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Improving livestock production assuring natural grassland ecosystem conservation: three key management practices at farm level

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Introduction

Ecosystem changes by human activities are a central topic in environmental discussions and temperate grasslands are among the most altered ecosystems on the planet (Millenium Ecosystem Assessment, 2005). The Rio de la Plata grasslands are among of the most extended temperate grasslands in the world, along with the prairie system of North America, the grasslands in east Europe and Mongolia, the g*rassvelds* in South Africa and the New Zealand plains. They cover the central-eastern part of Argentina, Uruguay and south of Brazil. Natural grasslands are very rich in terms of number of species, reaching up to more than 3,000 vascular plants (Bilenca and Miñarro., 2004; Miñarro *et al*., 2008).

Almost all Uruguayan lands are private property and most of them have some agriculture use. In this context, any conservation strategy must take into consideration production systems, including not only natural resources that are strongly related to production as soil and water, but also other ecosystem services, including biodiversity. On the other hand, natural grasslands have a high potential for meat production being of great economic importance for the country, and increasing the production efficiency is a main topic. Extensive livestock production seems to be compromise solution between conservation and production, but the main challenge is to maintain ecosystems functionality improving productive results. Considering all this, a re-designing production system strategy was developed with farmers in two different regions of the country. This work involved a co-innovation approach, which objective was to increase income and farmer´s family life quality involving management practices changes with none or minimum investment and ensuring environmental protection. In this article, in order to show the multi-dimensional approach for environmental information, we analyze a case study.

Materials and Methods

Stocking rate (LU/ha), sheep/cattle relation, meat productivity (kg equivalent meat/ha) and economic results as net income (U$S/ha) were calculated for each farm annually. Forage mass (kg DM•ha^{-1}) was estimated every 45 days by the comparative yield method (Haydock and Shaw, 1975).

Water was seasonally (four times a year) sampled on streams and dams in at least six points in each farm. Turbidity, dissolved oxygen, total dissolute solids, nitrate, pH and temperature were measured with a Hanna HI 9828 Multiparameter meter. Phosphorus was determined with Hanna HI736 Handheld Colorimeter -Phosphorus Ultra Low Range. A water quality index was obtained with media values of selected variables. The calculation of the index was done through the following formula: WQI =$\sum$ni=1 (Ci.Pi)/$\sum$ ni=1 Pi, where n represent the number of total variables, Ci the value assigned to variable i of the normalization and P is the value between 1 and 4, were 4 is assigned to the more important variable for aquatic life (*e.g*. dissolved oxygen).

Biodiversity was evaluated through monitoring four different variables: species composition of the herbaceous community, structure of bird and spider assemblages and an Ecosystem Integrity Index. Herbaceous plant communities of natural grassland were annually evaluated using Botanal method in reference paddocks. Birds were monitored each season following line transects at three reference plots in each farm. Transects were divided in 300 m segments, totalizing 900 m to 1800 m long depending on the area of the reference unit. In every case the presence of species using habitat and number of individual was recorded. Grasslands spider community was sampled by captures with sweep netting directly on natural grasslands and seeded prairies (Ten samples of 20 sweeps were taken in every reference unit, determining species presence and number of individuals. Species were classified into guilds.

Ecosystem Integrity Index is a tool in development phase, whose main objective is to evaluate the ecosystem capacity for maintaining services and wildlife habitat while it is properly used for livestock production. It was made with a qualitative assessing of the status of the ecosystem relative to the same environment in a low intervention, natural condition. It is a 10

points scale index (from 0 to 4.5, 0.5 step) that includes five aspects: vegetation, spatial structure, species presence, soil erosion and state of streams including water, riparian zone and vegetation. Values were determined for each paddock and a general value was calculated by prorating the area contribution of each paddock.

Results and Discussion

Considering project average results, between 2010 and 2014 stocking rate decrease from 0.94 to 0.84, sheep/cattle relationship reduced from 2.4 to 1.4 and average forage allowance increase from 3.4 to 6.0. Meat equivalent production increased from 94 kg to 122 kg, resulting in a 71% of improvement of net income. WQI values were 72 for streams and 65 dams. Table 1 shows the values for each individual parameter used for calculation.

Table 1 - Water analysis for streams and dams (means ± SD) for individual variables

Type	DO ppm	pH	P ppb	Turbidez FNU	TDS ppm	NO_3mg/L
Streams	6,1±2.5	7,6±0.4	75,5±16.8	24,3±20.2	127.0±49.8	0.42±0.3
Dams	4,8±2.4	7,8±0.4	30,0±15.8	59.8±17.2	59,5±17.2	0.45±0.3

DO=dissolved oxygen, TDS=total dissolved solids, NO_3= nitrates and TP= total phosphorus

Regarding to vegetal biodiversity, 60 species of herbaceous plants and 22 species of trees associated to grasslands were found. Ten species represent 71.8% in terms of soil covering in the reference plots, those species were: *Cynodon dactylon, Axonopus affinis, Richardia humistrata, Paspalum notatum, Piptochaetium montevidense, Ciperus sp., Trachipogon montufari, Andropogon ternatus, Botriocloa laguroides*. Is also remarkable the presence on *Cynodon dactylon* that is an alien plant considered a weed.

Considering bird diversity, 63 species of birds were found during the first year of counts in transects, and after two years 79 species were registered, and reach 95 species considering those registered out of transects. Accumulation curves showed differences in the estimated richness projecting four years sampling for natural grasslands transect (84), and annual pastures (39). The effect of reduction of richness in seeded area is considered with a limited impact due to this land use, represent 18% of total farm area. Most of the production areas are covered with natural vegetation communities providing birds with adequate habitat despite the important presence of *Cynodon dactilon* and the effect of years of a high sheep stocking rate that affects structure in some paddocks. Seven species considered of national conservation priority were recorded: *Coragyps atratus, Donacospiza albifrons, Gnorimopsar chopi, Nothura maculosa, Rhea americana, Rynchotus rufescens and Xolmis dominicanus.*

Concerning spiders communities, 12 families belonging to seven different gilds and a total of 24 species were registered. In both evaluated situations, natural grasslands and annual pastures, the most frequent gild was the orbicular web builders and *Larinia vivittata* the most frequent species, although in natural grasslands the population was up to four times higher. Soil Running Hunters guild was recorded exclusively in natural grasslands.

General ecosystem integrity index of the whole farm was 3.5, which result from a good indexes vale in the majority of the area and with lower values for the more intensive production zone. In Fig. 1 the distribution of index values for each paddock is shown.

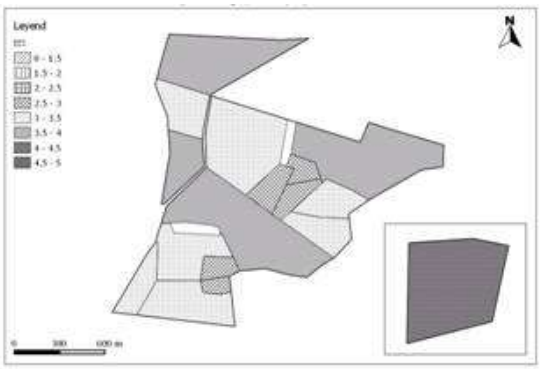

Fig 1: Ecosystem integrity index values for each paddock of the farm

Conclusion

Increasing productiveness in livestock production system without negative impacts on natural ecosystems is possible managing some key issue adjustments like stocking rate, cattle/sheep ratio and forage allowance adjusted by animal categories. With these strategies are possible increase economic results maintaining an acceptable ecosystem integrity and reach biodiversity. In these small area farms it is crucial to make strategic use of seeded pastures, modifying only a low proportions area of the total farm.

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