



Ecosystem integrity index (EII) in ranchers of the “grass management” project in Uruguay

Cáceres Bentancor, D¹; Laborde, J¹; Orihuela, D¹; Sancho, D¹; Beretta, A¹; Pereira Machín, M²

^{1,2}Ministry of Livestock, Agriculture and Fisheries, Constituyente 1476, Montevideo, Uruguay;

²Institute Plan Agropecuario, Br. Artigas 3802, Montevideo, Uruguay.

Key words: Grassland; conservation; index; livestock

Abstract

Grasslands cover about 60% of Uruguay and are the main forage for cattle and sheep production. This ecosystem and the other natural resources of livestock systems show great variability in their conservation status and little information is available. The Ecosystem Integrity Index (EII) is an indicator that assesses the state of a specific ecosystem under agricultural use, with reference to an optimal state that should be established for the ecoregion. Its application involves a qualitative and quantitative visual assessment, it has a scale of points (from 0 to 5) that includes four aspects: vegetation structure, species diversity, soil erosion and condition of watercourses and riparian zones. We carried out the EII in 12 ranches distributed throughout Uruguay, as part of the Grass Management Project of the Institute Plan Agropecuario, in the spring and summer of 2021 and 2022, years with below-average rainfall. A total of 10,808 hectares were studied. The EII showed different starting situations among the ranches. Within ranches, the EII showed differences between plots, and plots also showed differences in index composition. The EII was able to assess the conservation status of livestock systems in a simple way. The results made it possible to objectively characterise, target and localise restoration and conservation activities and make them more effective. It is planned to repeat the indicator at the end of the project to compare the ranchers' assessments.

Introduction

Uruguay is included within the grasslands of the Río de la Plata (Soriano, 1991), where they occupy 60% of the territory and are the main nutritional support for livestock production. Livestock systems present great variability in the state of conservation of grasslands and other ecosystems that need to be evaluated. To meet this objective, the Ecosystem Integrity Index (EII) was developed within the framework of the extension project of the Institute Plan Agropecuario (IPA) called Grass Management Project.

The EII is a point scale index (from 0 to 5) that includes four aspects: vegetation structure (VE), species diversity (SP), soil erosion (S) and condition of watercourses and riparian zones (RZ) (Figure 1). The index evaluates the state of a specific ecosystem under agricultural use, referring to an optimal condition to be established for the ecoregion (Blumetto et al., 2019). Its application involves a qualitative and quantitative

visual assessment. The value is calculated for each paddock and an overall value weighted by the size of each paddock using the following equation:

$$EII = \sum_{n=1}^n \frac{(VE_i + SPp_i + S_i + RZ_i)AP_i}{4RA}$$

Fig 1. Where, VE_i = vegetation structure score for paddock i, SPp_i = species presence score for paddock i, S_i = soil score for paddock i, RZ_i = riparian zone score for paddock i, AP_i = area of paddock, and RA = total ranch area, adapted from (Blumetto et al., 2019).

Methods

The EII was obtained in 12 ranches. The survey was carried out in the springs and summers of 2021 and 2022, totalling some 10,808 hectares distributed throughout Uruguay. Four ranches were selected for a second evaluation in the spring of 2024.

During the years 2021 and 2022, there were negative anomalies in precipitation indicators in all livestock regions of the country (MGAP, 2023), an aspect that is being reversed in the spring of 2024 (INUMET, 2024).

The relation between land use and the values of EII and they components was evaluated by regression coefficient. The general comparison between years of the EII and its components was performed by paired two-tailed t-test. The comparison within each ranch was performed by Fisher's test, the measurement site effect was considered a random effect, and the difference was significant when the p-value was less than 0.05.

Results

The Ecosystem Integrity Index and its four components are presented separately for each facility.

Table 1 Ecosystem Integrity Index and its components by ranches at the beginning (2021 and 2022) and at the end (2024).

Ranche	----- Initial (2021/2022) -----					----- Final (2024) -----				
	EII global †	VE	SP	S	RZ	EII global	VE	SP	S	RZ
G I	3,5 (0,22) A‡	3,7 (0,36) A	3,1 (0,21) A	4,2 (0,42) A	2,9 (0,37) A	3,6 (0,31) A	3,9 (0,30) A	3,1 (0,52) A	4,2 (0,42) A	3,0 (0,48) A
Bar	3,4 (0,39) A	3,6 (0,49) A	2,5 (0,65) A	4,2 (0,38) A	2,9 (0,40) A	3,3 (0,37) A	3,6 (0,38) A	2,3 (0,77) A	4,2 (0,29) A	2,9 (0,33) A
L. P	2,9 (0,47) B	2,7 (0,68) A	1,7 (0,49) A	3,9 (0,63) A	3,0 (0,61) A	3,0 (0,34) A	3,1 (0,51) A	1,7 (0,56) A	4,1 (0,49) A	3,0 (0,61) A
AA	3,4 (0,05) B	3,5 (0,31) A	2,8 (0,22) B	4,3 (0,15) A	3,0 (0,19) A	3,5 (0,34) A	3,8 (0,51) A	3,2 (0,56) A	4,2 (0,49) A	3,1 (0,61) A
De B.	3,4	3,2	2,0	4,0	3,0	nd	nd	nd	nd	nd
Ver.	3,3	3,9	2,6	3,7	3,0	nd	nd	nd	nd	nd
And.	3,2	3,2	2,5	4,1	3,1	nd	nd	nd	nd	nd
Sang.	3,0	3,4	1,9	3,5	2,8	nd	nd	nd	nd	nd
L. D	3,4	3,9	2,3	4,4	2,8	nd	nd	nd	nd	nd
S. R	2,8	3,7	1,2	3,3	2,5	nd	nd	nd	nd	nd
F.E	2,7	2,6	1,5	4,1	1,8	nd	nd	nd	nd	nd
Tro.	2,6	2,5	1,7	3,6	2,9	nd	nd	nd	nd	nd

†: Mean value and between parentheses the standard deviation. ‡ The letters indicate comparison of means between years for the same variable and ranches, the procedure of different means test of Fisher LDS was used whit $\alpha = 0,05$.

In the evaluation 2021/2022 the average EII of the 12 ranches was 3.1, a standard deviation of 0.31 and a variance of 9%. On average, the EII had a significant increase of 0.10 points from 2021/2022 to 2024, in the ranches evaluated in both instances. The increased observed to VE was no significant (0,43). To the components RZ, S and SP, the means values had a significant increase of 0.05, 0.14 and 0.15 respectively.

The proportion of grassland increase the EII values (regression coefficient = 1.05, p-value=0.02), the VE values (regression coefficient = 1.71, p-value=0.02) and SP values (regression coefficient = 1.81, p-value=0.02). No significant coefficient regression coefficient was observed between proportion of grassland and S or ZR.



Fig. 2: EII per ranch and per paddock

Discussion

The EII obtained was above its mean value in all the ranches, showing different starting points between ranches and differences in the internal composition of the index (Table 1). On the other hand, differences were observed within each ranch; these findings allow focusing and locating restoration and conservation measures, and to this end maps were generated for each cattle farmer (Figure 2).

On the other hand, the data on land use in each ranch were related by regression with the EII obtained, resulting those ranches with a higher proportion of grasslands obtained a higher value of EII, this was explained by its positive and significant coefficient regression of the structure (VE) and species (SP) components, which highlights the environmental importance of grasslands for livestock systems.

In the four ranches where the index was performed again in 2024 the results indicate that in general terms there was a positive evolution of the overall EII and also in most of its components (p value < 0.05), this coincides with what was found by Blumetto et al., 2019. and shows a positive effect of the project on the environmental quality of the ranches, although there may also be an effect of the change in the rainfall regime existing in the period.

Conclusions

The EII was able to evaluate the conservation status of livestock systems in a simple way. It allowed characterizing the different systems and having objective criteria to locate and focus restoration and/or conservation actions. The grassland showed a great importance in the environmental quality of the ranches. Moreover, the index showed significant changes between the beginning and the end of the project in four selected ranches, which shows a positive effect of the project and/or an effect of improved rainfall, it would be important to continue monitoring these ranches.

Acknowledgements

To the 12 ranches who allowed us to enter their farms to carry out the necessary surveys, to the authorities and board of directors of the IPA for their confidence in the technical team of the DGRN of the MGAP to execute this Project and allow us to present it at this congress. To Oscar Blumetto of INIA for the training and technical support.

References

- Blumetto, O., Castagna, A., Cardozo, G., Garcia, F., Tiscornia, G., Ruggia, A., Scarlato, S., Albicette, M.M., Aguerre, V., Albin, A., 2019. Ecosystem integrity index, an innovative environmental evaluation tool for agricultural production systems. *Ecol.Indic.* 101, 725–733. <https://doi.org/10.1016/j.ecolind.2019.01.077>.
- INUMET.2024. Balance hídrico 2024. Available at: <https://www.inumet.gub.uy/clima/agricultura/balance-hidrico> . Accessed 28/11/2024.
- MGAP 2023. Estimaciones preliminares impacto déficit hídrico 2022-2023. Available at: https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/sites/ministerio-ganaderia-agricultura-pesca/files/documentos/noticias/_Estimaciones%20perdidas%20deficit%20hidrico%202022-.pdf . Accessed 28/11/2024.
- Soriano, A. 1992. Río de la Plata Grasslands. *Ecosystems of the world 8A*. COUPLAND R.T. (ed.) Natural grasslands. Introduction and Western Hemisphere. Elsevier, Amsterdam. pp. 367–407.