II WORLD CONGRESS ON INTEGRATED CROP-LIVESTOCK-FORESTRY SYSTEMS

May 4th and 5th, 2021 – 100% Digital

USING INDICATORS TO ASSESS THE PRODUCTIVITY AND ECOSYSTEM SERVICES OF NATIVE GRASSLANDS MANAGED AS PASTURELANDS IN THE PANTANAL WETLAND, BRASIL

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ABSTRACT

Integrated management approaches are essential for the sustainability of the beef cattle production system in the Pantanal wetland, and it would direct the adoption of adequate management practices that favor multiple ecosystem services and biodiversity. This paper exemplifies the evaluation of the pasture attributes in a ranch at the Nhecolândia sub-region, Pantanal. The evaluation is based on an indicator of natural pasture conservation status (PCS) applied to landscapes with dominance of native grasslands. To estimate the net primary productivity (NPP) and forage provision, the vegetation at two different landscapes was mapped, one with "regular" and another with a "good" PCS performance. Grassland landscape with "good" PCS presented more than three times NPP than the "regular" one, reflecting the greater forage provision and grazing capacity. This result indicates the PCS indicator is suitable to differentiate among grassland condition with potential positive impact on animal performance and ecosystem services. The integration of different complementary evaluation tools provides useful information for decision making on sustainable grassland management.
Key words: forage provision; net primary productivity; rangeland

INTRODUCTION

The Pantanal wetland is a large floodplain whose biodiversity and ecological processes are driven mainly by the flood pulse (JUNK et al., 1989). The landscapes consist of a mosaic of woodland savannas), open grasslands and forests, as well as aquatic habitats. A major part of the plain is used for livestock ranching based on abundant provision of native forage (SANTOS et al., 2013). However, grazing capacity has spatio-temporal variation because it depends mainly on proportions of landscapes with dominance of native grasslands and climatic conditions. For instance, extreme flood events can decrease forage availability, as well as extreme droughts may decrease its quality.

Santos et al. (2017) developed a comprehensive tool to assess the sustainability of beef cattle ranching in Pantanal, Sustainable Pantanal Ranch (SPR). The SPR tool uses a hierarchical structure of attributes and indicators of the three dimensions of sustainability (economic, social, and environmental). Among the indicators used by the SPR there are four adopted to evaluate the native grasslands attributes (economic and environmental dimension). The pastureland conservation status indicator (PCS) evaluates the conservation and degradation status, as well as the degree of invasion by undesirable species in the grasslands. This diagnosis allows the identification of the causes of degradation and the solutions to prevent degradation and to further rehabilitate degraded pastures.

A comprehensive and adaptive grazing management plan requires an understanding of the animal vs. plant vs. soil interaction at landscape scale to establish the best practices, which in turn also produce multiple ecosystem services such as supply and flow regulation of water and carbon storage

(BENGTSSON et al., 2019). Conserved native grasslands landscapes enable capture, infiltration, and storage of rainwater into soils that promote higher soil organic carbon (SOC) storage, increase forage covering, increase carbon dioxide sequestration, reduced methane emissions among other services.

An effective strategy to develop multifunctional ranches in the Pantanal in which livestock production and biodiversity are integrated involve adopting good pasture management practices. In this study we aim to evaluate the applicability of indicator of the SPR framework in assessments of ecosystem services related to the provision of forage by the native grasslands in the Pantanal wetland.

MATERIAL AND METHODS

The study was conducted in two actual management unit (enclosures) with 300 hectares at Nhumirin ranch, representative of the Nhecolândia sub-region, Pantanal, Wetland, Brazil (S 18°59'49.5", W 56°38'16.1"). The region is characterized by a mosaic of forest, savanna, grasslands, and wetlands. The different landscapes were mapped (RODELA et al., 2007) as forests (FA), woodland savannas (SA), non-floodable grasslands (OG), intermediated floodable grassland (SOG), and wetland grassland (WG). Intermediated floodable grasslands are strips of open wetlands located in the ecotone between non-floodable grasslands and those often inundated, with flood lasting up to 6 months, while wetland grasslands are often flooded up to 9 months. These areas present different plants species composition.

The indicator of the SPR tool (Figure 1) for the natural pasture conservation status (PCS) was applied to two different situations: one for grasslands with "regular" PCS and another with a "good" PCS. The net primary productivity (NPP) was estimated for each grassland landscape according to Santos et al. (2020), and the available forage was estimated according to Santos et al. (2013). The net primary productivity (NPP) was estimated by summing the aerial and the root dry mass (considered to be 40% of aerial dry mass). The available forage (AF) was estimated according to the proportion of key forage species following the SPR protocol (Santos et al., 2015) and considering a grazing utilization degree of 50%. The total NNP and the total available provision were estimated based on the proportion of these landscapes in the management unit.
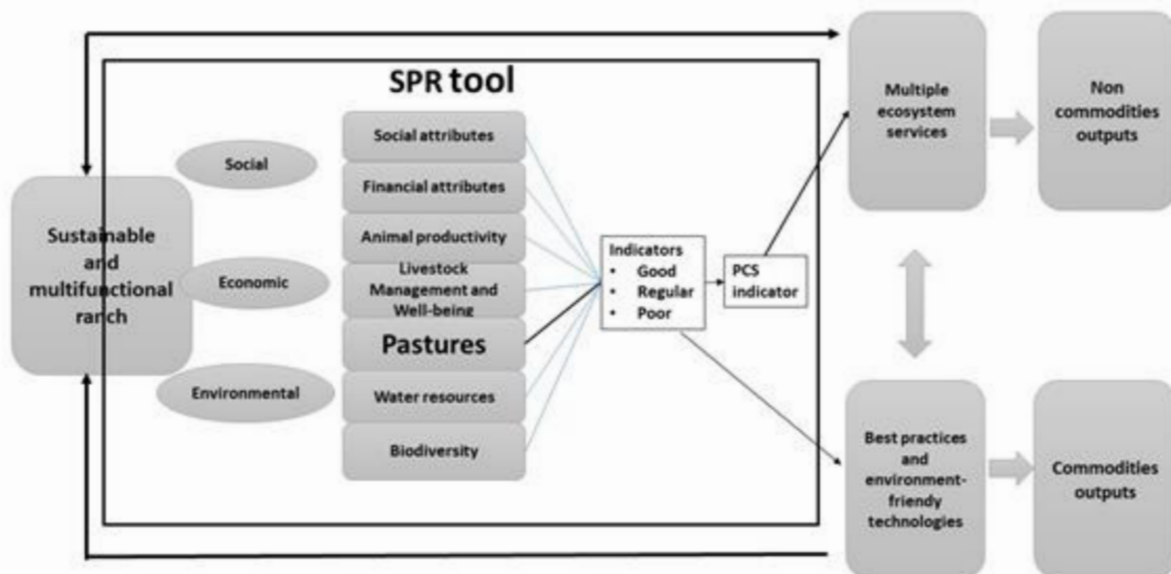

Figure 1. A simplified assessment model of the cattle ranch sustainability in the Pantanal wetland, Brazil, using the SPR tool and multiples ecosystem services, exemplifying the PCS indicator.

RESULTS AND DISCUSSIONS

The performance of the PCS indicator clearly differentiated the two assessed grassland landscapes. Table 1 shows the proportion of landscapes used for grazing and respective key forage species, the net primary productivity (NPP), and total available forage in a management unit assessed using the PCS indicator.

Pasture landscape with good PCS performance presented more than three times total NPP than landscape of the poor PCS. These values reflected on total available forage. Although most of the key forage species are similar between scenarios, their percentual cover is different. Moreover, the result suggest that several key forage species may disappear if good management practices are not applied to the native grasslands in the Pantanal.

Pantanal has a diversified landscape with high spatio-temporal variation. Estimates of NPP and forage production are variable in function of climatic conditions and management practices. In our assessment pasture landscape with "good" conservation status had higher NNP and forage provision, reflecting an impact on the productivity potential and ecosystem services. NNP is considered the basis of all ecosystem services (WAD, 2019) and affect the grazing capacity of the grassland landscapes used as pastureland for cattle ranching. The NPP value relates to the carbon that can be sequestered by grasslands and it is an indicator often used to evaluate ecosystem response to climate change (BILGILI et al, 2020). These values are important to estimate the soil organic carbon (SOC), composed of part of the vegetation NPP (their roots) and soil mineralization (YU et al., 2020). Thus, sustainable management strategies to improve the performance of the PCS indicator of the SPR tool contribute with several ecosystem services. Preventing and restoring degraded pastures in the Pantanal may contribute to mitigate climate change effects and increase the productivity and the maintenance of several ecosystem services, some eligible for environmental service payment schemes.

Table 1. Estimates of net primary productivity (NPP) and total available forage in two pastures at the Pantanal wetland, Brazil, assessed using the PCS indicator.

Status of pastureland conservation (PCS): Good (forage cover >65%)					
Pasture Landscapes	**Proportion/area, % (ha)**	**Forage species**	**NPP[1] (t DM ha^{-1} year^{-1})**	**Available forage (t DM ha^{-1} year^{-1})**	**Total available forage**
Non-floodable grasslands	14.4 (43.2)	*Mesosetum chaseae*	2.8	1.0	43.2
Intermediated floodable grassland	66.3 (98.9)	*Axonopus purpusii Reimarochloa brasiliensis Steinchisma laxum*	4.2	1.5	298.3
Wetland grassland	7.8 (23.4)	*Hymenachne amplexicaulis Luziola subintegra Leersia hexandra*	14.1	5.1	119.6
Total			**21.1**	**7.6**	**461.1**
Status of pastureland conservation (PCS): Regular (forage cover 30-65%)					
Non-floodable grasslands	14.4 (43.2)	*Mesosetum chaseae Richardia grandiflora*	0.6	0.6	8.6
Intermediated floodable grassland	66.3 (198.9)	*Axonopus purpusii Reimarochloa brasiliensis Steinchisma laxum*	1.4	0.5	99.5
Wetland grassland	7.8 (23.4)	*Hymenachne amplexicaulis Luziola subintegra Leersia hexandra*	4.2	1.5	35.1
Total			**6.2**	**2.2**	**143.2**

In the "good" scenario we evaluated, the fact of presenting higher forage availability would allow a moderate grazing aiming higher individual animal performance, and even improve the methane emission rate (methane/kg of meat produced). The moderate grazing in the rainy season also may help to extend pasture availability and, therefore, help to alleviate the dry spells that have been predicted for the region by climate change models. Thus, proper management may be key to adapt to the climate change, and to mitigate its impacts on ecosystems and productivity.

Integrated evaluation tools such as SPR tool may be relevant to induce the adoption of good management practices, to ensure multiple ecosystem services in multifunctional landscapes, to conserve biodiversity and to ensure food provision (BENGTSSON et al., 2019).

CONCLUSIONS

Pasture conservation Status Indicator provides useful information for decisions making in sustainable grassland management approaches and development of multifunctional ranches in the Pantanal wetland integrating livestock production and ecossytem services.

ACKNOWLEDGMENTS

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