Re-disigned farming system as a key for biodiversity conservation in Uruguay

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1 Introduction

Only 0,6 % of Uruguayan land is under somehow protection such as National Parks or Protected Landscape. In this context wild life and biodiversity conservation in general depends on private areas which major part are under different production systems. Taking this into consideration, this work was developed in seven livestock farms (cattle and sheep) using a co-innovation approach (Dogliotti *et al*, 2014) that allows re-designing systems increasing meat productivity, reducing environmental crisis risk and reducing overgrazing. As main productive results, after two years of project, meat production increased 23%. Forage biomass availability increased 70%, from 1473 ± 644 kg DM•ha-1 to 2111 ± 979 kg DM•ha-1. These results are mainly based on livestock stocking rate reduction, a decrease of the sheep to cattle ratio and increase forage allowance, considering animal category and physiological state. Although productivity results are promissory, it is necessary to evaluate the effect of these management strategies on ecosystem functions. In the present article we are exposing the status of the measured environmental variables, relative to biodiversity conservation, in the redesigned systems.

2 Materials and Methods

Water was seasonally (four times a year, one on each season) sampled on streams and dams in at least six points of each farm. Turbidity, dissolved oxygen, total dissolute solid, nitrate, pH and temperature were measured with Hanna HI 9828 Multiparameter meter. Phosphorus was determined with Hanna HI736 Handheld Colorimeter -Phosphorus Ultra Low Range. A water quality index -WQI-(Michalos, 2014) was performed with media values of selected variables throw the following formula: $WQI = \sum_{i=1}^{n} (C_i.P_i)(\sum_{i=1}^{n} P_i)^{-1}$, 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 are assigned to the variable more important for aquatic life (e.g. dissolved oxygen).
Biodiversity was evaluated throw studying botanic composition of the herbaceous community, birds and spiders assemblages and an Ecosystem Integrity Index (EII).
Herbaceous plant communities of natural grassland were annually evaluated in the reference units using the point quadrate method. This method was used in each transect relieving all species present at contact points every 50 centimetres. Distribution of species was studied by calculating specific frequencies, richness and diversity indices (Daget & Poissonet, 1971)
Birds were monitored each season following line transects (Sutherland, 2006) at three reference units in each plot, two on natural grasslands (NG) and one in seeded pastures (SP). Transect was performed in 300 m segment, totalizing 900 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.
Spiders sampling was done with sweep netting directly on grasses (Sutherland, 2006). Ten samples of 20 sweeps were taken in every reference unit, determining species presence, number of individuals and the belonging gremmies of each species. Natural grasslands and seeded prairies were sampled.
Ecosystem Integrity Index is a tool on developing phase and its main objective is to make a fast evaluation of the estate of the ecosystem relative to an "optimal" in a low intervention natural ecosystem. It is a 10 points scale index (from 0 to 5, 0.5 step) including four evaluated aspects: structure, species, soil erosion and state of streams including water, riparian zone and vegetation.
In order to display specific results and properly discussion, information of one case study is presented. This case is a livestock grazing system based on natural grasslands (364 ha) located in Eastern Uruguay.

3 Discussion

General water quality was good (>60) in both streams and dams, although we found turbidity and dissolved oxygen values at suboptimal levels for dams, which significantly reduce the index. WQI was 91 and 68, for streams and dams respectively. In table 2 selected parameters for the WQI are presented.

Table 2. Parameters registered for analysed water (mean± SD)

Type	DO ppm	pH	Turbidity FNU	TDS ppm	NO^3	TP ppb	WQI
Streams	7.1±2.7	7.5±0.4	5.5±10.8	87.8±21.2	0.42±0.1	47.5±18.8	91
Dams	5.3±2,9	7.6±0.4	122.0±33.4	49.7±43.8	0.40±0.1	49.3±21.8	68

References: DO=dissolved oxygen, TDS=total dissolved solids, NO3= nitrates, TP= total phosphorus and WQI=water quality index

Regarding to vegetal biodiversity, 61species of herbaceous plants and 25 species of trees associated to grasslands were found. Ten species represent 74% of the soil covering in the reference plots at the beginning of the project, those species were: *Axonopus affinis*, *Cynodon dactylon*, *Piptochaetium montevidense*, *Chevreulia sarmentosa*, *Ciperus sp.*, *Richardia humistrata*, *Panicum sabulorum*, *Dichondra microcalix*, *Paspalum quadrifarium* and *Danthonia rhizomata*. After two year of project implementation, the proportion and the ranking of species changed due to a combination of factors both grazing management and climate, specifically the high levels of rainfall recorded in the past years. There was an increase of summer grasses species, specially *Axonopus affinis* and others with similar functional type while *Ciperus sp., Juncus sp.* and *Mimosa australis* also increased. Is also remarkable the reduction of the presence on *Cynodon dactylon* which is an alien plant considered a weed and the increase of *Coelorhachis selloana,* a high quality forage supplier. Other changes were registered in structure and average forage mass which increased from 1152 to 1718 $kg.ha^{-1}$. Besides of changes in species contributions, there was no evidence of any species disappearance.

Considering bird diversity, 59 birds species were found during the first year (transects method), and after two years 88 species were registered, and reach 100 species considering those registered out of transect. Accumulation curves showed differences in the estimated richness project in four years sampling for natural grasslands (89), and annual pastures (68). Eight species considered as national conservation priority (Soutullo et al, 2013) were recorded: *Cariama cristata*, *Coragyps atratus, Donacospiza albifrons, Gnorimopsar chopi, Lochmias nematura, Nothura maculosa, Picumnus nebulosus, Rhea americana* and *Rynchotus rufescens.* The effect of richness reduction in seeded area is considered to be low impact due to the low fraction of the total farm area dedicated to this used, only 11.3%. Most of the production areas are covered with natural vegetation communities providing birds with rich habitat and a well-preserved structural complexity.

In relation to spiders communities, nine families belonging to seven different gilds and a total of 20 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 NG the population was three time higher. Irregular web builder and ambush hunters' gilds were found exclusively in NG.

General ecosystem integrity index of whole farm was 4.0, which result from the integration of "good" indexes in the majority of the area and lower values in a relative small zone of more intensive production used. In Fig.1 the distribution of index values for each paddock is shown.

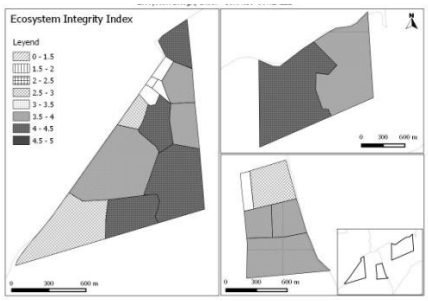

Fig. 1. Map with Ecosystem Integrity Index for each plot of the farm.

4 Conclusions

We found a general well preserved natural ecosystem that support the studied production systems, including biodiversity with a wide range of flora and fauna species. Initial records and in-course samplings showed the stability of wildlife species and favorable changes in the herbaceous species composition and structure.

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