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ARTICLE

Co-innovation and farm technical assistance to contribute to a sustainability transition of livestock farming in Uruguay

Coinnovación y asistencia técnica predial para contribuir a una transición sostenible de la ganadería en Uruguay

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Abstract: The transformation of the existing agrifood system towards more sustainable systems requires sociotechnical strategies that can boost radical changes. In Uruguay there is a community of practice committed to the sustainable development of family livestock farming which has developed alternative production practices, that improve the sustainability of farms based on ecological intensification, for more than fifteen years. Co-innovation as a modality of intervention was a fundamental aspect in the results achieved, being the work on farms a key factor, with a very special bond between extensionist and family. Taking this community of practice as a case study, this text characterizes co-innovation as a modality of intervention for farm technical assistance, offering a vision to enhance the scaling of the interventions and contribute to the sustainable transformation of livestock farming. Results are presented on: 1) general characteristics of the intervention modality, 2) stages of work and practices on farms, 3) characteristics of the family-extensionist bond and 4) lessons learned. Finally, key aspects are pointed out to scale co-innovation, in order to contribute to a sustainability transition of Uruguayan family livestock farming.

Keywords: rural extension and technical advice, sustainable transformation, ecological intensification, livestock based on natural grassland, family production.

Resumen: La transformación del sistema agroalimentario actual hacia sistemas más sostenibles requiere estrategias sociotécnicas que puedan impulsar cambios radicales. En Uruguay existe una comunidad de práctica comprometida con el desarrollo sostenible de la ganadería familiar que ha desarrollado prácticas productivas alternativas, que mejoran la sostenibilidad de los establecimientos con base en la intensificación ecológica, durante más de quince años. La coinnovación como modalidad de intervención fue un aspecto fundamental en los resultados alcanzados, fue clave el trabajo situado en los predios, con un vínculo muy especial entre extensionistas y familias. Tomando la comunidad de práctica como un estudio de caso, este texto caracteriza a la coinnovación como modalidad de intervención para la asistencia técnica predial, ofreciendo una visión para potenciar el escalamiento de las intervenciones y contribuir a la transformación sostenible de la ganadería. Se presentan resultados sobre: 1) características generales de la modalidad de intervención, 2) etapas de trabajo y prácticas en predios, 3) características del vínculo familia-extensionista y 4) lecciones aprendidas. Finalmente, se señalan aspectos clave para escalar la coinnovación, de manera de contribuir a una transición sostenible de la ganadería familiar uruguaya.

Palabras clave: extensión rural y asesoramiento técnico, transformación sostenible, intensificación ecológica, ganadería sobre campo natural, producción familiar.

1. Introduction

The current agrifood system proves ineffective to feed the world's population and causes serious negative environmental and social impacts (Gaitán-Cremaschi et al., 2019; Tittonell et al.,

2016). A deep transformation of the existing agrifood system towards an alternative system is required to achieve food and nutritional safety (El Bilali, 2020). Innovations such as the production of food based on ecological intensification, which promotes the intensive and intelligent use of the natural functionalities of ecosystems by managing biodiversity, solar energy, and biogeochemical cycles (Tittonell et al., 2016), could play a radically significant role in such transformation (Gaitán-Cremaschi et al., 2019). Alternatives based in ecological processes are opposed to the dominant food production model that started with the green revolution and which promotes the use of technology based on external inputs.

Livestock farming is the predominant production activity in Uruguay. It is developed in 11.7 million hectares and 26.000 establishments, with more than 88% of its grazing area consisting of native grassland (NG). NG-based livestock family farming represents 17% of the country's livestock surface and 60% of establishments (Tommasino et al., 2014). This model is "exogenously" threatened by the growth of agriculture and NG replacement with crops, and "endogenously" threatened by NG degradation due to overgrazing, which is detrimental to meat production while also reducing ecosystem services provisioning. The ecological intensification is an alternative for improving sustainability in productive systems because it combines high ecosystem services provisioning levels with meat production by implementing changes oriented to improve grassland and livestock management (Ruggia et al., 2021; Tittonell, 2021; Modernel et al., 2016), which would cause a radical impact on the predominant overgrazing situation. Research institutions have generated process technologies that can foster ecological intensification trajectories in NG-based livestock farming (Ruggia et al., 2021), but they are barely used by local livestock farmers[1] (Gómez Miller, 2017; Gómez Miller & Saravia Díaz, 2016). The diffusionist approach, related to the promotion of technology based on external inputs, has had little efficiency when applied to family livestock farming, which demands process technologies that may not be available in physical formats and require context-based knowledge (De Hegedüs & Pauletti, 2022). In order to contribute to the development of sustainable family livestock farming systems, and as an alternative to the diffusionist approach, participatory research approaches are being implemented in farms by involving producers in the identification of problems and the design of solutions (Aguerre & Bianco, 2023).

The Sustainability Transitions (ST) approach, which refers to long-term transformation processes in systems that cover social demands such as energy, water, shelter, and food (Schot & Kanger, 2018; Geels, 2004), is a suitable tool for examining such radical changes. Therefore, a socio-technical transition is the way to systemic transformation. This requires changing the dominant "way of doing things" and starting scaling innovative initiatives, *i.e.* off-system innovative practices or radical alternatives that are developed in protected spaces called *niches* (Geels, 2004, 2002). Considering their transformation potential, niches can be considered as transition seeds (Wiskerke & van der Ploeg, 2004), since they create alternatives that may favor ST.

In Uruguay, a NG-based livestock farming niche was developed under co-innovation and ecological intensification premises (Aguerre & Bianco, 2023). This niche, where researchers, farmers, extension agents and other actors involved in livestock farming, could be considered a community of practice (CoP) (Wenger & Snyder, 2000). Being committed to the sustainable development of family farming, particularly livestock farming, this CoP conducted alternative production practices that improve the sustainability of establishments based on ecological

[1] With the intention of not overloading the manuscript, the generic masculine is used (for example, producers, extension workers, researchers), with the understanding that these nouns always represent men and women.

intensification. By chaining projects for more than fifteen years, this CoP has accumulated knowledge on a new form of promoting changes based on co-innovation. Most of the participant establishments were able to improve productivity and income, protect natural resources, and organize and simplify family farming work. Different from diffusionist approaches with unsatisfactory results in terms of technology use (Pereira Machín et al., 2011), co-innovation proves a convenient intervention model for Uruguayan family livestock farming, and its ST could be fostered through a continued intervention strategy based on co-innovation.

Co-innovation targets complex socio-technical problems and involves changing the conventional way of producing knowledge towards a more action-based, interactive, and interdisciplinary model (Aguerre & Bianco, 2023; Ingram et al., 2020; Botha et al., 2014). In this context, and as an alternative to the linear technology transference model, innovation is the result of a network-based work and interactive learning processes within a heterogeneous group of actors (Coutts et al., 2017; Botha et al., 2014). As innovation is conceived not only as a technical process, but also as social and institutional, the literature reports the emergence of intermediaries performing new roles with the main purpose of creating suitable connections and facilitating the interaction between multiple actors interested in change (Klerkx, 2020; Botha et al., 2017; Klerkx et al., 2009; Koutsouris, 2014).

Experiences focused on implementing co-innovation in farms under a systemic perspective and aiming to improve sustainability are still scarce and remain restricted to Uruguayan experiences (Colnago et al., 2023; Ruggia et al., 2021; Albicette et al., 2017; Dogliotti et al., 2014). In these experiences, which are implemented within the above-mentioned livestock farming niche, participants considered the intervention model (co-innovation) was a fundamental aspect for the results attained. The work in the farms, which included a very special bond between extensionists and families, was reported as a key factor (Aguerre & Bianco, 2023). This bond is crucial and shows that the above-mentioned intermediaries play a key role in co-innovation processes. Nevertheless, no research analyzing the bond established between families and extension technicians in co-innovation processes was identified. This kind of characterization work could be useful to foster co-innovation as an intervention model for technical assistance and rural extension (TARE) (Christoplos, 2010).

Aiming to contribute to a ST of family livestock farming in Uruguay, this work examines co-innovation as a TARE intervention proposal, particularly for farm technical assistance. We understand farm technical assistance as a joint work process between extensionists and family producers, oriented to support decision-making and developing capacities to achieve sustainable farming and improve their quality of life. Based on the CoP experience related to the livestock farming niche, the objectives of this article are: 1) to identify the general characteristics of co-innovation as an intervention model for farm technical assistance; 2) to characterize work stages and practices for co-innovation in farms; 3) to characterize the family-extensionist bond in order to recommend a suitable extension agent profile for implementation; and 4) to identify lessons derived from implementation. Lastly, in the light of the objectives set, the key aspects for scaling co-innovation and contributing to the TS of Uruguayan family livestock farming are pointed out below.

2. Theoretical framework

This section introduces a synthetic view of the current state of TARE and its conceptions in Latin America and Uruguay, as well as its challenges for contributing to sustainable agriculture. Afterwards, the background of co-innovation application and its relation with TARE are summarized.

2.1. TARE in Latin America and challenges for sustainable agriculture

2.1.1. Rural extension in Latin America & Uruguay

Rural extension in Latin America was developed in two main historical trajectories: the conventional model that emerged in the 1950s; and a second approach proposed as an alternative to the first, which started in the 60s and 70s (Alemany & Sevilla-Guzmán, 2006). It is based on these models that the different perspectives (Landini, 2016c, 2021; Klerkx et al., 2016) mentioned below emerge.

The diffusionist-based conventional extension (Rogers, 1962) is influenced by North American rural sociology and aims to modernize and industrialize both agriculture and rural societies. Through persuasion, technology is transferred to farmers using knowledge generated in universities and research centers, where extensionist agents act as "experts" and establish hierarchical bonds with farmers.

Among the alternative views, dialogic extension stands out, which is based on Freire's (1973) thinking and the reflective integration of learnings resulting from participatory action research (PAR) experiences and popular education (Fals Borda & Anisur Rahman, 1991). Under this conception, rural extension has the objective of transforming reality and its fundamental pillars include the development of the farmers' critical capacities and the promotion of participation for change and social reflection. Extension is understood as a horizontal communication process focused on the dialog between technicians and farmers and the recognition of farmers' knowledge.

In the late 20th century, within alternative extension emerge new approaches that recover the territorial dimension and the articulation of different actors in the innovation and development processes. Multi-actor and multi-institutional approaches are emphasized, as well as local articulations where extension agents are conceived as facilitators or intermediaries, closer to the concept of rural development agent. Two lines emerge at this point: rural development with a territorial approach (Sepúlveda et al., 2003); and the conception of innovation understood as the result of the articulation of heterogeneous actors in a context of power asymmetry (Berdegué, 2005).

Currently, this diversity of perspectives coexists in Latin America, with the diffusionist approach as predominant (Landini, 2016c). Particularly in Uruguay, Landini (2016c) and Landini & Riet (2015) point out a coexistence of perspectives, remarking that it is the only country where the extension based on dialogic-oriented horizontal relations prevailed over the transference of technology. This fact is related to a change in the public policies developed since 2005 with the vision of transforming TARE from a mainly technical perspective to a more complex approach that integrates social work technicians in the extension teams and prioritizes the consolidation of farmers' organizations. Nevertheless, the interdisciplinary work did not extend beyond the farmers' organization sphere to farm-level extension work. Furthermore, this policy was interrupted, a fact that is characteristic of TARE policies in the history of the country (De Hegedüs & Pauletti, 2022).

2.1.2. Roles and capacities of extension agents to promote sustainable agriculture

At an international level, the literature remarks that the diffusionist model is not suitable for the challenge of achieving sustainable agriculture (Lybaert et al., 2022; Charatsari & Lioutas, 2019; Ingram & Mills, 2019). In this line, Méndez Sastoque (2020) mentions the need to advance towards a horizontal extension approach, based on the synergistic dialog and joint action between farmers and extensionists, which allows for combining the knowledge from both

parts in order to take action around contextualized problems. This framework proposed by dialogic extension approaches could avoid certain problems of "top-down" extension, based on assistentialist programs that target short-term issues but lack a clear strategic vision that could contribute to self-management capacities and social capital to guarantee the sustainability of processes in rural communities (Rodríguez-Espinosa et al., 2016).

Similarly, Uruguay has evidence that shows the diffusionist model does not work for family livestock farming (Morales Grosskopf, 2009), therefore it would not be suitable for promoting a transformation based on ecological intensification. At this point, it is necessary to understand how livestock farming systems work, bring local knowledge to light and integrate it with other available sources in order to implement adaptative maagement aiming to achieve collective learning (Pereira Machín et al., 2011). There are also experiences based in alternative technical assistance approaches for family farmers called Holistic Approaches to Agricultural Enterprises (Ferreira Rivaben et al., 2023; Chia et al., 2003; Figari et al., 2002). This approach was developed in France in the 1990s and is based on systemic thinking, which focuses on the creation of models that explain decision-making processes for system management and consider family objectives and their decision rules as elements of interest. However, it does not target the causes that explain the performance of the farming system and its alignment with the family objectives that could structure future proposals of alternative decision rules and promote sustainable transformation.

On the other hand, changing toward sustainable systems demands the participation of intermediaries. In this line, Ingram (2008) states that the role of extensionist agents should transition from experts to facilitators. Therefore, they should become involved in learning processes jointly with farmers by developing bonds based on trust, reliability, empathy, dialog, exchange, mutual respect, and shared expectations. Extensionists and farmers would thus collaborate in the joint understanding of problems and opportunities within agricultural systems by empowering themselves in order to increase general awareness about their problems as well as to explain and teach certain principles and practices that can lead to a more sustainable agriculture. The emergence of intermediation in rural extension (mentioned in literature as facilitators, intermediaries, or *brokers*) positions co-learning facilitation as a significant role for the development of shared significations and languages between dialog partners that stimulate changes and develop solutions and innovation (Koutsouris, 2014). Likewise, this author emphasizes the need to generate better descriptions and definitions on the operationalization and assessment of the work of intermediaries in order to improve interpretation and offer guidelines for their practice.

Therefore, apart from technical knowledge, extension agents with communicational skills are also desirable. This aspect is remarked on by Koutsouris (2008) and Leeuwis (2000), who refer to the "social agronomist," as well as Hansen et al. (2018), who give importance to relational capacities. From a complementary perspective, Gorman (2019) states that multi-actor group facilitation and intermediation related to innovation are essential capacities of extension agents. As it is unlikely that one person might have all these required skills, the conformation of interdisciplinary extension groups is a necessary step that should be considered in order to face the challenges of sustainable agriculture (Lybaert et al., 2022; Landini, 2016a).

2.2. Co-innovation as an intervention model

Acknowledging the collective nature of innovation, co-innovation requires multi-actor experimentation, learning and negotiation processes (Botha et al., 2017). A fundamental

aspect is that contributions from all actors should be considered as significant in each part of the co-innovation process: from the definition of the problem to the implementation of the solution (Srinivasan et al., 2019). Thus, a network-based work and interactive learning generate innovation co-produced between different actors (Coutts et al., 2017). Due to their conception of innovation as a social process based on interactive learning, the new intermediation roles become truly significant (Klerkx, 2020; Botha et al., 2017; Klerkx et al., 2009; Koutsouris, 2014). In the context of research projects, Botha et al. (2017) remark that researchers are required to perform new roles to support these processes as experts that facilitate interactions, design solutions and products, monitor processes and promote critical thinking.

The bibliography on co-innovation includes works that report on intermediation in research projects at a global level, particularly regarding the role of "reflective monitors" and relevant characteristics in the performance of their work (Fielke et al., 2017; Rijswijk et al., 2015; van Mierlo et al., 2010). Likewise, Ingram et al. (2020) state that, the performance of facilitation or intermediation functions is especially important to leverage co-innovation, since they allow active learning and effective action between interdependent actors. Research projects, they add, cannot be analyzed based on case studies without considering contextual aspects or facilitation activities.

The scarce records reporting co-innovation implementations at farm level, stand out the presence of an extension agent conducting frequent visits along a 3 to 4-year work process that featured diagnosis, redesign, implementation and monitoring stages (Aguerre & Bianco, 2023; Colnago et al., 2023; Ruggia et al., 2021; Albicette et al., 2017; Dogliotti et al., 2014). Derived from research projects, these processes can be related to the PAR perspective, as part of an extension approach that is alternative to the diffusionist model as mentioned above. Nevertheless, even though they mention the relevance of the extensionist-family bond, these experiences do not further explore this essential aspect of co-innovation processes. While certain impacts of the results on extension services are discussed, co-innovation is not identified as an intervention modality for TARE, particularly for farm technical assistance. Therefore, this article aims to contribute in that direction and collaborate to the transformation of livestock farming by offering a perspective that improves scaling of the interventions.

3. Methodology

Previous works analyze the development of a socio-technical niche related to NG-based sustainable livestock farming in Uruguay, derived from a sequence of six research projects conducted during 15 years (2004-2019). These projects used co-innovation in order to promote and assess ecological intensification strategies in family production systems in Uruguay, both horticultural and livestock farming systems (Aguerre & Bianco, 2023).

The niche gathers researchers, farmers, extensionists and other actors related to livestock farming, taken here as a community of practice (CoP). A CoP consists of a collaborative work environment oriented to develop a way of thinking in terms of social learning processes and the generation of shared knowledge. They are groups of people that share values, experiences, interests and practices, fostering new approaches to problem solving (Wenger & Snyder, 2000). In the case of the livestock farming CoP, the common goal is to improve the sustainability of family production with a repertoire of ways of thinking and doing things, which involves co-innovation and ecological intensification.

This work followed the case study design (Yin, 2013) to analyze the CoP formed by the actors of the NG-based sustainable livestock farming niche in Uruguay (Aguerre & Bianco, 2023).

The approach was qualitative and aimed at understanding the practical implementation of co-innovation, based on the perspectives of the actors involved (Corbetta, 2007), in order to characterize this as an intervention model for farm technical assistance and contribute to the design of a sustained intervention strategy that would significantly increase the number of farmers involved. This initiative proceeds from the immersion of one of the authors in several of the research projects mentioned and was conducted after their completion.

The inquiry started with the exploration and systematization of documents generated by the different projects in order to contextualize the process and participant actors. Afterwards, 20 qualified informants were interviewed, taking into consideration the variety of actors involved in the CoP: 8 researchers, 6 extensionists, 5 farmers and 1 actor who participated in strategic activities designed with a broader scope than just the work at the farm level in the projects. The selection of informants aimed at having all projects represented at least by two interviewees, giving priority to those who had participated in more than one project, in order to capitalize on their experience.

The interviews had a semi-structured format (Corbetta, 2007), were conducted in person, with 14 men and 6 women, between September 2019 and March 2020. The interview guide aimed at knowing about the informants' link with and role within the projects of the CoP, obtaining detailed descriptions of the activities carried out specially in the farms, identifying interactions among the members of the CoP and their objectives, spotting improvement opportunities and aspects to be strengthened in relation to the practice of co-innovation. The interviews were recorded and then transcribed for later analysis using the MAXQDA software.

The transcripts were subject to an iterative reading process to identify passages relevant to the objectives of the analysis, and an inductive coding was performed (Miles & Huberman, 1994). The general dimensions defined included: characteristics of co-innovation as an intervention model for farm technical assistance; implementation practices on farms; links between families and extensionists; and lessons learned. These dimensions are presented in the Results and Discussion section and exemplified with fragments of the interviews made, stating their number (Ix) and Informant category (Researchers: R; Extensionists: E; Farmers: F).

4. Results and Discussion

The background information gathered and the stories of interviewees from experiences in CoP projects, allow us to identify key elements for understanding co-innovation as an intervention modality for farm technical assistance. In the following sections, we will go deeper into these key elements, and into some lessons learned from the experience, which are discussed taking into account relevant bibliographic background.

4.1. General Characteristics of Co-innovation

The most relevant general characteristics to describe co-innovation as an intervention model are presented below and summarized in Table 1.

Co-innovation aims at fostering changes that improve the sustainability of the productive system. As a researcher states, *"a technician visiting a farm has to generate positive change, it is not just about accompanying, but about making proposals and trying that the farmer may change and get better"* (I4-R). The other characteristics implemented by extensionists are derived from this premise.

The main objective of the extensionists' work is to help the farmer and their family achieve their goals, not by executing a preconceived plan, but by guiding the actions that help them achieve such goals and discouraging actions that may represent a threat: *"It is about helping the other person do what they want to do, not about them doing what you want them to do. Because all the farmer wants is to live their life and, what you have to do is to guide them, and if you have to put a stop, you have to put a stop and say* no [...]. *If you do that, in five years you'll have no soil"*(I1-E). Thus, it is necessary to implement *"an approach to the farm as a whole and not by product or discipline"* (I1-E) and to elaborate it in the experience with the farmer: *"This holistic approach starts by helping farmers learn what to look at and how to look at it"* (I9-R).

Additionally, the knowledge dialog (Méndez Sastoque, 2020) appears as essential in the CoP, articulating and valuing both the scientific-technical knowledge and the know-how or practical knowledge of families. From a technician's point of view: *"I think that if you establish a relationship with the farmers from an equality perspective, acknowledging that there are certain things that you don't know and you can learn from them, they'll be more receptive"* (I2-E). And, from the farmers' perspective: *"Sometimes we had ideas and other times they did, and we came to agreements together"* (I17-F). This process is seen as *"a way to exchange and learn, and maybe the two of us will learn"*(I14-F). Inevitably, the time horizon of the intervention requires to go beyond the usual immediacy that characterizes one-off technical advice to address specific situations: *"That the farmer may see the technician with another role other than the usual one* [...]. *Starting to play with longer-term planning tools, different from the more immediately of the traditional relation, which is the application of agrochemicals or immediate management practices"* (I1-E).

Table 1. General characteristics of the co-innovation implemented by the CoP.

✓ Orientation: generating change to improve the sustainability of the productive system.
✓ Purpose: contributing to the family achieving their goals.
✓ Approach: the farm as a whole, systemic and sustainability-centered approach.
✓ Communication: knowledge exchange articulating the technician's scientific-technical knowledge with the family's practical knowledge.
✓ Time horizon: medium/long-term planning.

Thus, co-innovation aligns with alternative extension approaches, with a dialogic approach for technical assistance at farm level. The importance of building on the knowledge and experience of farmers and establishing horizontal, interactive and co-construction relationships between extensionists and farmers is to be highlighted, for it allows for targeting contextualized problems (Méndez Sastoque, 2020).

4.2. Work stages and practices

The co-innovation implementation process lasts several years and includes different stages such as characterization and diagnosis, redesign proposal and implementation, monitoring and adjustment. These stages overlap, but each of them aims at generating specific results which have to be achieved in order to make progress.

The extensionist's visit to the farm is the key moment that nurtures the co-innovation process and allows the interaction with the farmer and the family. The frequency of visits varies according to the production system; livestock systems receive visits on a monthly basis. Interviewees underline the necessity of preparing for each visit to the farm. This involves: defining a clear objective, reviewing the outcomes of the previous visit, generating feedback for the producer

if necessary, and identifying strategic productive situations to be analyzed. At the end of each visit, it is important to make a summary, agree upon an action plan and dedicate some free time to share with the family. After each visit, the information generated has to be processed, systematized, and integrated with previous information. This is an important input for planning the following stage, and so forth.

The following three sections show the practices employed by the CoP to implement the work stages.

4.2.1. Characterization and diagnosis

This first stage of the process has two relevant working lines. The first one focuses on creating information to understand each production system; the second one focuses on building trust and mutual understanding between the family and the extensionist. Both are essential and nurture each other to go through the process of changer. The main aspects of this stage are detailed below and are summarized in Table 2.

To understand the production system, it is necessary to know the family's goals, understand the structure, operation, and results of their farm; also, to identify and agree on positive aspects and aspects to be improved. As stated by an extensionist: *"Trying to learn as quickly and precisely as possible how the farm works, the previous results of the farm and how the farmer used to think* [...] *seeing the general coherence of the productive system taking the farmer as part of it, that is, what the farmer expected from the farm and what was actually being done to reach this goal"* (I8-E)

In general, for family farms, their production is their livelihood and there are additional objectives than only increasing production and income which have to be inquired about and detailed so as to be taken into consideration in every change proposal. Several families mentioned the need to have free time and to reduce the workload was as important as their income, or even more. Therefore, from the beginning of the work, it is essential to involve all family members who participate in the decision-making process: *"Working together with the farmer and with the core team making decisions"* (I10-R). In order to learn, the extensionist tries to *"see much, ask many questions, listen a lot and give few opinions at the beginning"* (I8-E).

Information is essential in order to know the starting point and identify improvement areas. It is necessary to retrospectively reconstruct the information to be able to quantify the farm's functioning and results. It is critical *"to move to numbers,* [...] *if they knew how much money they were making, and if they didn't, to estimate together how much money they had made in the past, or how much money their system made in that operating logic"* (I8-E). For this purpose, all available sources of information are used (notes, notebooks, receipts, affidavits, calendars, records). In case of information gaps, estimations are suggested to obtain numbers as accurate as possible.

It is also important to go to the field together and comparing the farmer's view with the technical view: *"You had to go out to the field and look, because you have what the farmer says and what you see in the field with your own technical experience and studies, and then you have to start distinguishing between what the farmer says and what you are seeing"* (E11-E). In order to align points of view, it is important to identify and unify the reference parameters for each situation and to highlight potentialities: *"Farmers tell you 'I'm doing pretty fine', but they are comparing themselves to their own previous year performance, or to his neighbor's who is having terrible results. And they don't think where they can get with what they already have"* (I9-R).

Some useful strategies presented by the technicians include describing and comparing different situations in the same farm: *"Exemplifying that if you make things as they are in this pasture or in this category, and you replicate it in the whole farm, you will have this much grass production, this much animal production"* (I8-E). Similarly, by identifying the elements that determine the productive result and making tests by changing the values of the indicators, in order to identify how each one of them affect the final result, problems can be better assessed: *"Identifying what would happen if I changed some of the indicators, for example, increasing the number and/or weight of the calves produced* [...], *what I can correct to get a different result"* (I8-E).

Once the areas for improvement have been identified and prioritized, a fundamental aspect is to look for causal relationships in order to picture possible solution paths and move on to the next stage of proposal development. From this perspective, a practical tool was the preparation of problem trees and their discussion with the family: *"Thinking in terms of connections among all the problems we identified* [...], *thinking in terms of causal relationships and of the things we can handle in order to improve"* (I9-R).

Meanwhile, the trust bond between the family and the extensionist is nurtured by the frequency of the visits and by the mere fact of *"complying with what we said we'd do* [...] *and part of complying is going when we said we would go, and letting them know if we're not going"* (I9-R). It is necessary to connect and empathizing with the family: *"Taking into account and be aware of the situations that concern the farmer"* and *"sharing time beyond work, having lunch together, sharing family stories, showing interest for what the other people feel and think. This creates a relationship that enables other types of technical discussions later"* (I13-E).

In addition, a key tool for generating trust mentioned by the technicians for the early stages of the process, is to make recommendations that have quick positive impacts on specific results, *"with simple things or recommendations you can have good results immediately or almost immediately, this makes the farmer change their idea of you as a technician and start paying attention to you.* [...] *As we made the characterization and diagnosis, or prepared a proposal, some of which took quite a long time, we were also performing a more traditional advising role. It wasn't like you went there, took information, and then came back with a diagnosis and then with the proposal"* (I2-E).

Clearly, the diagnosis begins on the first day, but at some point, it is necessary to make a synthesis, draw a line and agree on the farm's situation. Thus, *"it's not that you come to the moment of discussion and agreement with the farmer from scratch and with everything being new. No, it's something that you are already discussing and what you're going to discuss that day is almost obvious"* (I9-R). It is very important "*to have a specific moment for that and then generating a discussion and an agreement or disagreement space, but also discussion and update"* (I9-R) Preparing for this moment requires the elaboration of specific support materials as foundations for the exchange. Although there is usually a visit to the farm planned with that specific goal, it is a continuous process and the rhythm of stages differ from one family to another, *"it's not a two-hour meeting that we start and finish, we have to start, take the necessary time for each of us to think about and process the information, and then we sit down together to discuss everything again"* (I9-R). All in all, the resulting product of this stage is an agreement between the family and the extensionist about the strengths and weaknesses of the system, which will be the starting point to move to the next stage.

Table 2. Main aspects of the characterization and diagnosis implemented in the CoP.

Objective/ Products	✓ Knowing the family objectives. ✓ Knowing the structure, operation and results of the production system. ✓ Identifying and agreeing on strengths and weaknesses. ✓ Building trust between the family and the extensionist.
Strategies to build the necessary evidence	✓ Watching much, asking many questions, listening a lot and giving few opinions at the beginning. ✓ Integrating the whole decision-making team in the process. ✓ Inquiring about family goals considering production as their livelihood. ✓ Quantifying the operation and results of the farm within a 3-year retrospective period. ✓ If there is any information gap, applying competent estimation criteria. ✓ Identifying improvement areas: • Aligning reference parameters and comparing them with the achievable objective. • Identifying well-performed tasks that are not generalized. • Identifying what happens if some indicators are changed. ✓ Check coherence between what they expected from their farm and what they were actually doing. ✓ Creating problem trees, prioritizing and identifying causal relationships. ✓ Discussing and agreeing on the diagnosis. • Preparing support materials for the discussion. • Respecting each family's own rhythms in order to achieve mutual understanding.
Strategies to develop mutual understanding and trust	✓ Continuity of the visits. ✓ Sharing time beyond work. Showing interest for the family and what they are going through. ✓ Taking the farmer's interests into account, beyond the visit plan. ✓ Making recommendations that show almost immediate results and generate family trust towards the technician, allowing him/her to make recommendations with long-term results.

4.2.2 Redesign proposals

The redesign proposal is a goal for the future in relation to the farm's structure, operation and results. It aims at improving the farm's performance using the resources the families have, and its technical basis is ecological intensification. However, it is important that proposals focus on the goals set by each family. Therefore, *"it was case by case* [...], *we had all the technical part and then the part that the farmer wanted"* (I4-R). The main aspects for its preparation are developed below and summarized in Table 3.

Usually, what the technician tries to do is *"motivating farmers by trying to make them understand better what they do, thinking of different ways of doing this, and adding quantitative and qualitative technical elements about the way to do this. But, in the end, it all comes down to the motivation process, to be different, to innovate"* (I8-E). Preparation is a process that develops by successive approximation: *"It is not about going to the office with the diagnosis ready, thinking of the redesign and preparing the proposal. This doesn't work"* (I9-R).

Departing from the aspects for improvement identified in the diagnosis and their causes, solution paths and change strategies are identified: *"Usually a little or a lot of the results were improvable, and then almost immediately you started discussing what does improvement mean, what are the implications of changing to improve, thinking if it's worth it"* (I8-E). In this regard, as one of the researcher states, *"the most important thing when redesigning is setting priorities for the problems"* (I10-R).

Thus begins the technical work of generating possible scenarios for change and quantifying their results, which is discussed and worked together with the family *"until we get to a point when we make a choice, we come to an agreement about the general strategies, the big things we are going to move, that's when we get going and think it through, we prepare a formal proposal"* (I9-R). Depending on the agreed change strategy, a single or several redesign proposals are developed, *"on the one hand, they should have an assessment of the productive result, and on the other hand, making sure that we are not increasing cost or investment, nor labor, we want to rest assured that we are not generating a problem"* (I9-R).

Also, an implementation plan has to be designed: *"The proposal has to have sorted out how we depart from where we're standing to get to the goal* [...], *you have to walk with your path or your steps planned* [...] *otherwise, you'll end up the proposal is not consistent, because it's seen as a far away and sometimes scary thing"* (I9-R) The redesign stage itself ends with the elaboration of the schedule, establishing what we are going to do, how and when.

The redesign that is finally decided to be implemented is the result of a formal discussion and agreement with the family. It is useful to manage a few options and incorporate suggestions from the family so as to appropriately ground it to what they are willing to implement: *"There was a sort of negotiation there, maybe from the proposals A, B and C presented by the technician, A was not accepted, nor were B or C, and there was maybe a D proposal created as a mix of all of them"* (I4-R). In this moment it is also important to give time to process information, offering a clear explanation of the different options and analyzing them together for as long as it takes for each family. In order to build trust, motivate change and achieve the necessary agreement, the idea that the extensionist will be supporting the implementation of the agreed changes with regular visits during a reasonable period of work to achieve the goals needs to be emphasized: *"so... about this issue... great... but are going to be there? I will change. Who is going to be with me along this change? To keep a perspective and sustaining mid-term work with those technicians that are already working is essential, otherwise the process is cut short"* (I9-I).

Table 3. Main aspects of the preparation of redesign proposals implemented in the CoP.

Objective/ Products	✓ Agreeing on a future goal (3 years) regarding farm structure, operation and results. ✓ Agreeing on an implementation plan to achieve this goal.
Strategies to prepare a redesign proposal	✓ Challenging the family to imagine something different and better for the farm. ✓ Ecological intensification as technical base; needs adaptation to each case. ✓ Working with successive approximation. ✓ Beginning with the improvement areas and causes found in the problem tree to identify possible solution paths. ✓ Building different "virtual" scenarios to discuss possibilities. ✓ Agreeing on general change strategies. ✓ Preparing one or several redesign proposals. Assessing expected results, costs, and labor. ✓ Creating a transition plan from the current situation to the target situation of the proposal. ✓ Preparing a schedule of future tasks. ✓ Discussing and agreeing on the redesign to be implemented. • Preparing support materials for the discussion. • Respecting each family's own rhythms in order to achieve mutual understanding. • Bearing in mind the importance of frequent extensionist visits during the implementation. • Ensuring reasonable terms to comply with the goals (2 to 3 years).

4.2.3 Implementation, monitoring and adjustment

The essence of this stage is to accompany the implementation of the agreed redesign, according to the calendar of activities defined. At the same time, the evolution of the system is monitored based on indicators, so as to support decision making and allowing for evaluating the implementation of the plan, as well as to make the necessary changes or adjustments. The main aspects of this stage are detailed below and summarized in Table 4.

While the implementation of changes begins earlier in the process, once the redesign proposal and an overall implementation plan have been agreed upon, the role of the technician is *"to prioritize what we said we should prioritize, and then be burdened by the daily stuff and end up not paying attention to the things we had defined as important"* (I9-R). It is also important to take into consideration the farmer's specific and current needs *"having that double view over the daily routine, but always trying to dedicate some time during the visit to check where we're standing and where we were heading to"* (I9-R).

Throughout the process and due to different reasons, it is common that measures that were agreed upon are not implemented. In this situation, the technicians' role is to contribute to the systemic vision and the hierarchical vision, to identify the things that have an actual impact: *"Having a hierarchical vision of the things or measures to be taken as soon as possible, this month or the next one, which are extremely vital* [...]. *There are certain measures that have to be fought for, in the good sense of the word, in order to achieve them"* (I8-E). It is pointless to confront things that do not have an impact on the final goal, but it is important to highlight those that are most relevant to achieve it. In these cases, the recommendation is *"not beating ourselves up for or crying over the things what we didn't do, but looking ahead"* (I8-E); giving reasons to convince about changing, quantifying the impact on the system caused by the lack of implementation of a particular strategic measure. In this regard, a farmer states: *"The necessary trust to be able to take these steps* [...] *I took it from the information and support provided by the field technicians* [...] *and numbers speak for themselves, the results set the course"* (I19- F).

In addition to implementation support, monitoring and evaluation of the process have to be conducted at this stage. The work on farms requires the measurement of quantitative and qualitative indicators considering productive-economic, as well as environmental and social aspects, selected for each specific context. These aspects are evaluated in terms of process, analyzing the initial situation and its progress over time. This allows for evaluating the implementation of the redesign plan, and to determine whether goals and results have been fulfilled or not. It is necessary to share these results with farmers in frequent instances of assessment and reflection, such as the end of an agricultural exercise or the evaluation of the annual work plan, in order to nurture learning processes. Additionally, fit is intended that farmers learn to identify key moments to make decisions and aspects (indicators) to be observed and monitored for that purpose: *"I know when to make a decision* [...], *I manage the information to make decisions* [...], *I manage the farm, everything as a whole* [...], *looking at the grass, looking at the cows, looking at the economic part"* (I16-F).

This monitoring and evaluation of the process leads to adjustments in the designed plan, which must be flexible. In some cases, such adjustments are derived from short-term operational or financial issues, as reported by one farmer: *"We adjusted some things on the fly. Sometimes, because of cost issues, or because we couldn't do some sowing or something, or maybe because of the purchase of a bull we had to make, costs were added up. Some things changed..., we were not tied to the project, it was flexible"* (I17-F). In other longer-term cases, readjustments to the initial redesign were necessary, for instance, based on changes in land tenure: *"Some*

with leased areas, so, one area was handed over or another was taken, and then we had to try and adjust things so that we could keep the same results" (I11-E).

Table 4. Main aspects of implementation, monitoring and adjustments implemented by the CoP.

Objective/ Products	✓ Accompanying the implementation of the redesign agreed upon, following the set activity schedule. ✓ Monitoring system evolution. ✓ Implementing adjustments and changes as necessary. ✓ Implementation of changes begins as from the earliest visits.
Follow-up strategies for the implementation of changes.	✓ Prioritizing strategic and long-term planning. ✓ Considering the producer's demands and their day-to-day focus. ✓ Maintaining a systemic and hierarchical focus in order to promote the implementation of the agreed upon strategies. Confront on important matters. ✓ Not complaining about undone things, moving forward and justifying the impact or cost of not having made those strategic changes. ✓ Insisting and following cases closely, beyond farm visits. ✓ Monitoring indicators (economic-productive, environmental, and social). ✓ Frequent assessment and reflection instances, for instance, closure of agricultural exercise, annual work planning. ✓ Training producers in identifying key decision-making moments, as well as which aspects to consider and monitor for decision-making. ✓ Becoming flexible and make the necessary adjustments, adapting to operative and family contexts.

4.2.4. Remarks on the work in farms

The results shared previously show that the implementation of co-innovation as a modality of farm technical assistance is not only a participative approach, but it also requires working with an adaptive systems vision of the production systems, which not only includes productive resources, but also the management system, made up of people who have the ability to learn and change. To this end, monitoring and assessment activities are designed and implemented throughout the whole process, with the aim of fostering learning and adaptation. This is consistent with its definition based on three areas: complex adaptative systems, social learning, and monitoring and assessment (Aguerre & Bianco, 2023; Rossing et al., 2021; Albicette et al., 2017; Dogliotti et al., 2014).

Farm technical assistance under co-innovation is based on the interaction between the family and the extension agent. In this interaction, knowledge dynamics are essential. With this approach, learning and knowledge are the result of an active construction process, in which horizontal exchange and dialog seek to build a collective construction of meaning used to cognitive and emotionally understand the world around us and act upon it (Long, 2001). In this process, knowledge from both the extensionist and the family are combined, and technical knowledge is aimed to help the family build a new focus and framework on the system's problems, design of solutions and their implementation. To this end, deep reciprocal understanding is needed, with real participation not only including families when it comes to deciding which problems to address, but also influencing their focus on such problems, design of solutions and assessment of results. In this context, according to Landini (2016a), a fair disagreement does not seem to be a setback, but rather a way of producing innovations that jointly include scientific knowledge and the experiences, contexts and logics of farmers; differences become opportunities for innovation.

During the characterization and diagnosis stage, the family commits to providing information on the production system, their practical experience and related knowledge, while the extensionist

brings technical knowledge to quantify initial results, assess reachable results and, in virtue of the family's objectives, provide a new framework to address the system's problems. In the elaboration of redesign proposals, the family outlines their objectives and available resources, and provides their practical experience and knowledge of the production system, whereas the extensionist brings technical proposals and alternative management to build an option suiting the specificities of the farm. During the implementation, the technician's role is to enable that the agreed upon strategic changes are put into practice, to provide evidence and support it with arguments. When changes are not implemented, it is necessary to reconsider whether the original plan is adequate or needs adjustments to move forward; flexibility to accompany changes in the context is key. The joint analysis of results by technicians and families, identifying the right times and key elements to make decisions, allows building learning processes that will foster the sustainability of changes.

This kind of approach is recommended for the construction of demand in extension processes (Landini, 2016b), and specifically for family farmers, as it allows for negotiating and designing agreed upon strategies which are compatible with the context they arise from (Méndez Sastoque, 2020). In this view, co-innovation may help improve certain extension problems pointed out by Rodríguez-Espinosa et al. (2016) related to the design of services with a top-down approach, agreeing on needs and developing capacities among family members to give sustainability to the process.

We are interested in pointing out that, as an intervention modality for farm technical assistance, co-innovation has in its essence the elaboration of redesign proposals and the support of their implementation. Redesign is technically based on ecologically intensification of livestock farming, which leads to a radical change of the dominant overgrazing situation. Proposals are built based on identifying the causes behind the system's performance and whether or not the system meets the family's objectives. Agreeing on the redesign proposal and accompaniment its implementation are key to achieving the production system transformation, and require at least 3 to 4-year work to achieve the desired improvement.

All things considered, it is obvious that this modality requires a very special bond between the extensionist and the family and, therefore, a special profile of those carrying out the tasks. These aspects are developed in the following section.

4.3. Characteristics of the family-extensionist bond and outline of the profile required for the extensionist

The family and the extensionist working in co-innovation develop a horizontal bond that is developed during the process. The technician's perspective acknowledges the need of genuinely including the other party in an active way: *"A technician who doesn't believe the other person* [the farmer] *is their peer or doesn't feel this way, will have a hard time putting this approach in motion, even though they are told how to do it and everything is sorted out to work out this way"* (I2-E). The farmers' perspective highlights the role of the technician: *"A person open-minded, flexible, with a lot of psychology to understand the farmer and never remove him from his place because it is his money, his business, give him the place that belongs to him, no matter how much he tells him, 'if I were in your place, I would do such a thing, I would do this', but always maintaining that place. It seems much more important to me than what he knows as a technician."* (I16-F).

In order to achieve changes, a two-way exchange is essential to reach agreements. As mentioned, the family's background and knowledge are also highly valued: *"And you have*

to negotiate. The product has to be attained, and if the other one [the farmer] *doesn't let you move forward, you* [as a technician] *also have to rethink whether what you are proposing is adaptable or of interest to him."* (I1-E).

Constant commitment is required on both parties in order to nurture this relationship and go along the stages of the process, as producers explain: *"She* [the extensionist] *has always been there for us, rain or shine, we know she'll show up. She's really committed, she'll call us, ask us"* (I14-F). Besides: *"The farmer plays a crucial part and the degree of commitment and attitude are key, even Superman won't work with a guy who's not interested or keen* [...] *or do in one day* [on technical visit] *what you failed to do over the entire past month [...],in that month the farmer has to continue working"* (I17-F).

From the technician's point of view, this shows they cannot impose their knowledge: *"You can't just show up with your truth or with knowledge which is on another level and all the answers from out there* [...], *it just won't work"* (I2-E). Practical, applied knowledge is required: "*But not an overuse of this technical knowledge, because if he starts talking to you all the time about grass or legume or whatever, and takes you away from reality and takes you to a more theoretical world that the farmer doesn't handle that well, I thinkthat is not the way.""* (I16-F).

The extensionist needs to develop empathy towards the process and the people involved. Warmth and closeness are key, as well as developing an open rapport which enables varied communication ways: "*She would even give us a call [...] and we´d also tell her about our technical doubts on the phone"* (I17-F).

Under this model, the extensionist focuses on learning, that is why "*the interaction with the farmers has to be formative, one of sharing experiences and information"* (I2-E); it is crucial to discuss and exchange based on arguments, and to this end it is very useful to quantify and show concrete examples from their own farm. One of the technicians points out that *"you need to go over and over the main concepts again, visit after visit. Because you tell them and they nod and say 'yes', and they do understand it right then and there, but it doesn't really sink in so, one thing is saying 'yes', understanding it, but really incorporating it is another story. So, we repeat, insist on the big guidelines, time and again in different situations. On the field you'll see something and go 'see this?' and link it to something important you'd say before and use to insist on those things"* (I18-E). It is also necessary to acknowledge the experience and information farmers have and incorporate them into the proposals and recommendations. For instance: *"There are plots you need to handle with more grass, because their quality is not as good as the other one. So, you need to keep an eye on that one and not saturate it with too many animals. But I know the ropes, I handle those things"* (I17-F).

There is a key attitudinal skill in field technicians consisting in the ability to motivate and persuade in order to generate change. *"Certain features of the technician concern their attitude but also have to do with this, with how they go about work, because it's not about imposing yourself here, but to dialogue and coming to agreements* [...], *but on the other hand, it's odd because, it's not about letting the farmer do whatever they want either because, then, the necessary changes are not achieved* [...] *It's like a game, you know, you need to be flexible but also to get firm when things hot up"* (I4-R).

In the light of the results presented before, it becomes obvious that, in order to implement co-innovation, extensionists are required to have a systemic vision, solid technical expertise and a set of relational skills. In this sense, individuals who have implemented co-innovation reflect on the importance of these relational skills: *"In order to work this way you need no super-technicians, you need soundness. But most of all, you need attitude and skills that have little to do with agricultural education, that won't give you the tools you need"* (I2-E).

These results show that the co-innovation approach integrates various types of knowledge and demands a horizontal bond between the extensionist and the farmers, enabling learning and fostering the change in usual forms of, in line with propositions by Méndez Sastoque (2020), Hansen et al. (2018), Ingram (2008) and Alemany & Sevilla-Guzmán (2006) on the imprint of alternative approaches to extension.

The described characteristics of this bond coincide with the type of relationship deemed effective so as to promote change towards more sustainable production practices (Ingram, 2008). Attitudes and abilities to relate to people are considered essential for an extension practice that understands farmers and their contexts, developing horizontal, productive and dynamic interactions, based on mutual trust and respect (Landini, 2016a). In other words, evidence on this CoP shows that relational skills are as significant for providing quality extension as technical knowledge, as suggested by authors analyzing extension experiences (Hansen et al., 2018; Ortiz Dardón et al., 2011; Koutsouris, 2008; Swanson, 2008; Leeuwis, 2000). Bearing in mind the nature of the relationship to be established, Table 5 outlines the main aspects of the profile required from extensionists working on co-innovation.

Table 5. Profile of extensionists to work with co-innovation.

Attitude:
✓ Willing to work with a horizontal, interactive focus and motivation to overcome and learn from difficulties.
Relational skills:
✓ Establishing horizontal relationship with the family.
✓ Valuing the family's background and knowledge.
✓ Reaching agreements and consensus through dialog.
✓ Fostering learning.
✓ Building personal and technical trust with the family.
✓ Working with commitment and get involved.
✓ Empathizing, warmth, closeness in dealing with the family.
✓ Ability to motivate and persuade to generate change.
✓ Teamwork.
Technical skills:
✓ Systemic vision and solid technical expertise. Problem hierarchy.
✓ Adaptable and flexible regarding the family's objectives and their context.
✓ Good command of technology aligned with ecological intensification.
✓ Transmit practical and applied knowledge.

4.4. Some lessons emerging from the CoP

The interviews conducted show some difficulties resulting from the poor training of the extensionists working in co-innovation and ecological intensification: *"Technicians are far from well-prepared to quickly get down to working on this"* (I10-R). The extensionists themselves acknowledge this weakness: *"Our training is very limited... I think our training is aimed at something else, and reality out there is different"* (I11-E). In this sense, the interviewees agree that putting the systemic vision into practice and hierarchize problems was not easy: *"Extensionists had a really rough time grasping the system's working and trying to represent it quantitatively and qualitatively"* (I8-E). They also identify some difficulties in terms of their relational skills: *"For me, it was the hardest thing, for instance, show them the problems or limitations they were having and suggest for each limitation what was the proposal I had, that seemed to me*

could resolve that situation, and based on that talk with them, if they agreed, if they saw that they were going to be able to achieve it or not, and then make the adjustments that had to be made based on what they agreed to do or not" (I11-E). Besides, they mentioned that there is a component of training that is practice and it is developed with experience: *"You learn the ropes on the go. University prepares you up to a point, all the rest is hands-on"* (I2-E).

In general, experience within the CoP shows some difficulties in establishing an appropriate rapport between the family and the extension agent, arising not only from the extensionists' relational and communicational skills, but also from their poor quantitative systemic training, leading occasionally to poor or inappropriate technical feedback and technological proposals.

These difficulties around the extensionists' training correspond with the weakness in Latin America's university degrees in rural extension reported by Landini (2020): weaknesses in methodology and in the ability to relate to farmers; lack of practical training; a tendency to oversimplify complex agroecosystems, ignoring the role that social factors play. In this line, Rodríguez-Espinosa et al. (2016) describe universities have an insufficient offer of rural extension programs for undergraduates, and state and private institutions do not have continuous training programs for their extension workers regarding technical and methodological aspects. Another relevant factor is the predominance of the diffusionist approach in Uruguay; despite some institutional efforts made to integrate the technical-productive and the social aspects towards a more participative practice, said strategies have not been assessed and the corresponding programs have not been maintained in time (De Hegedüs & Pauletti, 2022; Landini & Riet, 2015).

All in all, in order to help transform family livestock farming in Uruguay based on co-innovation for farm technical assistance, it is crucial to consider the existing gap between the actual extensionists' training and experience, and the ideal conditions required in order to successfully implement this intervention modality. This leads us to conclude there is a need to change and improve the extensionists' practice, thus outlining new roles, experimenting with new identities, and validating new work practices (Nettle et al., 2018). In this sense, the difficulties found coincide with the need for a better training pointed out by Méndez Sastoque & Giraldo Restrepo (2022) when it comes to establishing a kind of dialogic extension between farmers and extensionists, which requires incorporating effective communication for practice in context and for interdisciplinary and integral assistance Shifting towards alternative models generates demand for training from Uruguayan extensionists, not only on a "technical-productive" level and on "managing natural resources", but also including "methodologies in rural extension and technical assistance" (Areosa et al., 2015; Ferreira & Rossi, 2015).

The strategy developed in the CoP to deal with this weakness was the conformation of a team to support their work, with a low presence in the field, but which indirectly nourished the interventions. This team was comprised of researchers from diverse disciplines (plant production, animal production, soil science, environmental impact assessment and, more specifically, social science) involved with economic-productive as well as environmental and social aspects: *"In these co-innovation projects, it is key who is the interface with the farmer, the technician who is the reference for the farmers does a lot to the thing... If that works, it works, and if that doesn't work, it doesn't work. And I say interface because it is not only the relationship of that technician with the farmer, but of that technician with the rest of the team, how he capitalizes on having a group of people with different specialties to rely on, what is that support like, the interaction and the alignment with the strategy to make it"* (I5-R). In this sense, the CoP nurtured from this interdisciplinary dialog, which generated a group capable of co-producing answers to the concerns of the extension workers. This strategy coincides with the recommendations of interdisciplinary work in extension teams (Ortiz Dardón et al., 2011;

Landini, 2016a; Lybaert et al., 2022). An opportunity for improvement regarding interdisciplinary work would be strengthening the social areas, mainly in order to train and support extensionists concerning their social and relational skills and also to contribute to a better understanding of the productive rationale of the familys.

This support to extensionists implemented within the CoP initially consisted of an integral training, which then gave place to accompaniment and support of their work: *"Hiring young people, no matter their experience, but their willingness. Carrying out a good initial training and intense accompaniment* [...]. *I would balance experience differently with attitude and ability, mainly attitude* [...]. *And add some good tools and good tutoring, work protocols and information processing"* (I8-E). Training included relational skills and co-innovation methodologies as well as technical content on systemic vision and ecological intensification in livestock farming systems. Follow-up and support of the extensionists' work was based on strategies summarized in Table 6.

Table 6. Strategies used to support extensionists.

✓ Initial integral training.
✓ Design of guidelines for the observation and collection of information in the farms.
✓ Definition of registration protocols and processing of farms information.
✓ Development of quantitative tools to implement calculations and facilitate their interpretation.
✓ Development of simulation models to support decision making.
✓ Meetings to discuss about specific farms: diagnoses, redesign proposals, specific problems.
✓ Accompanying of the support team during farm visits.
✓ Ateneos on relevant technical subjects.
Permanent contact and inquiries by email and WhatsApp.

The CoP recommends planning the interaction between extensionists and their support team. "*I think collective instances require much attention and planning* [...] *the fact that someone is thinking about how to generate a team seems central to me"* (I9-R). In this sense, we need to consider that: *"it takes time and work to consolidate a team which is interdisciplinary and interinstitutional, consisting of people with different backgrounds, and that it really works properly"* (I10-R). For this reason, it is also important the time horizon of the work and have medium/long-term processes for the joint work. It must be considered that meeting and interaction spaces are real spaces of practice to integrate knowledge and generate complex ways of understanding reality. If they are complemented with the exchange of experiences and reflective spaces, they are excellent tools to develop capacities in extension workers, as proposed by Gorman (2019), Landini & Brites (2018), and Landini et al. (2017).

We consider that an integral support team that accompanies the extensionists' in the territory is an extremely relevant aspect to bear in mind when it comes the proposal of co-innovation as an intervention modality of farm technical assistance. Based on the CoP experience and considering the relevance and validity of think creatively about the link between research and extension (Conti et al., 2024), we propose that interdisciplinary has a role to play. Therefore, it is imperative to advance in the promotion of interdisciplinary research and extension in universities and research centers.

5. Conclusions

Co-innovation is a collaborative process of interaction and learning between actors of different backgrounds, experiences, and perspectives, in which the relationship between families and extensionists is essential for the innovation towards sustainable production systems. In this

work we set out to examine co-innovation as a modality of intervention for farm technical assistance oriented to a ST of Uruguayan family livestock farming systems.

Based on the experience of a CoP with more than 15 years of work in co-innovation and ecological intensification, with the common aim of improving the sustainability of the family production and that shares the repertoire of ways of thinking and doing things, the key aspects of co-innovation as an intervention modality for farm technical assistance were characterized.

From the results obtained and discussed in the previous sections, we point out a set of aspects we consider crucial for scaling co-innovation and contribute to a ST in family livestock farming in Uruguay:

Interventions aim to promote changes in order to improve the sustainability of the production systems and the achievement of the family's objectives. To this end, we work with a systemic approach, oriented towards planning with a medium/long-term perspective and with execution periods of 4 to 5 years. Horizontal communication is required between the extensionist and the family, combining technical knowledge and the farmers' experiences.

It is necessary to build an interdisciplinary work team contemplating the diversity of relevant institutions on the subject, integrated by extension agents working directly on farms together with support team that includes specialists in the economic-productive, environmental, and social areas.

It is essential to have extensionists with a positive attitude towards dialogic approaches, trained in relational skills, systemic vision, and technical knowledge of productive systems.

It is necessary to dedicate an initial time to assembling and promoting the team, aligning it with the technical strategy and way of working and allocating time to comprehensive initial training of extensionists.

Field work is based on monthly farm visits by the extensionists, following the stages of characterization and diagnosis, redesign proposal and implementation, monitoring and adjustments. Practices need to be adapted to each particular productive and family context, considering the CoP experience.

Simultaneously, it is necessary to design and implement a monitor and support system of extensionists' work through interaction with an interdisciplinary and interinstitutional work team.

Results show that the process requires an intervention plan sustained in time and that it takes a quite intense family-extensionist rapport, which is why scaling should be gradual and cumulative.

Despite having gained vast experience, fundamentally in livestock farming systems, the CoP was originated from horticultural systems (Aguerre & Bianco, 2023) and is now taking over dairy systems (Centro Emmanuel, 2022), thus strengthening its versatility to operate in different systems. A key aspect to scale co-innovation is the CoP's expansion towards institutions playing specific roles in agricultural policy as well as in research, extension and organizations of farmers from different production systems. The challenge posed consists of being able to integrate and scale these experiences into virtuous dynamics in order to articulate with public policies and public and private actors, thus advancing towards a ST in family livestock farming in Uruguay.

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6. References

Aguerre, V., & Bianco, M. (2023). Co-innovation and socio-technological niche development: the case of livestock farming on natural grassland in Uruguay. *Journal of Rural Studies*, *97*, 81-94. http://doi.org/10.1016/j.jrurstud.2022.12.003

Albicette, M. M., Leoni, C., Ruggia, A., Scarlato, S., Blumetto, O., Albín, A., & Aguerre, V. (2017). Co-innovation in family-farming livestock systems in Rocha, Uruguay: a 3-year learning process. *Outlook on Agriculture*, *46*(2), 92-98. http://doi.org/10.1177/0030727017707407

Alemany, C. E., & Sevilla-Guzmán, E. (2006). ¿Vuelve la extensión rural? Reflexiones y propuestas agroecológicas vinculadas al retorno y fortalecimiento de la extensión rural en Latinoamérica. Acta Académica. Recuperado el 13 de octubre de 2023, de https://www.aacademica.org/eduardo.sevilla.guzman/20

Areosa, P., De Hegedüs, P., Ferreira, I., Fuster, F., Rossi, V., Morales, H., Teixeira, J., & Widmaier, G. (2015). Seminario Técnico sobre Extensión Rural y Asesoramiento Técnico (ATER) para la Producción Familiar (PF): principales conclusiones. *Revista Plan Agropecuario*, *156*, 24-28. Recuperado el 13 de octubre de 2023, de https://www.planagropecuario.org.uy/publicaciones/revista/R156/R_156_24.pdf

Berdegué, J. A. (2005). *Pro-poor innovation systems* (Background Paper). Rome: IFAD.

Botha, N., Klerkx, L., Small, B., & Turner, J. A. (2014). Lessons on Transdisciplinary Research in a Co-Innovation Programme in the New Zealand Agricultural Sector. *Outlook on Agriculture*, *43*(3), 219-223. http://doi.org/10.5367/oa.2014.0175

Botha, N., Turner, J. A., Fielke, S., & Klerkx, L. (2017). Using a co-innovation approach to support innovation and learning: cross-cutting observations from different settings and emergent issues. *Outlook on Agriculture*, *46*(2), 87-91. http://doi.org/10.1177/0030727017707403

Centro Emmanuel. (2022). *Caminos diversos hacia la Agroecología en sistemas lecheros.* Colonia, Uruguay. Recuperado el 13 de octubre de 2023, de https://centroemmanuel.org/wp-content/uploads/2022/09/Folleto-lecheria-agroecologia-Baja.pdf

Charatsari, C., & Lioutas, E. D. (2019). Is current agronomy ready to promote sustainable agriculture? Identifying key skills and competencies needed. *International Journal of Sustainable Development and World Ecology*, *26*(3), 232-241. http://doi.org/10.1080/13504509.2018.1536683

Chia, E., Testut, M., Figari, M., & Rossi, V. (2003). Comprender, dialogar, coproducir: reflexiones sobre el asesoramiento en el sector agropecuario. *Agrociencia Uruguay*, *7*(1), 77-91. Recuperado el 13 de octubre de 2023, de http://www.fagro.edu.uy/agrociencia/VOL7/1/p77-91.pdf

Christoplos, I. (2010). *Mobilizing the potential of rural and agricultural extension.* Rome: FAO. Recuperado el 13 de octubre de 2023, de https://www.fao.org/3/i1444e/i1444e.pdf

Colnago, P., Favretto, G., Carriquiry, M. E., Bianco, M., Carámbula, M., Cabrera, G., Rossing, W. A. H., & Dogliotti, S. (2023). ¿Cómo fomentar cambios hacia la sostenibilidad? Aprendizajes desde un proyecto de coinnovación en predios familiares hortícola-ganaderos de Uruguay. *Agrociencia Uruguay*, *27*, e1012. http://doi.org/10.31285/AGRO.27.1012

Conti, S., Villalba, A. E., & Landini, F. P. (2024). Vínculos entre investigación agropecuaria y extensión rural: factores clave y propuestas de abordaje desde una revisión sistemática de literatura. *Revista de Economia e Sociologia Rural*, *62*(1), e265087. http://doi.org/10.1590/1806-9479.2022.265087

Corbetta, P. (2007). *Metodología y técnicas de investigación social.* Madrid: McGraw Hill.

Coutts, J., White, T., Blackett, P., Rijswijk, K., Bewsell, D., Park, N., Turner, J. A., & Botha, N. (2017). Evaluating a space for co-innovation: Practical application of nine principles for co-innovation in five innovation projects. *Outlook on Agriculture*, *46*(2), 99-107. http://doi.org/10.1177/0030727017708453

De Hegedüs, P., & Pauletti, M. (2022). *Dinámicas de la información y el conocimiento: asistencia técnica y extensión rural en Uruguay desde la época colonial al presente.* Montevideo: Hemisferio Sur.

Dogliotti, S., García, M. C., Peluffo, S., Dieste, J. P., Pedemonte, A. J., Bacigalupe, G. F., Scarlato, M., Alliaume, F., Álvarez, J., Chiappe, M., & Rossing, W. A. H. (2014). Co-innovation of family farm systems: a systems approach to sustainable agriculture. *Agricultural Systems*, *126*, 76-86. http://doi.org/10.1016/j.agsy.2013.02.009

El Bilali, H. (2020). Transition heuristic frameworks in research on agro-food sustainability transitions. *Environment, Development and Sustainability*, *22*(3), 1693-1728. http://doi.org/10.1007/s10668-018-0290-0

Fals Borda, O., & Anisur Rahman, M. (1991). *Acción y conocimiento: cómo romper el monopolio con investigación-acción participativa.* Bogotá: CINEP.

Ferreira Rivaben, I., Rossi, V., Figari, M., & Chia, E. (2023). Identifying agroecological transition pathways based on the Global Approach to Agricultural Systems: the case of family livestock farmers in northern Uruguay. *Agrociencia Uruguay*, *27*, e1069. http://doi.org/10.31285/AGRO.27.1069

Ferreira, I., & Rossi, V. (2015). Construyendo una agenda de capacitación en metodologías de extensión rural en el litoral uruguayo. *Cangüé*, *33*, 23-29. Recuperado el 13 de octubre de 2023, de http://www.eemac.edu.uy/cangue/joomdocs/cangue_36/cangue_ferreira.pdf

Fielke, S. J., Nelson, T., Blackett, P., Bewsell, D., Bayne, K., Park, N., Rijswijk, K., & Small, B. (2017). Hitting the bullseye: Learning to become a reflexive monitor in New Zealand. *Outlook on Agriculture*, *46*(2), 117-124. http://doi.org/10.1177/0030727017708490

Figari, M., Rossi, V., & Nougué, M. (2002). Impacto de una metodología de asesoramiento técnico alternativo en sistemas de producción lechera familiar. *Agrociencia Uruguay*, *6*(2), 61-74.

Freire, P. (1973). ¿Extensión o comunicación? La concientización en el medio rural. México, D.F.: Siglo XXI.

Gaitán-Cremaschi, D., Klerkx, L., Duncan, J., Trienekens, J. H., Huenchuleo, C., Dogliotti, S., Contesse, M. E., & Rossing, W. A. H. (2019). Characterizing diversity of food systems in view of sustainability transitions. A review. *Agronomy for Sustainable Development*, *39*(1), 1-22. http://doi.org/10.1007/s13593-018-0550-2

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, *31*(8-9), 1257-1274. http://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, *33*(6-7), 897-920. http://doi.org/10.1016/j.respol.2004.01.015

Gómez Miller, R. (2017). *Adopción de tecnología en sistemas ganaderos del norte* (Serie Técnica, No. 235). Montevideo: INIA. http://doi.org/10.35676/INIA/ST.235.

Gómez Miller, R., & Saravia Díaz, H. (2016). Tecnología en sistemas ganaderos criadores de Sierras del Este: oferta disponible y toma de decisiones tecnológicas en el predio. *Agrociencia*, *20*(1), 113-122. http://doi.org/10.31285/AGRO.20.1.14

Gorman, M. (2019). Becoming an agricultural advisor – the rationale, the plan and the implementation of a model of reflective practice in extension higher education. *Journal of Agricultural Education and Extension*, *25*(2), 179-191. http://doi.org/10.1080/1389224X.2018.1559742

Hansen, B. G., Stræte, E. P., & Kvam, G. T. (2018). The importance of the advisor's relational and professional competence and formal power in meetings with farmers. *Journal of Agricultural Education and Extension*, *24*(4), 361-375. http://doi.org/10.1080/1389224X.2018.1479280

Ingram, J. (2008). Agronomist-farmer knowledge encounters: an analysis of knowledge exchange in the context of best management practices in England. *Agriculture and Human Values*, *25*(3), 405-418. http://doi.org/10.1007/s10460-008-9134-0

Ingram, J., & Mills, J. (2019). Are advisory services "fit for purpose" to support sustainable soil management? An assessment of advice in Europe. *Soil Use and Management*, *35*(1), 21-31. http://doi.org/10.1111/sum.12452

Ingram, J., Gaskell, P., Mills, J., & Dwyer, J. (2020). How do we enact co-innovation with stakeholders in agricultural research projects? Managing the complex interplay between contextual and facilitation processes. *Journal of Rural Studies*, *78*, 65-77. http://doi.org/10.1016/j.jrurstud.2020.06.003

Klerkx, L. (2020). Advisory services and transformation, plurality and disruption of agriculture and food systems: towards a new research agenda for agricultural education and extension studies. *Journal of Agricultural Education and Extension*, *26*(2), 131-140. http://doi.org/10.1080/1389224X.2020.1738046

Klerkx, L., Hall, A., & Leeuwis, C. (2009). Fortalecimiento de la capacidad de innovación agrícola: ¿los gestores sistémicos de innovación son la respuesta? *International Journal of Agricultural Resources, Governance and Ecology*, *8*(5-6), 409-438. http://doi.org/10.1504/IJARGE.2009.032643

Klerkx, L., Landini, F., & Santoyo-Cortés, H. (2016). Agricultural extension in Latin America: current dynamics of pluralistic advisory systems in heterogeneous contexts. *Journal of Agricultural Education and Extension*, *22*(5), 389-397. http://doi.org/10.1080/1389224X.2016.1227044

Koutsouris, A. (2008). Innovating towards sustainable agriculture: a greek case study. *Journal of Agricultural Education and Extension*, *14*(3), 203-215. http://doi.org/10.1080/13892240802207619

Koutsouris, A. (2014). Exploring the emerging 'intermediation' (facilitation and brokerage) roles in agricultural extension education. *International Journal of Agricultural Extension*, *2*, 21-37.

Recuperado el 13 de octubre de 2023, de https://journals.esciencepress.net/index.php/IJAE/article/view/641

Landini, F. (2016a). How to be a good rural extensionist. Reflections and contributions of Argentine practitioners. *Journal of Rural Studies*, *43*, 193-202. http://doi.org/10.1016/j.jrurstud.2015.11.014

Landini, F. (2016b). Unfolding the knowledge and power dynamics of the 'farmers-rural extensionists' interface in North-Eastern Argentina. *Journal of Agricultural Education and Extension*, *22*(5), 399-413. http://doi.org/10.1080/1389224X.2016.1227050

Landini, F. (2016c). Concepción de extensión rural en 10 países latinoamericanos. *Andamios (México, D.F.)*, *13*(30), 211-236. http://doi.org/10.29092/uacm.v13i30.9

Landini, F. (2020). Límites y potencialidades de la formación universitaria en América Latina para la práctica de la extensión rural. *Educação & Sociedade*, *41*, e218569. http://doi.org/10.1590/es.218569

Landini, F. (2021). Cambios en la comprensión del propio rol de extensionista a partir de la experiencia: un estudio latinoamericano. *Revista de Economia e Sociologia Rural*, *59*(2), 1-19. http://doi.org/10.1590/1806-9479.2021.224267

Landini, F., & Brites, W. (2018). Evaluation and impact of a reflective training process for rural extension agents. *Journal of Agricultural Education and Extension*, *24*(5), 457-472. http://doi.org/10.1080/1389224X.2018.1500922

Landini, F., & Riet, L. (2015). Extensión rural en Uruguay: problemas y enfoques vistos por sus extensionistas. *Mundo Agrario*, *16*(32), 1-17. Recuperado el 13 de octubre de 2023, de https://www.mundoagrario.unlp.edu.ar/article/view/MAv16n32a09

Landini, F., Brites, W., & Mathot y Rebolé, M. I. (2017). Towards a new paradigm for rural extensionists' in-service training. *Journal of Rural Studies*, *51*, 158-167. http://doi.org/10.1016/j.jrurstud.2017.02.010

Leeuwis, C. (2000). Learning to be sustainable: does the Dutch agrarian knowledge market fail? *Journal of Agricultural Education and Extension*, *7*(2), 79-92. http://doi.org/10.1080/13892240008438809

Long, N. (2001). *Development sociology: actor perspectives.* New York: Routledge.

Lybaert, C., Debruyne, L., Kyndt, E., & Marchand, F. (2022). Competencies for agricultural advisors in innovation support. *Sustainability*, *14*(1), 1-16. http://doi.org/10.3390/su14010182

Méndez Sastoque, M. J. (2020). Hacia una extensión rural fundada en el diálogo sinérgico de saberes: campesinos y extensionistas construyendo juntos. *Redes*, *25*(1), 189-210. http://doi.org/10.17058/redes.v25i1.14684

Méndez Sastoque, M. J., & Giraldo Restrepo, E. (2022). Aproximación dialógica a las necesidades formativas para perfeccionar la práctica de la extensión rural con campesinos en Caldas, Colombia. *Revista de Economia e Sociologia Rural*, *60*(1), e242488. http://doi.org/10.1590/1806-9479.2021.242488

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: an expanded sourcebook.* Thousand Oaks: Sage Publications.

Modernel, P., Rossing, W. A. H., Corbeels, M., Dogliotti, S., Picasso, V., & Tittonell, P. (2016). Land use change and ecosystem service provision in Pampas and Campos grasslands of southern South America. *Environmental Research Letters*, *11*(11), 113002. http://doi.org/10.1088/1748-9326/11/11/113002

Morales Grosskopf, H. (2009). Proyecto integrando conocimientos. In H. Morales Grosskopf & F. Dieguez Cameroni (Eds.), *Familias y campo: rescatando estrategias de adaptación* (pp. 19-28). Instituto Plan Agropecuario. Recuperado el 13 de octubre de 2023, de https://planagropecuario.org.uy/uploads/libros/16_familias_y_campo.pdf

Nettle, R., Crawford, A., & Brightling, P. (2018). How private-sector farm advisors change their practices: an Australian case study. *Journal of Rural Studies*, *58*, 20-27. http://doi.org/10.1016/j.jrurstud.2017.12.027

Ortiz Dardón, R., Mejía, F. S., Ceville, X., Preissing, J., Boerger, V., Solórzano, N., Meyrat, M., Marín, X., & Morrás Dimas, E. (2011). *Buenas prácticas en el manejo de extensión en América Central.* Rome: FAO. Recuperado el 13 de octubre de 2023, de https://www.fao.org/3/i2355s/i2355s00.pdf

Pereira Machín, M., Morales Grosskopf, H., & Bartaburu Mazzarino, D. (2011). Los desafíos de la adopción de tecnología en sistemas de producción ganadera extensiva. In A. Altesor, W. Ayala & J. M. Paruelo (Eds.), *Bases ecológicas y tecnológicas para el manejo de pastizales* (Serie FPTA, No. 26, pp. 215-219). INIA. Recuperado el 13 de octubre de 2023, de http://www.inia.uy/Publicaciones/Documentos%20compartidos/18429020511100111.pdf

Rijswijk, K., Bewsell, D., Small, B., & Blackett, P. (2015). Reflexive monitoring in New Zealand: Evaluation lessons in supporting transformative change. *Evaluation Journal of Australasia*, *15*(4), 38-43. http://doi.org/10.1177/1035719X1501500405

Rodríguez-Espinosa, H., Ramírez-Gómez, C. J., & Restrepo-Betancur, L. F. (2016). Nuevas tendencias de la extensión rural para el desarrollo de capacidades de autogestión. *Ciencia y Tecnología Agropecuaria*, *17*(1), 31-42. http://doi.org/10.21930/rcta.vol17_num1_art:457

Rogers, E. (1962). *Diffusion of Innovations*. New York: The Free Press of Glencoe.

Rossing, W. A. H., Albicette, M. M., Aguerre, V., Leoni, C., Ruggia, A., & Dogliotti, S. (2021). Crafting actionable knowledge on ecological intensification: lessons from co-innovation approaches in Uruguay and Europe. *Agricultural Systems*, *190*, 103103. http://doi.org/10.1016/j.agsy.2021.103103

Ruggia, A., Dogliotti, S., Aguerre, V., Albicette, M. M., Albin, A., Blumetto, O., Cardozo, G., Leoni, C., Quintans, G., Scarlato, S., Tittonell, P., & Rossing, W. A. H. (2021). The application of ecologically intensive principles to the systemic redesign of livestock farms on native grasslands: a case of co-innovation in Rocha, Uruguay. *Agricultural Systems*, *191*, 103148. http://doi.org/10.1016/j.agsy.2021.103148

Schot, J., & Kanger, L. (2018). Deep transitions: emergence, acceleration, stabilization and directionality. *Research Policy*, *47*(6), 1045-1059. http://doi.org/10.1016/j.respol.2018.03.009

Sepúlveda, S., Rodríguez, A., Echeverri, R., & Portilla, M. (2003). *El enfoque territorial del desarrollo rural.* San José, Costa Rica: IICA.

Srinivasan, M. S., Jongmans, C., Bewsell, D., & Elley, G. (2019). Research idea to science for impact: Tracing the significant moments in an innovation based irrigation study. *Agricultural Water Management*, *212*, 181-192. http://doi.org/10.1016/j.agwat.2018.08.045

Swanson, B. (2008). *Global review of good agricultural extension and advisory service practices.* Rome: FAO. Recuperado el 13 de octubre de 2023, de https://www.fao.org/3/i0261e/i0261e00.pdf

Tittonell, P. (2021). Beyond CO2: multiple ecosystem services from ecologically intensive grazing landscapes of South America. *Frontiers in Sustainable Food Systems*, *5*, 664103. http://doi.org/10.3389/fsufs.2021.664103

Tittonell, P., Klerkx, L., Baudron, F., Félix, G. F., Ruggia, A., van Apeldoorn, D., Dogliotti, S., Mapfumo, P., & Rossing, W. A. H. (2016). Ecological intensification: local innovation to address global challenges. In E. Lichtfouse (Ed.), *Sustainable agriculture reviews* (Vol. 19, pp. 1-34). Springer. http://doi.org/10.1007/978-3-319-26777-7_1

Tommasino, H., Cortelezzi, A., Mondelli, M., Bervejillo, J. E., & Silva Carrazzone, M. E. (2014). Tipología de productores agropecuarios: caracterización a partir del Censo Agropecuario 2011. In M. Balparda & R. Pérez (Eds.), *Anuario 2014* (pp. 471-490). Ministerio de Ganadería, Agricultura y Pesca-OPYPA. Recuperado el 13 de octubre de 2023, de https://www2.mgap.gub.uy/OpypaPublicaciones/ANUARIOS/Anuario2014/pdf/estudios/E%20-%20Tommasino%20Cortelezzi%20Silva%20Mondelli%20Bervejillo%20-%20Tipolog%C3%ADa%20de%20productores%20agropecuarios%20carac.pdf

van Mierlo, B., Regeer, B., van Amstel, M., Arkesteijn, M., Beekman, V., Bunders, J., Buning, T., Elzen, B., Hoes, A. C., & Leeuwis, C. (2010). *Reflexive monitoring in action: a guide for monitoring system innovation projects*. Wageningen: Wageningen University and Research.

Wenger, E. C., & Snyder, W. M. (2000). Communities of practice: the organizational frontier. *Harvard Business Review*, *78*(1), 139-145.

Wiskerke, J. S. C., & van der Ploeg, J. D. (2004). *Seeds of transition: essays on novelty production, niches and regimes in agriculture*. Assen: Royal van Gorcum.

Yin, R. (2013). *Case study research: design and methods* (5th ed.). Thousand Oaks: Sage Publications.

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