, LAI and dry matter accumulation. In addition, in multispecific environments, such as natural pastures, growth processes, and forage accumulation can be influenced by species composition (ALVES et al., 2021).

The remaining LAI, the amount of photosynthetically active tissue that remains in the plant after different managements, is of fundamental importance for forage species. Regrowth will use products from photosynthesis from the remaining leaves, provided that the amount of $CO_2$ absorbed is greater than or equal to the amount released by the plant during respiration. However, it must be considered that photosynthetic efficiency decreases as the leaves age. Therefore, if forage plants are managed under intense defoliation, the growth of the root system and the accumulation of carbohydrate reserves will be impaired. However, when management is promoted, a minimal negative effect on plant vigor is desired (MOUSEL et al., 2005), which can be expressed by the level of carbohydrates stored in the plant in the storage organs above and below ground, available for use in the recomposition of photosynthetic tissues.

The optimal LAI of a forage plant is that associated with high yields, well distributed throughout the growing season, typically occurring when the leaves intercept about 90% of the incident radiant energy. For *Paspalum atratum* cv. Pojuca, Costa (2004) observed that regrowth vigor was directly proportional to the remaining LAI.

The differences between the leaf area indices of the treatments increased with time, reaching the most significant differences on the 35th day when the LAI was 1.16 m² of leaves/m² of soil in the oversowing treatment (highest value) and 0.71 m² of leaves/m² of soil for treatment with fire (lower value).

The response of plants to fire is also related to the time of burning due to the interaction of fire and climatic factors (humidity and temperature) on the germination and regrowth of plants. However, this response may still depend on fire intensity, post-burn growth conditions, and interspecific interactions in the ecosystem (MILLER et al., 2019).

**Natural and dry mass of the aerial part of the plants**

Treatments and time influenced both the natural and dry mass of forage shoots ($p<0.05$), but for both, no interaction was recorded. The natural mass differed between treatments, with the highest values being registered for the oversowing and mowing management, followed by the absence of management and fire. Oversowing reached the highest value for dry matter, differing from the other treatments (Table 1).

**Table 1.** Natural and dry forage shot mass from forage of native pasture in southern Brazil under different managements.

| Management | Natural mass (kg ha$^{-1}$) | Dry mass (kg ha$^{-1}$) |
|---|---|---|
| Oversowing | 2569.2 ± 202.8 a | 960.3 ± 70.5 a |
| Mowing | 2189.4 ± 170.7 ab | 800.2 ± 56.9 b |
| Control | 1960.0 ± 174.9 bc | 719.2 ± 60.9 b |
| Fire | 1681.0 ± 151.4 c | 658.0 ± 54.4 b |

Mean ± standard error followed by the same letter in columns do not differ from each other by Duncan's test ($p<0.05$).

These results agree with those of Heringer and Jacques (2002) in similar work, who also found that management systems influenced forage production. In a study on the effect of the use of fire on the production of dry pasture biomass in the Pantanal, it was verified that the burning resulted in lower values of shots mass of cespitose forages (CARDOSO et al., 2003). In addition, the burning had a negative effect for almost a year, since even 11 months after the use of fire, this treatment represented only 25% of the dry mass obtained in the treatment without burning.

In another study, in Rio Grande do Sul, the fire used biennially reduced forage production to approximately one-third of the forage obtained in the unburned area (HERINGER; JACQUES, 2002). In addition, the fire resulted in a dry mass production 31% lower than oversowing.

The oversowing treatment achieved the highest value of shots dry matter, ahead of all the others. The positive effect of oversowing with winter forage species aiming to improve forage production in native grasslands of southern Brazil was already reported by previous works (FERREIRA et al., 2011). Black oats and ryegrass are forage species well known by ranchers for their rusticity, high forage production capacity, and palatability.

The natural mass of forage was influenced by time. The highest rate of natural matter production occurred until the 14th day, with a deceleration in the production rate in the following interval until the 35th day (Figure 2).

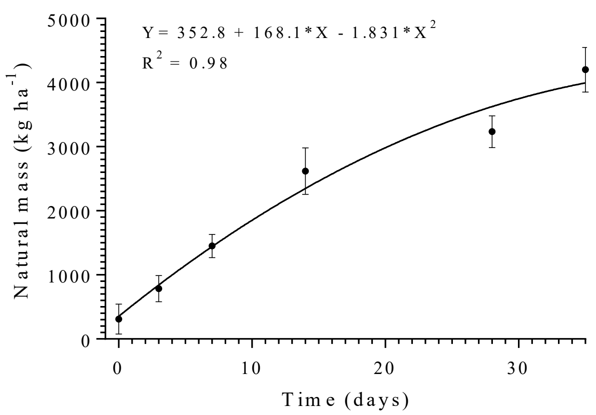


**Figure 2.** Accumulation of shots natural mass from forage of native pasture in southern Brazil as a function of time. Points correspond to the mean and the bars to the standard error.

Dry matter production was also influenced by time, which was expected. The highest rates of dry mass production of the forage shots occurred until the 14th day, with a deceleration in the following interval and reaching its maximum productive potential on the 35th day (Figure 3).

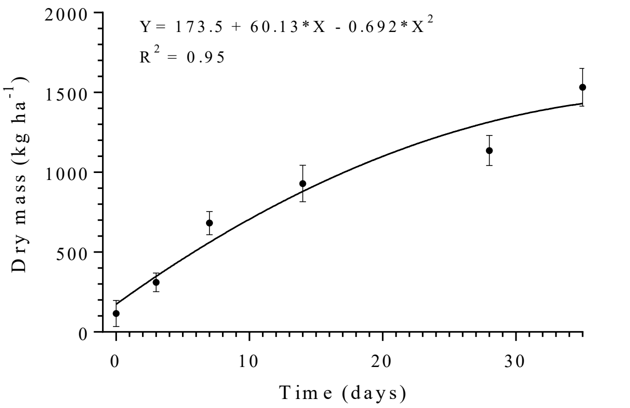


**Figure 3.** Accumulation of shots dry mass from forage of native pasture in southern Brazil as a function of time. Points correspond to the mean and the bars to the standard error.

**Crude forage protein**

The forage protein content from shots was influenced by time ($p<0.05$) but not by the management or the interaction between the two factors (Figure 4).

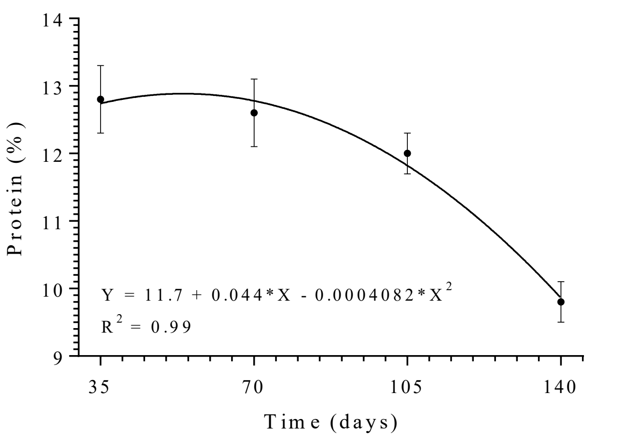


**Figure 4.** Protein content in shots from forage of native pasture in southern Brazil as a function of time. Points correspond to the mean and the bars to the standard error

On the 53rd day, the highest crude protein (12.9%) was recorded in the forage shots. From the maximum point, there was a reduction in the crude protein content of the forage. The lowest value was recorded on the 140th day (9.8%), representing a 24% reduction from the maximum.

The tendency of native grassland forage, therefore, is to present a reduction in the protein content as the plants approach senescence or in periods when there is difficulty in the development of the forages. According to Freitas (2010), the protein content found in native grassland samples from the Santa Catarina is, on average, 7.8% but can drop to 3.2% in winter.

As the plant matures, the concentration of potentially digestible components, such as soluble carbohydrates, proteins, and minerals, tends to decrease, and fiber increases. Consequently, declines in digestibility and intake are expected (MERTENS; GRANT, 2020). In addition to changes in chemical composition, there are changes in morphological characteristics.

Low protein levels in forage can decrease the palatability of plants (MARTEN, 1978), resulting in a lower digestibility coefficient and negative nitrogen balance. Thus, the values found are above what would be limiting for forage intake but within the values found by other authors in natural pastures.

**CONCLUSIONS**

The oversowing should be emphasized for native grassland forage production improvement in southern Brazil compared to mowing, burning or absence of management. Additionally, the pasture should be grazed or used near its 53rd day to avail the highest protein content.

**REFERENCES**

ALVES, C. P.; CIRINO JÚNIOR, B.; ROCHA, A. K. P.; VIEIRA, D. S. M. M.; EUGÊNIO, D. S.; LEITE, M. L. M. V. Respostas morfofisiológicas das plantas forrageiras sob manejo de cultivo e pastejo: Uma revisão. Research, Society and Development, v.10, p.e10610615405, 2021. 10.33448/rsd-v10i6.15405

BARRACLOUGH, A.; OLSSON, P. Slash-and-burn practices decrease arbuscular mycorrhizal fungi abundance in soil and the roots of Didierea madagascariensis in the dry tropical forest of Madagascar. Fire, v.1, p.37, 2018. 10.3390/fire1030037

BENGTSSON, J.; BULLOCK, J. M.; EGOH, B.; EVERSON, C.; EVERSON, T.; O'CONNOR, T.; O'FARRELL, P. J.; SMITH, H. G.; LINDBORG, R. Grasslands-more important for ecosystem services than you might think. Ecosphere, v.10, p.e02582, 2019. 10.1002/ecs2.2582

BRINKMANN, W. L. F.; NASCIMENTO, J. C. The effect of slash and burn agriculture on plant nutrients in the Tertiary Region of Central Amazonia. Acta Amazonica, v.3, p.55–61, 1973. 10.1590/1809-43921973031055

CARDOSO, E. L.; CRISPIM, S. M. A.; RODRIGUES, C. A. G.; BARIONI JÚNIOR, W. Efeitos da queima na dinâmica da biomassa aérea de um campo nativo no Pantanal. Pesquisa Agropecuária Brasileira, v.38, p.747–752, 2003. 10.1590/S0100-204X2003000600011

CÓRDOVA, U. A.; PRESTES, N. E.; SANTOS, O. V.; RAMOS, C. I. Validação da tecnologia de melhoramento de pastagens naturais no Planalto Sul de Santa Catarina. Revista de Ciências Agroveterinárias, v.11, p.54–62, 2012.

COSTA, N. L. Formação, manejo e recuperação de pastagens em Rondônia. Porto Velho: Embrapa Rondônia, 2004. 219p.

DALMINA, J. C.; TEIXEIRA, G. L.; MATTÉ, J. A.; VELHO, D. A.; VARGAS, V. R.; CONTE, E. D. Melhoramento de campo nativo com uso de calcário e gesso agrícola nos Campos de Cima da Serra/RS. Revista de Ciências Agroveterinárias, v.20, p.325–331, 2021. 10.5965/223811712042021325

DORNELES, G.; PAIVA, S. M.; MARTINS, G. B.; MENDEL, H. T.; COMIN, H. B.; FONTOURA JÚNIOR, J. A. S. Diagnóstico e alternativas forrageiras para um sistema produtivo de cria com aumento de demanda nutricional. Em: ANAIS DO 11o SALÃO INTERNACIONAL DE ENSINO, PESQUISA E EXTENSÃO 2019, Itaqui. Anais. Itaqui: Unipampa, 2019.

EMBRAPA. Solos do estado de Santa Catarina. Em: Boletim de Pesquisa e Desenvolvimento. Rio de Janeiro: Embrapa Solos, 2004. p.721.

EPAGRI. Banco de dados de variáveis ambientais de Santa Catarina. Florianópolis: Epagri. 20p.

FERREIRA, E. T.; NABINGER, C.; ELEJALDE, D. A. G.; FREITAS, A. K.; CARASSAI, I. J.; SCHMITT, F. Fertilization and oversowing on natural grassland: effects on pasture characteristics and yearling steers performance. Revista Brasileira de Zootecnia, v.40, p.2039–2047, 2011. 10.1590/S1516-35982011000900028

FONTANA, C. S.; BENCKE, G. A.; REIS, R. E. Livro vermelho da fauna ameaçada de extinção no Rio Grande do Sul. Porto Alegre: Edipucrs, 2003. 632p.

FREITAS, E. M. Campos de solos arenosos do Sudoeste do Rio Grande do Sul: aspectos florísticos e adaptativos. Universidade Federal do Rio Grande do Sul, Porto Alegre. 2010. 171p.

GOMIDE, J. A. A. Fisiologia do crescimento livre de plantas forrageiras. Em: PEIXOTO, A.; MOURA, J. C.; FARIA, V. P. (Ed.). Pastagens: fundamentos da exploração racional. Piracicaba: Fealq, 1986. p.01–10.

HERINGER, I.; JACQUES, A. V. Á. Qualidade da forragem de pastagem nativa sob distintas alternativas de manejo. Pesquisa Agropecuária Brasileira, v.37, p.399–406, 2002. 10.1590/S0100-204X2002000300022

MARTEN, G. C. The Animal-Plant Complex in Forage Palatability Phenomena. Journal of Animal Science, v.46, p.1470–1477, 1978. 10.2527/jas1978.4651470x

MERTENS, D. R.; GRANT, R. J. Digestibility and Intake. Forages. Wiley, 2020. p.609–631. 10.1002/9781119436669.ch34

MILLER, R. G.; TANGNEY, R.; ENRIGHT, N. J.; FONTAINE, J. B.; MERRITT, D. J.; OOI, M. K. J.; RUTHROF, K. X.; MILLER, B. P. Mechanisms of Fire Seasonality Effects on Plant Populations. Trends in Ecology & Evolution, v.34, p.1104–1117, 2019. 10.1016/j.tree.2019.07.009.

MONTEIRO, A. L. G.; MORAES, A. Fisiologia e morfologia de plantas forrageiras. In: MONTEIRO, A. L. G. (Ed.). Forragicultura no Paraná. Londrina: CPAF, 1996. p.75–92.

MOUSEL, E. M.; SCHACHT, W. H.; ZANNER, C. W.; MOSER, L. E. Effects of Summer Grazing Strategies on Organic Reserves and Root Characteristics of Big Bluestem. Crop Science, v.45, p.2008–2014, 2005. 10.2135/cropsci2004.0694

OVERBECK, G.; MULLER, S.; FIDELIS, A.; PFADENHAUER, J.; PILLAR, V.; BLANCO, C.; BOLDRINI, I.; BOTH, R.; FORNECK, E. Brazil's neglected biome: The South Brazilian Campos. Perspectives in Plant Ecology, Evolution and Systematics, v.9, p.101–116, 2007. 10.1016/j.ppees.2007.07.005

PANDOLFO, C.; BRAGA, H. J.; SILVA JÚNIOR, V. P.; MASSIGNAN, A. M.; PEREIRA, E. S.; THOMÉ, V. M. R.; VALCI, F. V. Atlas climatológico do Estado de Santa Catarina. Florianópolis: Epagri, 2002.

PILLAR, V. P.; VÉLEZ, E. Extinção dos Campos Sulinos em Unidades de Conservação: um Fenômeno Natural ou um Problema ético? Natureza & Conservação, v.08, p.84–86, 2010. 10.4322/natcon.00801014

PILLAR, V. P. Campos sulinos: conservação e uso sustentável da biodiversidade. Brasília: Ministério do Meio Ambiente - Brasil, 2009. 403p.

RIETZ, J. Z. Leguminosas utilizadas como forrageiras na fronteira oeste do RS. Universidade Federal do Pampa, Itaqui. 2022. 41p.

SILVA, D. J.; QUEIROZ, A. C. Análise de alimentos: métodos químicos e biológicos. Viçosa: UFV, 2002. 235p.

STORCK, L.; GARCIA, D. C.; LOPES, S. J.; ESTEFANEL, V. Experimentação vegetal. 3rd.ed. Santa Maria: Editora UFSM, 2011. 200p.

TAIZ, L.; ZEIGER, E.; MØLLER, I. M.; MURPHY, A. Fisiologia e desenvolvimento vegetal. 6th.ed. Porto Alegre: Artmed, 2017. 888p.

ZANINI, G. D.; SBRISSIA, A. F. Fogo em pastagens: estratégia de manejo? Revista de Ciências Agroveterinárias, v.12, p.94–103, 2013.