

Production gaps in livestock grazing systems in Sierras del Este, Uruguay: magnitude, causes and strategies to reduce them.

Ignacio Paparambora ^{*±1} & Raúl Gómez ¹

¹ National Institute of Agriculture Research, INIA, Uruguay.

* Speaker

± Corresponding author: ipaparamborda@gmail.com

1 Introduction

In Uruguay beef cattle production is the main source of income in 24848 farms, covering an area of 11.5 million hectares, being 55% of those farms classified as family. The main productive orientation in family farming is cattle breeding, based on natural grasslands. Those systems have very low productivity: 70-80 kg of meat ha⁻¹ (Berreta, 2003), calving rate of 62%, and only 50% of the heifers get pregnant with 2 years (DIEA, 2002). Natural grasslands are the main forage resource available in those systems, representing at least 60%. It has been reported that grassland productivity has been low, exists risk of erosion, loss of biodiversity and high presence of weeds (Boggiano, 2003).

Most of the studies in yield gaps analysis have been developed in cropping systems. In these studies the current levels of production are analyzed, potential and achievable yields are determined, considering defining, limiting and reducing factors (van Ittersum *et al.*, 2013). In animal production this approach has been rarely used (Cortez-Arriola *et al.*, 2014). However, it would be very adequate for studying livestock production systems, especially in the analysis of resource use efficiency. In livestock grazing systems the production gaps may be caused by an inadequate management of the forage (without considering time and space) and the herd. Consequently, forage production and utilization are affected (Carvalho *et al.*, 2004). Based on this approach we want to answer which is the magnitude and which are the causes of the production gaps in livestock grazing systems in the region of Sierras del Este, Uruguay. This information is of great relevance to think the re-design of production systems, but looking for a diagnosis for action, since our purpose is to intervene on the causes that limit or reduce production levels.

This work is part of the extension and development project "Improving the sustainability of family farming", carried out by the National Institute of Agriculture Research and Plan Agropecuario of Uruguay with AgResearch of New Zealand, between 2014 and 2017. The aim of this project is to increase the productivity and quality of natural resources in family cattle farms.

2 Materials and methods

We are working in 22 focus farms throughout Uruguay, around each of which it has been formed a group of 8-12 farmers. A co-innovation approach (Dogliotti *et al.*, 2014) is being followed. The approach involved characterization and diagnosis of the farm system's sustainability, followed by cycles of re-design, implementation, and monitoring of system evolution. In this paper we present the farm diagnosis and discuss the production gap of four focus farms located in the region Sierras del Este, Uruguay.

The four focus farms were selected with the support of local farmers organizations and extensionist. The main criteria for choosing the focus farms were: being family farmers, being livestock grazing systems with at least 60% of the area with natural grasslands, and showing interest in making changes in their farms. The characterization and diagnosis of the farms was done during 2014, while farm re-design and its implementation started during 2015 (to be developed until 2017).

Monthly visits during the first year were done to evaluate farm resource availability and productive results in addition to farmers objectives. To analyze the magnitude of the production gap, we compared the meat production levels of the four focus farms with those obtained in the seven case studies reported by a Co-innovation project in Rocha-Uruguay (Ruggia *et al.*, 2014). The average gap was estimated as: [(average production obtained in the 4 focus farms - average production obtained in the Co-innovation project in Rocha after three years of work) / average production of Co-innovation project in Rocha after three years of work] * 100. We also compared other important indicators for cattle breeders systems: the forage allowance, cow's pregnancy rate and kg of weaning calf per breeding cow.

3 Results and discussion

The focus farms are representative of the predominant family livestock farms in the region. They have small land area, predominance of family labor, the main forage source is natural grassland and the production orientation is breeding. On average, productivity levels were low: meat production of 84 kg equivalent meat (meat + wool) ha⁻¹, cow's pregnancy rate of 77%, and 98 kg of weaning calf per breeding cow (Table 1). This diagnosed situation was similar to the baseline reported by the 7 pilots farms of the Co-innovation project of INIA for the same region. These farms after

three years of working with a co-innovation process achieved an increase in productive results reaching the following results: meat production of 122 kg equivalent meat per year ha⁻¹, a pregnancy rate of 90% and 149 kg of weaning calf per breeding cow. Considering those production levels as achievable, the production gaps in our focus farms was estimated in 31%.

Table 1. Farm characteristics and productive results of each of the four focus farms, its average, and the average for the seven pilot farms of the CoInnovation project in Rocha, at the beginning and after three years of changing implementation.

Farm	Total area (ha)	Stocking rate (LU)	Natural grassland area/ Total area (%)	Sheep-to-cattle ratio	Cow's pregnancy rate (%)	Meat yield (kg ha ⁻¹)	Weaning calf per breeding cow	Number of cows mated per year	Forage allowance (kg DM per kg LW)
1	179	0.89	53	0.14	80	86	97	105	3.0
2	517	0.83	90	1.5	79	99	110	202	2.8
3	520	0.62	60	0.5	63	65	79	171	3.8
4	189	1.10	100	2.0	85	86	105	92	3.9
MSGF Este 2014 ¹	351	0.86	76	1.0	77	84	98	143	3.4
CoInn Rocha 2014 ²	240	0.84	84	1.4	90	123	149	101	6.1
CoInn Rocha 2012 ²	240	0.92	87	2.6	76	99	107	95	3.5

LU: livestock units. DM: dry matter. LW: live weight.

¹Average Project "Improving the sustainability of family farming" year 2014.

²Average Co-innovation project in Rocha (Ruggia *et al.*, 2014) years 2012 and 2014.

Which are the causes of current production levels and the production gaps?. There is lack of planning in the production systems and an imbalance between forage production and animal requirements. Forage allowance, an instantaneous measure of the forage-to-animal relationship, was on average low in the 4 focus farms (3.4 kg dry matter kg live weight⁻¹). Consequently, exist low levels of consumption, higher energy costs on grazing, leading to breeding cows to be at many times of the year in negative energy balance (Carvalho *et al.*, 2004). Moreover no management practices for breeding were used in the cattle herd, such as: differential feeding management according to body condition and physiological state, mating period setting, suckling control, final weaning in March and diagnosis of ovarian activity and pregnancy, differential feeding management of the female calves in the first winter.

A successful co-innovation process involving farmers in the same region and with the same problems, resulted in important improvements of system functioning within three years, providing specific technical information to re-design the farm systems and elements to think about the possible trajectories for change, inspiring to apply this knowledge to reduce production gaps in other farmers. In this sense, although the current gap is around 31%, there are alternatives to reduce it. These requires re-thinking the systems globally working together extensionists and farmers, redesigning them based on a different organization of the resources that are available.

4 Conclusions

There is an important production gap in family livestock farms under study. They are reaching lower results than the possible ones to achieve with the available resources. As reported by national research this gap can be reduced. The challenge is to generate changes in management practices without adding external inputs based on systems approach and with active participation of farmers

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