

Managing pasture-herd interactions in livestock family farm systems based on natural grasslands in Uruguay

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1 Introduction

Livestock production in Uruguay involves the management of C4-species dominated natural grasslands, which cover more than 70% of the country's surface area. Almost 80% of the farms specialized in beef and wool production are family farms, which usually exhibit low sustainability due to low family income and grassland overgrazing. Historically, natural grasslands have been managed with low forage heights (2 to 4 cm), and consequently low leaf area indices, reducing the capacity of the sward to intercept light and photosynthesize, and providing niches for invasion by low productive grass species. As a result, grassland productivity has been low, and risk of erosion and loss of biodiversity high. Experimental evidence suggests that improving management of the pasture-herd interactions by seasonal modulation of animal density could improve natural grassland growth and increase meat production, which would contribute to the design of more resilient systems less vulnerable to droughts. To test this hypothesis at the scale of real family farms, a co-innovation approach was implemented on seven pilot farms in the east of Uruguay with the aim of improving family income and reducing natural resource degradation.

2 Materials and Methods

A co-innovation approach (Dogliotti *et al.*, 2014) was implemented during two years in seven pilot farms involving family livestock grazing systems based on natural grasslands, located in the East of Uruguay. The approach involved characterization and diagnosis of the farm system's sustainability, followed by cycles of re-design, implementation, and monitoring of system evolution. Proposals for re-design were based on changes in management practices without adding external inputs and without increasing costs. The relevance of increasing the amount of standing biomass and improving pasture-herd management at farm level was discussed between technicians and farmers. Productivity (meat productivity, stocking rate, sheep to cattle ratio, kg of weaning calf per breeding cow and forage allowance), and economic (net income) indicators were estimated for the three previous years before starting the project from farmers' records, and records were kept during the project. After starting the project also forage mass (Haydock & Shaw, 1975) and forage height (Barthram, 1986) were measured twice per season in all farms.

3 Discussion

During characterization and diagnosis at farm level, we found low physical and economic results and natural resource degradation. Low values of standing biomass (1.183 ± 335 kg of dry matter (DM) ha^{-1}) were found and areas with low soil cover, presence of low productive grass species and problems of forage structure, revealing natural grassland degradations were observed. Low biomass, and as a consequence low leaf area index values reduced the capacity of the sward to intercept light and photosynthesize, affecting pasture growth. Inadequate feed supply resulted in low cattle sale weights and low animal reproductive efficiency, which led to low meat productivity and family income. Those problems were discussed with farmers and agreed. Historically, farmers managed their systems with large numbers of animals and high sheep to cattle ratio. Stocking rate is one of the most important management variables in grassland ecosystems, since it determines the relationship between forage offer and animal demand. Proposals for redesign were done by technicians and discussed with farmers. The main strategy elaborated with and implemented by the farmers was to increase standing biomass and forage production of the grasslands by reducing stocking rate and the sheep-to- cattle ratio, and adjusting allocation of animal categories to paddocks over the course of the year. Also the use of low cost breeding practices, such as allocation of different animal categories to different paddocks according to standing biomass, feed provision according to body condition, temporary weaning, definitive weaning of calves in autumn, and extra attention to feeding female calves and heifers during their first winter (Quintans & Scarsi 2013). After two years of implementation of the redesign proposal, significant improvements were achieved at farm level.

On average, farms decreased total stocking rate by 8% (from 0.92 Livestock Unit (LU) to 0.84 LU ha^{-1}) and decreased the sheep to cattle ratio by 34% (from 2.6 to 1.4). The improved management of the pasture-herd interaction resulted in

an increase in standing biomass (Fig. 1). The average forage height at the beginning of the project (summer 2012-2013), the moment in which cows are lactating and should get pregnant again, was half the amount required according to Soca and Orcasberro (1992) (Fig. 2). The next summer (2013-2014) average forage height was already at the recommended level and it was kept above requirements till spring 2014.

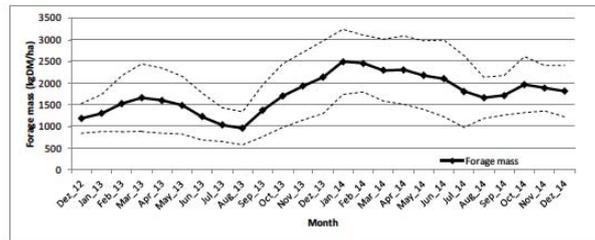


Figure 1. Monthly average forage mass (kg DM ha⁻¹) for 7 pilot farms during the two years of the project. Dotted lines indicate standard deviation.

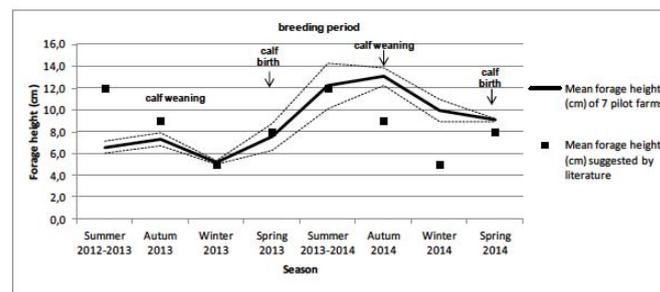


Figure 2. Average forage height (cm) for 7 pilot farms per season and forage height (cm) suggested by Soca and Orcasberro (1992). Dotted lines indicate standard deviation.

These increases in forage height and standing biomass resulted in an increase in forage and meat production per ha. Forage allowance, an instantaneous measure of the forage-to-animal relationship, increased on average, after two years of implementation of the project, from 3.5 ± 1.2 to 6.1 ± 2.0 kg of DM per kg Live Weight⁻¹. As a consequence, equivalent meat production (i.e. meat + wool) increased by 24% (from 99 kg ha⁻¹ to 123 kg ha⁻¹), and the weight of weaning calf per breeding cow increased by 39% (from 107 kg to 149 kg). Comparing the average of the two years before the beginning of the implementation of the re-design plans with the average of the two years after, the net income increased from 70 to 98 US\$ ha⁻¹. We hypothesize that a higher standing biomass also had a beneficial effect in terms of reducing the risk of erosion, climate vulnerability and increasing soil carbon.

4 Conclusions

We presented a successful co-innovation process involving farmers and scientists showing that, even in slow-responding perennial systems, ecologically intensive strategies that better utilized system functionalities without extra inputs resulted in important improvements of system functioning within two years.

Acknowledgements. The authors would like to thank the farmers and their families for their dedication. Also A. Albin, M. Albicette, M. Benvenuto, I. Bortagaray, O. Blumetto, A. Castagna, P. Clara, C. Leoni, L. del Pino, F. García, S. Montaldo, G. Quintans, M. Scarlato, P. Soca and G. Tiscornia for their contributions.

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