Co-innovation as an effective approach to promote changes in farm management in livestock systems in Uruguay

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1 Introduction

In Uruguay, livestock production involves 65% of the family farmers and more than 70% of the area of the country. Low levels of sustainability were diagnosed in livestock family farming systems based on natural grasslands in Uruguay, being the main causes low meat yield and income. Scientific evidence shows that it is possible to increase production while preserving natural resources and enhancing ecosystem services through changes in management practices of pastures and animals (Nabinger *et al.*, 2011). However, during the last decades low levels of technological innovation has been applied in livestock systems. Lack of improvement by farmers could be explained by the weakness and the traditional approach of the extension service. From a traditional approach, innovations are designed externally to the systems and farmers adopt those innovations by an "extension" process. Extension linearly involves awareness of the problem by the farmer, interest in the solution, evaluation, experimentation and finally adoption (Cramb, 2000). Nevertheless, the active participation of the farmers in the diagnosis and redesign might maximize the impact of the proposals generated, promoting learning processes that support innovation in practices in the long term (Leeuwis & Van der Ban, 2004). The co-innovation approach combines complex systems theory, social learning and dynamic project monitoring and evaluation to stimulate strategic re-orientation of family farm systems (Rossing *et al.*, 2010). We hypothesized that a systemic and participative approach such as this one is necessary for re-designing productive systems in order to improve their sustainability, being the learning process in farmers as important as the bio-physical changes in their production systems.

2 Materials and Methods

The co-innovation approach was implemented in 7 family livestock farms located in eastern Uruguay between 2012 and 2015, in order to generate and evaluate changes in systems sustainability. The approach involved characterization and diagnosis of the farm system's sustainability, re-design, implementation, and monitoring and evaluation of system evolution (Dogliotti *et al.*, 2014). By using the systems approach, an agreed baseline of farms sustainability was generated based on farm information of the three previous years before starting the project. To explore alternatives for re-designing, simple models of farm operation, scientific information and information obtained from other production systems were used. Feeding and financial budgets were performed to assess the impact of re-design. This process was carried out with farmers and their families, letting them choose the final alternative. Monthly visits to the farms were done to implement, support and monitor the process.

This project was based on a multiple case study design in which each farm constituted a case study. The study of multiple cases does not attempt to represent family farmers, rather it is based on replication logic: each case replicates a broader theoretical framework (Yin 2003). The research strongly relies on primary data, which emerges from the combination of different techniques: monthly visits to the farms to monitor and gather data on a series of environmental and economic-productive indicators, and a series of in-depth interviews throughout the project, and a historical analysis of the main milestones that have shaped the life of these farmers to study the main changes and learning processes that have taken place at the micro (family) level.

3 Results – Discussion

After two years of project implementation, significant improvements were achieved at different levels. Adjusted stocking rate and sheep-to-cattle ratio, combined with improved grazing management of the natural grasslands allowed increasing on average 20% the cow´s pregnancy rate and 24% the meat yield per hectare. Farm income increased 40%, as the proposals did not increase productive costs and improved animals' sales strategies. Improved management resulted in an increase in standing biomass of natural grassland, minimizing soil erosion risk and preserving biodiversity.

Changes in farmers' vision and in the way they think and decide on their farms were identified, being a key element for the project approach. The way farmers expressed main changes reflects an understanding and belief in what they are doing, as well as a consciousness about why they have made changes, and its implications (Table 1).

The improvements achieved at farm level, based on farmers learning, were also recognized, being critical for supporting innovation in practices in the long term.
Furthermore, farmers' shared perception is that the project has changed their life at the farm. Their perception regarding the use of time has changed, as well as the type and complexity of the tasks associated to farm management, their future prospects, their goals and their overall approach to the farm.

Table 1. Farmers' perception about the main changes in their farms

Sustainability dimension	Improvement area	Farmers' opinions related to changes in their farms
Bio-physical and Economic	Increased forage and meat production, improved reproductive efficiency. Increased net income.	"We have learned that we should not count how many animals we have, but how much meat we produce, and how many animals we need to produce as many kg of meat per hectare. Because we used to have too many animals per hectare, though with very low production."
Environmental	Soil, natural grasslands and biodiversity conservation.	"We have wasted and wasted the soil so much... now it is so difficult to get it back. Planting a pasture, as green manure. Always trying to leave some residue, not like in the past when we left only the ground and we kept nothing for restoration of the soil." "In pastures, for instance, the appearance of certain species that are indicators of good management of the natural grassland… besides the animals, the birds…"
Social	Use of the time.	"I notice that we are now more organized. And suddenly being more organized means working more comfortable… We are less demanded in winter, it used to be more complicated, but now as we have more forage, we are better prepared… We would have more time to do other things."
	Farm management.	"The pasture management has been very important. I learned a lot of pasture management, about forage height, how to see things I have not seen before. We just used to walk on the grass. We knew it was high or low. But now we can see other indicators in the grassland that are very good and sometimes we didn't realize they were so important."
	Methodological approach.	"The technician is talking about soils but also talks about the body condition of the animals, they cover a broad range of topics. The project has not put money, instead it has been about thinking." "On the technical approach, it has not only been about economics... being in close interaction has been key, and that technicians are so open, so sociable. It is essential that part of knowledge we have of each other… it allows to build confidence"

4 Conclusions

Farms' sustainability increased through a systems re-design. The involvement of farmers and their families in the farm diagnosis, in the development of alternatives for improvement and in monitoring progress was essential in order to promote learning processes to support changes. Changes in the farmers' vision of their own farm, and a new way of facing management decisions were found. The co-innovation approach was an effective tool for promoting changes in farms.

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