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## **Climate resilience of family livestock farmers with silvopastoral system**

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### **Introduction**

Socio-ecological systems represent a complex network of interactions between human communities and the environment that supports them. In the last decades, climatic and socio-economic changes have challenged these systems. In this context, resilience emerges as a central concept that defines the ability of a system to face and recover from adverse conditions. It can be divided into three capacities: Absorption, Adaptation, and Transformation.

In Uruguay, in response to commitments made under the United Nations Framework Convention on Climate Change (UNFCCC), various adaptation strategies have been implemented to build resilience, including the integration of afforestation into family livestock production. The country has a long livestock tradition and in some regions with over-exploited or degraded soils. In addition, climate variability is a phenomenon that poses multiple challenges to Uruguayan family ranchers, who have been identified as the rural population most vulnerable to adverse climatic events.

The main objective of this research is to analyse the resilience acquired through the implementation of silvopastoral systems (SPS) and other adaptation strategies against climate variability in family ranchers in the east and northeast of Uruguay. The hypotheses are: i) family livestock producers who have implemented measures to manage climate risks are better adapted to climate variability; ii) these families have a higher level of resilience compared to others that have not implemented these measures.

The work is an exploratory analysis that applies a qualitative-quantitative approach to the study of climate resilience in family livestock farming. A mixed strategy was implemented, from the design of the climate resilience matrix to the interpretation of the results, with a simultaneous collection and analysis of qualitative and quantitative data.

### **Material and Methods**

The methodology applied in the research is based on the approach from Béné (2012). A matrix of resilience indicators was developed, covering 5 dimensions: Social, Economic-Productive, Environmental, Physical and Institutional. Each dimension is analysed in terms of the three capacities that make up resilience: absorption, adaptation and transformation. Semi-structured interviews were conducted with two groups of livestock farmers who had implemented different adaptation strategies. On the one hand, a group of 18 producers who had implemented SPS together with other measures (SPS group) and, on the other hand, a control group of 11 producers without SSP and with adaptation measures on their farms (w/o\_SPS group). A central aspect of the interview was to ask about the climatic events that affected the properties during the years 2004-2019, a period in which the property adaptation projects supported by the Ministry of Livestock,

Agriculture and Fisheries of Uruguay (MGAP, 2019) were developed. The study area encompasses the eastern Uruguay and the surveys were carried out between September 2019 and March 2023.

## **Results and Discussion**

The farms in SPS group have a larger number of livestock, their farmers employ a higher proportion of permanent labour, and they actively participate in social organisations such as trade unions and cooperatives, among others.

Regarding resilience, which refers to persistence and recovery strategies in the face of adverse climatic events, the producers identify drought as the climatic event with the greatest negative impact. That is 83% and 91% of the cases in the SPS group and w/o\_SPS group, respectively.

In the SPS group, 100% of the farmers have water for livestock throughout the year and have fewer problems with lack of food in the fields. Similarly, 39% make food reserves, such as bales or fodder, to reduce dependence on external inputs.

In the w/o\_SPS group, 91% of the cases have water for livestock all year round; nevertheless, they have a higher frequency of losses in pastures, natural fields and greenery (91% in the w/o\_SPS group vs. 62% in the SPS group). In this way, they are more dependent on external sources to provide food for animals in the event of drought.

Producers in the SPS group recover more quickly after an adverse event than those in the w/o\_SPS group. That cohort perceives itself as less vulnerable, better prepared, and less decapitalized after a climatic adversity event. The w/o\_SPS group applied less often for funds from the Agricultural Emergency Fund.

When forecasts warn of drought, 89% of the SPS group are better prepared by setting up food reserves, facilitating access to shade, building water reserves and cleaning up cut-off water. In the w/o\_SPS group, only 64% of these cases were prepared by taking fewer measures, such as reducing stocks and buying rations.

In terms of adaptive strategies, both groups (with and without SPS) were able to enhance improvements in infrastructure and property management by engaging in transfer initiatives, which were possible through participation in technology transfer calls organised by MGAP.

It was found that the SPS group has implemented the soil conservation measures in addition to installing afforestation. They also have greater income diversification and financial support, allowing them to overcome economic adversity more quickly than the group without SSP.

The group with SPS has a larger area of native forest and receives more services from it, not only in terms of protection and shade but also as a source of energy and fodder. Regarding the objectives of installing silvopastoral arrangements, 59% of this group expressed a dual purpose, seeking both animal comfort and the sale of wood in the future.

Both groups aimed for infrastructure improvements to protect against climatic events, which included efficient water management. In terms of obstacles, the w/o\_SPS group faced the most problems in integrating adaptation measures to climate risks, such as labour shortages and a lack of economic resources.

In terms of approaches for generating long-term change, it can be noted that both groups have similar bases for generating transformative changes and attitudes in the future, especially those related to increasing social networks of work and support with neighbouring productions. Similarly, greater equality and a more representative role for women in rural work and a secure generational change are evident for both.

The w/o\_SPS group seems to be willing to make changes in their production system; although both groups express that in order to ensure the sustainability of their properties, the changes in management must allow them to continue their way of life. In this sense, in both cases the producers are planning changes to their properties, such as expanding the area with silvopastoral arrangements in the SPS group, subdivision of paddocks, water storage and the planting of pastures and greenery.

Discussion and exchange of information on climate issues within organizations are more frequent among producers in SPS group. Both groups are willing to continue participating in institutional adaptation projects or projects aimed at family producers, either individually or collectively.

With regard to the contribution of SPSs to building resilience, it was possible to establish that all the cases are witnesses, directly (those with SPSs) and indirectly (those who witness the experience of farms with forests), of the advantages of silvopastoral arrangements in times of climatic stress, not only in terms of animal welfare, but also as a protector of pastures and soils.

Cases with SPS (SPS group) report fewer problems related to animal weight loss, loss of entrails and a rapid recovery after the adverse event. At the same time, in 100% of the cases, the positive aspects of the services provided by silvopastoral arrangements are a key factor for the success of a livestock enterprise, according to the producers: shading increases animal comfort and weight gain, especially in summer when animals tend to seek out the forest, and is also important in the face of heat waves or droughts, preventing animals from suffering. Similarly, the contribution of shelter in winter, in the face of storms and strong winds, especially in sheep production when it is shearing and lambing season.

They emphasise the importance of using degraded soils when introducing woodland and point out that one of the limitations of integrating trees into their properties is the cost of implementation and maintenance until they can use the wooded areas.

Other benefits highlighted by producers include having wood to use on their properties or to sell, and the personal satisfaction of contributing to the protection of the environment.

In the w/o\_SPS group, 81% of the cases recognise the importance of having trees in their livestock production. They can confirm the benefits of protection from wind and shade through the experience of other producers. Those who have native forest recognise the value to have shelter and shade, as long as it is done without affecting the pastures and on soils intended for this purpose. Similarly, some consider that the integration of silvopastoral arrangements is an investment that can be rewarded in the long term by selling of timber and the use in for the own infrastructure. In two cases there is a certain averseness to use species such as eucalyptus, believing that it could affect their soils and the water availability, but they are open to using other types of forest species. As the results show, farmers with SPS are better able to withstand adverse events related to climate variability; likewise, cases in this group (SPS group) are better adapted to climate variability and therefore better able to withstand drought, a phenomenon to which they are more exposed and vulnerable. Although some adaptation measures were implemented in the w/o\_SPS group, they were less frequent, more limited, and with less planning of the property to face extreme events. The characteristic of having forests seems to be a symptom of foresight taken by the SPS group. On the other side, the w/o\_SPS group suffers more from the effects of drought and takes longer to recover from this climatic event. In addition, there is a willingness among producers to develop changes in their production systems while maintaining their essential function, identity and family structure. At the same time, in the SPS group, the benefits of incorporating the tree component in livestock systems are presented, reducing the negative effects of greenhouse gas emissions from livestock activity, favouring carbon sequestration in woody biomass and thus improving the balance of greenhouse gas emissions, nutrient recycling and soil fertility. Animal welfare is improved due to the microclimatic conditions provided by trees, creating an environment of low heat stress for livestock, allowing them better grazing conditions.

These exploratory results suggest that farms with SPS have environmental and productive benefits; the results obtained can contribute to understanding the advantages of these systems at the farm. This work also seeks to provide evidence that can be used in plans to promote silvopastoral systems for incorporation into livestock farms.

## References

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