Shared Innovation Space for Sustainable Productivity of Grasslands in Europe

Project Acronym: Inno4Grass

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D4.3 Adapted method for cognitive mapping of production systems (M24)

Responsible partner: INRA

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Content

At the end of the project, the scanning of the various case studies will lead to the identification and description of a large number of innovative production systems, each of them including either innovative practices or innovative combinations of practices. In the project, we aimed at identifying a unique methodology to describe those innovative systems and to connect different systems.

Cognitive mapping

Representing expert systems through cognitive mapping is a very active research sectors, as these techniques are used in very diverse domains. More than 2000 papers related to cognitive maps or mapping have been published in peer-reviewed international scientific journals. They make it possible to analyze the relationships between various actions, to assess the probability of co-occurrence of two actions and to approach causal relationships.

Vanwindekens et al (2014) proposed a first analysis of Belgian grassland-based systems, using cognitive mapping.

Yoon and Jetter (2016) presented a comparison of various Fuzzy Cognitive Maps (FCM) methods. Further theoretical developments of FCM were recently implemented, such as intuitionistic fuzzy cognitive map (IFCM) by Zhang et al (2019).

By representation of the ways of acting or farming, the relationships among actions and the possible relationships with contextual features, the cognitive maps aim at approaching and representing the way of thinking of the actors (Vuillot et al, 2016). In our case, we will focus on the innovative farms and farmers.

Materials and methods

For drawing the maps, we used the description of the case studies as they were prepared in WP2. The late delivery of case studies in WP2 (late January 2019) explains why the delivery of the present deliverable was delayed by 2,5 months.

On the basis of text describing each case study, we identified four elements related to the key issues necessary to establish a cognitive map.

Motivations: the objective of this item is to understand why the farmer or farmers group undertook actions. These motivations relate to the perceptions by the farmers of the various issues, as underlined by Smith and Sullivan (2014) regarding environmental issues.

Elements of context: the range of actions that can be undertaken in grassland-based systems are highly dependent upon the biophysics (soil and climate) and social context. The maps aim at capturing these contextual elements. This contextual analysis should also give clues about the future applicability of the most innovative systems.

Actions: The actions implemented in practice are identified. The main difficulty at the level is to have the right granularity and specially to use the same for the various case studies. It highly depends on the text written in WP2. As they were prepared by various persons, and as the farms gave various levels of precision, there is a need for a posteriori correction.

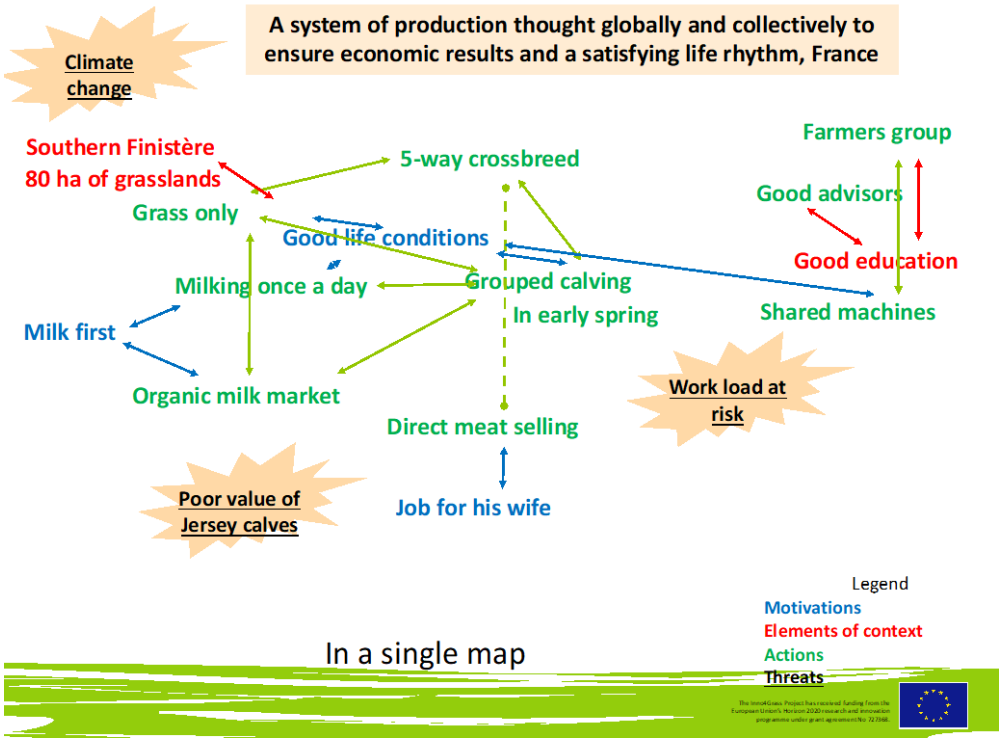
Threats: most case studies identified weaknesses and threats. Why could the innovation fail? In most cases, the threats relate to elements of context which could change over time.

As an illustration, in the following figure, we illustrate what can be extracted from a summary of a case study to identify **Motivations**, **Elements of context**, **Actions** and **Threats**. We checked that this summary was fully relevant to the full-length text corresponding to a case study farm in West of France.

Motivations. Elements of context. Actions. Threats

- In **Southern Finistere** (France), a dairy farmer has found a way to live a happy life while giving a **job to his wife**, **improving his life conditions** and, more importantly, **keeping producing milk**.
- Right now, they have 80 dairy (100% crossbred) cows producing around 240 000 liters of milk per year sold as organic milk since **their cows only eat grass all year**. Using a **5-way crossbreeding** and thanks to the **80 ha of temporary and permanent grassland and forest** they have to feed the cows, they are able to get a feed cost as low as 26€/1000L. At last, **they only milk the cows once a day** and close the milking parlour two months every year since **the cows calve within 5 to 6 weeks** during **early spring**.
- Multiple factors explain why the system works so well. First of all, the farmer has encircled himself with people who help him improve his system:
  - He is **part of a 25-farmers group** where at least two of them are also innovative and from whom he has learnt a lot to improve his system
  - He is also part of a famers union in which **they collectively buy the machineries** they need in order to share the expenses, which works quite well
  - He has **chosen good advisors** from the dairy controller, the Chamber of agriculture and from the accounting company who help him drive his farm through the changes.
  - He also has **good knowledge** and **great will** to improve his practices in order to keep the farm charges low. Finally, he has **chosen a promising market** since organic milk has only been increasing for the moment.
- The system has only two weaknesses: the **poor valorization of the Jersey calves** and the **fragility of the workforce**. It is indeed hard to get a satisfying price for the jersey calves even if, for now, **they sell them in crate, directly to consumers**. In case he or his wife encounter a health problem and are not able to work overnight they might find themselves in a difficult situation.
- At last, they feel threats by the **climate change** which **increases variability** of the weather and ask them and their system to be even more adaptable.

On the basis of these elements, it is then possible to draw a map summarizing all elements.



Results

The time required to fully analyze a case study is between one and 2 hours, depending on the complexity and the granularity of the analysis.

A first set of case studies have been analyzed up to now and some examples of maps are given below illustrating the diversity of situations.

« Marguerite Happy Cow » Differenciated milk cooperative, Belgium

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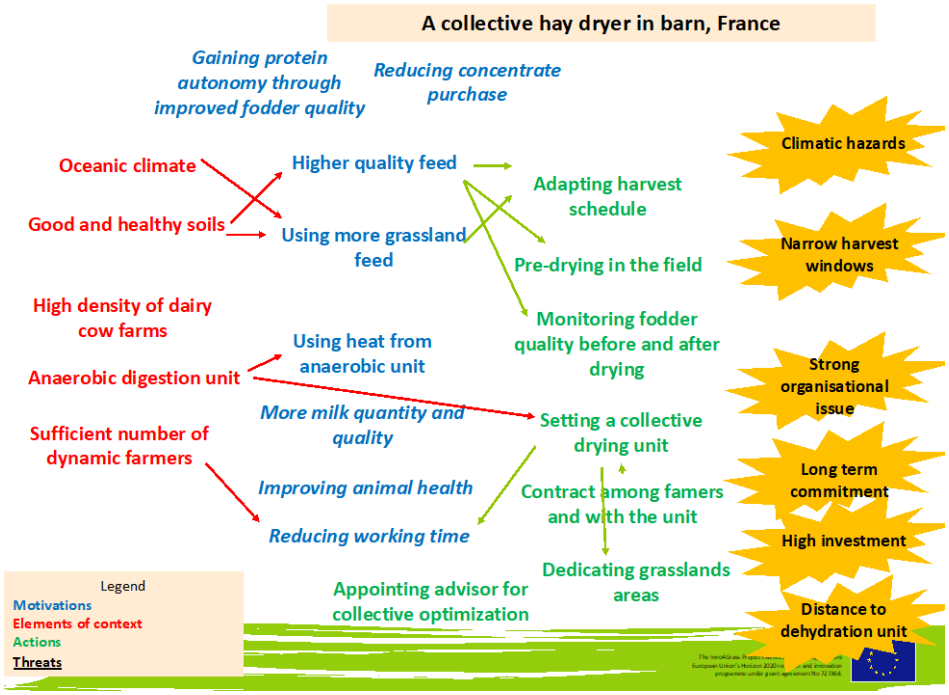

This very last one is a good illustration of the issue related to the granularity of the actions implemented. It also illustrates the connectivity between environmental issues (oceanic climate), social issue (animal welfare), and organizational issue (possibility to work together and with a anaerobic digestion unit).

Once all case studies will be mapped, two actions will be performed

- A consolidated map showing the frequency of relationships
- An Excel file with all the relationships between actions, contextual elements, motivations and threats.

Discussion

The first analysis of the cognitive maps showed some interesting features, that will have to be consolidated.

- The importance of the social networks around the farms. This proved to be the case when innovative systems were collective systems (cooperative for producing and marketing differentiated milk, dehydration system), when groups of farmers were increasing the security of decision and when strong advisory supports were provided.
- The importance of peripheral actions. Actions for a better and innovative grassland management are very often associated with landscape management, such as i) water management for water supply to cows when grazing, ii) pathways for improved animal circulation or iii) tree and shrub planting.

- Climate change is often considered as a key threat for the innovative grassland-based production systems. But the resilience is not yet considered in the a priori conception. Interestingly, the biodiversity that could be one of the environmental services provided by grassland-based systems is only mentioned in a few cases. As such the cognitive maps make it possible to explore the perceptions of farmers (Texeira et al, 2018).

Another approach had been investigated in the very first step of the project, i.e. using the text mining analysis, such as CoreText. This analysis was discarded for three reasons:

- The text mining does not separate a priori between motivations, context, actions and threats. To do this in a proper way, it would be necessary to reorganize the full-length texts before analysis
- The text mining tools requires the semantic basis of all texts to be common. In the present case, even if all texts are in English, they are for most of them a translation towards English. This is inducing discrepancies among texts
- The limited number of case studies and the large diversity of situations are weakening the possibility for the fully automatic approach to identify clusters of items. However, the very last developments of the tools seem to overcome this weakness.

References

Smith H.F., Sullivan C.A., 2014. Ecosystem services within agricultural landscapes—Farmers' perceptions. Ecological Economics 98, 72-80

Teixeira H.M., Vermue A.J., Cardoso I.M., et al., 2018. Farmers show complex and contrasting perceptions on ecosystem services and their management. ECOSYSTEM SERVICES 33, 44-58, Part A

Vanwindekens F., Baret P.V., Stilmant D., 2014. A new approach for comparing and categorizing farmers' systems of practice based on cognitive mapping and graph theory indicators. ECOLOGICAL MODELLING 274, 1-11

Vuillot C., Coron N., Calatayud F., et al., 2016. Ways of farming and ways of thinking: do farmers' mental models of the landscape relate to their land management practices? ECOLOGY AND SOCIETY 21, 1, Article Number: 35

Yoon B.S., Jetter A.J., 2016. Comparative Analysis for Fuzzy Cognitive Mapping. Conference: Portland International Conference on Management of Engineering and Technology (PICMET), Honolulu, HI, Sept 04-08, 2016, Portland State Univ, Dept Engn & Technol Management; Portland State Univ Fdn; InFocus Corp. Pages: 1897-1908

Zhang Y., Qin J., Shi P., et al., 2019. High-order Intuitionistic Fuzzy Cognitive Map Based on Evidential Reasoning Theory. IEEE TRANSACTIONS ON FUZZY SYSTEMS 27, 1, 16-30