A multi-criteria tool for jointly assessing the sustainability and resilience of dairy farms

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1. Introduction

Livestock farms are a major contributor to environmental impacts [1]. For dairy farms, one strategy for reducing these impacts is to increase the share of grass in the animals' diet [2]. However, this increases their dependence on grass growth, and therefore on the climate, in the context of climate change. This raises questions about the possibility of reconciling sustainability and resilience for these farms.
The aim of this study was to create and apply a tool for jointly assessing the sustainability and resilience of dairy farms.

2. Materials, methods

The study was conducted in collaboration with a group of farmers and advisers promoting the use of grass in dairy farms (CEDAPA). A literature review and participatory workshops involving scientists and farmers were employed to create a conceptual framework on sustainability and resilience concepts. This framework was then transformed into a tool comprising criteria and indicators, validated by the stakeholders; the tool was implemented using the DEX method [3].
The tool was then applied to 23 CEDAPA dairy farms. The determinants of sustainability and resilience were analysed by principal component analysis and hierarchical clustering using the tool's indicators as input variables (R software, version 4.2.2). The resulting determinants were associated with technical and economic descriptors of the farms.

3. Results

Creation of the tool

During workshops, tensions were identified between the two concepts, e.g. in terms of context and hypothesis: sustainability is assessed when the farm is in steady state whereas resilience is assessed when the farm faces changes. However, each concept was well-associated with a set of system properties, e.g. productivity or autonomy for sustainability and buffer capacity for resilience, represented in the conceptual framework. It allowed the creation of a tool that assesses whether dairy farms achieve the sustainability objectives and to what extent they can be maintained when facing disturbances. The tool was organised on six properties of sustainable and resilient farms (Figure 1), described by 37 indicators.

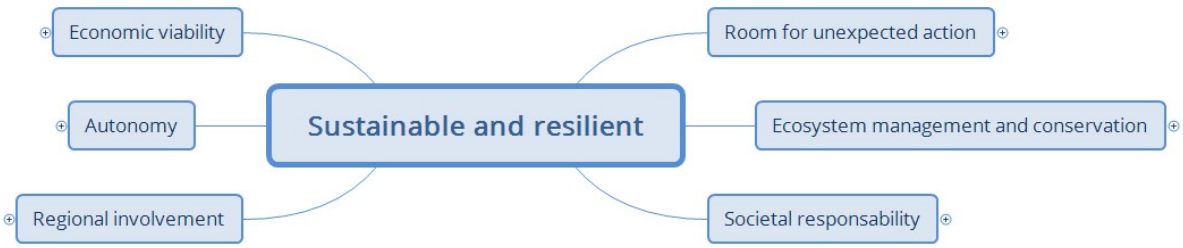

Figure 1: Properties used to jointly assess sustainability and resilience

The tool enables the classification of farms into five classes, ranging from those exhibiting very low resilience and sustainability to those demonstrating high resilience and sustainability.

Assessment of dairy farms with the tool

Fifteen farms were sorted in the two most sustainable and resilient classes, five farms in the intermediate class, three farms in the two least sustainable and resilient classes. An analysis of the determinants of the sustainability and resilience three clusters. Cluster 1 (eight farms) gathered organic, economically and environmentally efficient farms, all specialised in dairy production, with grass-based forage system. Ten of the eleven farms in cluster 2 were conventional, economically efficient, but not particularly environmentally effective. They were the most productive of the total set, used more maize and had a greater degree of diversification in sales than cluster 1. Cluster 3 comprised four organic farms, with moderate economic efficiency but good environmental performances. Their production strategy was grass-fed milk production and diversified sales.

In each cluster, at least two farms were in the most favourable class and the other were spread across two or four classes. This indicates that the three identified production strategies were capable of achieving satisfactory levels of sustainability and resilience.

4. Discussion

The farms assessed demonstrated good performances in terms of sustainability and resilience. To be sure that the tool does not sort farms too easily into the most favourable classes, a Monte Carlo analysis was performed and showed that the most likely class is the least sustainable and resilient one. However, it is possible that the tool, constructed with CEDAPA criteria, favours their farming practices. To validate the tool, it is necessary to test it on a second set of farms. This will enable the tool to be evaluated in terms of its ability to discriminate between farms and farming systems.

5. References

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