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Combining the diversity of resources and farming practices to ensure resilience at different scales

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Abstract. The resilience of livestock systems is confronted with many changes in the environment, the socio-technical and socio-economic systems. The diversity of resources mobilized by stakeholders is a source of resilience for livestock systems. On the one hand, to strengthen their resilience, they activate internal transformation levers. But on the other hand, they are confronted with the reality of the transformations allowed by the socio-technical systems in which they are embedded. This article describes the different elements and conclusions presented in session 37 of the Annual Conference of the European Federation of Animal Science (EAAP) which took place on a virtual platform in December 2020. This work shows how multidisciplinary research and research mobilizing socio-technical, economic and even social science approaches can enrich past work on livestock systems and how they are essential for building responses adapted to the diversity of territories in order to accompany the transition of livestock farming and its resilience.

Keywords. Livestock Farming System – Sociotechnical System – Resources – Diversity – EAAP2020 – Resilience.

Conjuguer la diversité des ressources et des pratiques agricoles pour assurer la résilience à différentes échelles

***Résumé**. La résilience des élevages est confrontée à de nombreux changement de l'environnement, du système sociotechnique et socioéconomique. La diversité des ressources mobilisées par les acteurs est une source de résilience pour les systèmes d'élevage. D'une part pour renforcer leur résilience ils activent des leviers internes de transformation. Mais d'autre part, ils se trouvent confrontés à la réalité des transformations permises par les systèmes sociotechniques dans lesquels ils s'insèrent. Cet article décrit les différents éléments et conclusions présentés dans la session 37 de la Conférence Annuelle de la Fédération Européenne de Zootechnie (EAAP) qui s'est déroulée sur une plateforme virtuelle en décembre 2020. Ces travaux montrent comment les travaux de recherches pluridisciplinaires et ceux mobilisant des approches sociotechniques, économiques et même de sciences sociales permettent d'enrichir les travaux passés sur les systèmes d'élevage et comment ils sont indispensables à la construction de réponse adapté à la diversité des territoires afin d'accompagner la transition de l'élevage et sa résilience.*

***Mots-clés.** Système d'Élevage – System Sociotechnique – Ressources – Diversité – EAAP2020 – Résilience.*

I – Introduction

The One-day Workshop "Addressing the challenges of agro-pastoral farming systems to strengthen their resilience" held during the 71st EAAP Virtual Congress in 2020 addressed the drivers of change facing the livestock sector in the Mediterranean regions and, more generally, in less-favored areas.

A variety of change factors can be considered, such as socio-technical, socio-economic and also environmental changes. These changes are driving the transition of agriculture (Geels, 2004; Geels and Kemps, 2007). A wide range of scales was addressed in this symposium, not only by looking at genetic resources but also by considering other types of resources. The diversity of these levers

can strengthen the sustainability of livestock systems in the face of climatic, social and economic changes. This concerns a wide range of resources (natural, technical, social and economic), including agricultural practices. In the context of agroecological transition, as emphasized by Thénard *et al.* (2021), the sustainable development of territories requires optimization and distribution in the use of material, immaterial and financial resources.

This article provides an overview of the contributions presented at the first session of this workshop (Session 37 of EAAP congress) on how to combine the diversity of resources to improve the resilience of farms and food systems. In addition, the integration of diversity at different scales was proposed as a central theme of this session. The first part of this article presents some research based on internal farm levers. The second part explains the role of sociotechnical level in the territorial anchoring as a driver of the agroecological transition.

II – Activating internal levers to reinforce farm resilience

An original talk introduced the session by Carvalho *et al*. (2022) who has focused on the importance of livestock integration to improve resilience of crop systems. Today, the damage to agriculture is numerous, and it is, according to the authors, the decoupling of livestock and crops that is mainly responsible for this, due to the lack of diversity in intensive systems. Therefore, integrated crop-livestock systems (ICLS) are gaining interest in many countries, because they are more diversified than specialized systems, and because they are a rare example of reconciliation between system intensification and environmental quality. However, the authors discuss other benefits of these systems and their advantages in a context of increasing uncertainty. More specifically, they focus on the resilience enhancement in ICLS that specialized systems face to economic and climatic variability. Using data from long-term experiments in southern Brazil, the authors show that ICLS increase overall system performance (e.g., in terms of human-digestible protein), increase profitability, and reduce negative environmental impacts (e.g., through soil and nutrient cycling indicators). The introduction of grazing (a new trophic level) into specialized cropping systems improves the resilience of nutrient cycling functions and of economic indicators to climatic and market stressors, and promotes the long-term stability of the whole system.

The viability of livestock farms, mainly in disadvantaged areas such as mountainous areas, is strongly linked to the sustainability of grazing management. Raniolo *et al*. (2020) suggest the need for a balance between milk production and supporting ecosystem services in highland pastures. Based on four different alpine pastures in the eastern Italian Alps, this study aimed to characterise the relationships between grazing animals, terrain morphology and the microbial community related to the nitrogen cycle. By combining the macro scale of the mountain pastures (livestock movements) and the micro scale of the soil and plots (nitrification genes) the authors showed that slope was the most important morphological variable at both spatial scales, determining animal movement patterns, and soil nitrification potential, which increased at lower slopes. Such knowledge about how grazing patterns and environmental conditions determine individual productivity and soil-supporting ecosystem services can be used to develop good practices for the sustainable management of mountain livestock-grazing systems, thereby increasing the resilience of grazing agro-ecosystems while maintaining the productivity of local livestock systems.

The inclusion of animals in the system of cultures is thus shown but who says animals call for the question of animal diversity (species and breeds). Animal diversity is one of important levers used by farmers to improve the resilience of farming systems. Joly *et al*. (2020a) showed how traditional pastoral societies use this diversity as portfolios of livestock species. For instance, in a Mongolian case-study combine slow growing resistant species, such as camels, and less resistant species, such as sheep with high growth potential. These farmers can provide a safety net in case of haz-

ards. Using a model built in the framework of the viability theory, authors scanned available management options to build resilient trajectories. This example could be a relevant approach. Identifying management options to ensure long-term respect of predefined constraints (income and subsistence consumption of livestock products) could be used in European agriculture to study how different robustness traits of dairy cows can improve the long-term stability of milk production, in the face of global change. Letaief and Bedhia (2022) presented how a better knowledge of camel breeding is important to understand the choice of breeders. Also, the implementation of a modern selection system for morpho-functional traits of economic interest will help increase camel productivity in North Africa. It also suggests the importance of laying the foundations for a reflection on the improvement of milk production as a source of resilience of the herds.

The role of genetic diversity is very important Brito *et al*. (2022) showed how the analysis of two local breeds morphometric parameters are the result of the adaptability to different ecosystems and the environment influence by breeds adaptation (*Bordaleira de Entre Douro e Minho* and *Churra do Minho*). The authors also explain the crucial role of rural policies in promoting local genetic resources and enhancing sustainable products. Breed adaptation and selection are the two parts of genetic resources management and valorization. Perucho *et al*. (2022) highlight how two dimensions are involved in the adaptation of livestock. The first concerns the specific properties of animals –or animal populations– and the second the dynamic process of their maintenance in the environment. Using several case studies of local sheep breeds in the French Mediterranean region (*Corsican*, *Raïole, Caussenarde des Garrigues* and *Rouge du Roussillon* sheep breeds), it is shown that the objectives of the two approaches are different. The first approach is based on the biological characteristics of the animals, while the second approach focuses on human practices and their interrelationships with the animals. Finally, the authors show that while the risk of the first approach is to limit the question to biological characteristics, the second, more complex approach invites us to understand how actors manage this adaptation at a collective level and to consider the diversity of levels involved. However, these two approaches are complementary and require multidisciplinary research.

The breeding practices implemented by the farmers are one of the means of adapting the system to hazards. Benoit *et al*. (2020) argue that the resilience of sheep farms is determined by internal mechanisms of adaptation to technical and economic hazards. They proposed a modelling approach to assess key performance indicators responding to technical and market hazards on five contrasting meat sheep farms in France and Ireland. The hazards were associated with three key technical variables (ewe fertility, prolificacy, lamb mortality) and four economic variables (price of two types of lamb, concentrate use, energy use). The authors analysed the links between breeding behaviour, input level and income variation. Overall, they showed that variations in technical variables had greater effects on income variability than those in economic prices. The very high potential prolificacy and highly variable lamb mortality may explain this. For them, the most resilient systems, i.e. with the lowest variation in net income, are those that combine a low level of inputs and at least two lambing periods per year.

Beyond the practices implemented by the farmers, in the most difficult areas, economic performance is also linked to the types of products marketed and the characteristics of the farm. This is the purpose of Angerer *et al*. (2020) who have studied how in the south Tyrol of Italy, beef production could be an alternative to milk production to increase the income of small mountainous farms. The objective of the study was to evaluate the economic results of 34 farms divided into two meat systems: (i) suckler cow rearing and (ii) heifer/beef fattening. The role of subsidies is essential for the results to be positive for the vast majority of farms. This leads to the conclusion that beef production is currently not profitable for small mountain farms. Consequently, cost reduction strategies (e.g. collaboration between farmers) and marketing programmes are needed to reduce costs on the one hand and to increase prices on the other hand. This point implies that it would be interesting to study the anchorage of the management systems with the territory.

III – Territorial anchorage as a socio-technical lever for transition

Many livestock farming systems in the Mediterranean, mountainous or less-favored areas are linked with their territory. The anchorage is based on natural resources, PDO products, and on the social environment. Martel *et al*. (2020) explained how territorial resource mobilization shapes agroecological transitions in crop-livestock systems. The authors explore 8 farming systems in 4 different territories to highlight the role of resource diversity in the sustainability of farming systems. In each territory, a baseline system and an agroecological system are compared. Four types of territorial resources are studied: natural, technical, social and economic (local communities). The two systems combine different resources. The agroecological systems rely on resources linked to a local territory and based on biodiversity, while the other systems are interested in resources that allow global exchanges and require inputs. The diversity of the resources mobilized makes it possible to duplicate certain knowledge and increase their resilience to changes in resources in the territory.

One way of strengthening economic resources is the maintenance of added value in the territory of the less-favoured agroecosystems. Orsi *et al*. (2020) studied how local sheep breeds (*Lamon* and *Alpagota*) contribute to this maintenance of the added value of Italian Alpine agroecosystems. These small-scale mountain farms seek to develop their production in connection with a "territorial marketing" strategy or for example with a cooperative with quality products design as Slow Food "Ark of Test". For the authors, the resilience of small ruminant farms can be strengthened by involving small farmers in cooperative/multi-stakeholder approaches that aim to conserve Alpine sheep breeds.

Livestock dynamics in mountain regions were presented by Muñoz-Ulecia *et al*. (2020) as complex interrelationships between human and environmental systems. The analysis of the trajectories, over the last 30 years, of 50 cattle farms in the central Pyrenees in Spain showed that general changes have transformed the systems: changes in the main orientation of production; other changes related to the technical and labor organization of these systems. The authors have also identified the role that the different valleys play on these dynamics. Each valley is a place of socio-technical organization subject to political or socio-economic transformations. The resilience of farms is presented as being influenced both by internal social factors at the farm level and by external political factors at the EU level.

The role of livestock partners is essential in anticipating transformations and supporting transitions in livestock production. It is on this point that Accatino *et al*. (2020) agree in assessing the resilience of extensive grass-based cattle breeding systems. Defining resilience as a combination of robustness, adaptability and transformability, the authors use interviews, participatory workshops and focus groups to identify livestock challenges and transition strategies. The main challenges were economic, social and environmental, and stakeholders were mainly concerned with developing the robustness of livestock production to hazards. Fewer strategies were devoted to improving adaptability or transformability. The strategies suggested by stakeholders for future implementation were mainly focused on adaptability.

By looking at traditional livestock farming societies in Mongolia and the Andes and analysing their proximity to the agroecological framework, Joly *et al.* (2020b) identified what Western livestock systems need to do to make the agroecological transition. In addition to reducing inputs, closing geochemical cycles and mobilising diversity, the authors pointed out the shortcomings of traditional systems that need to be addressed by our livestock systems. The first issue is the reduction of workloads, linked to the use of a diversity of resources. Secondly, the preservation of resilience could be achieved by optimising production, but also by reflecting on the phenotypes of the breeds. Where breeding systems try to react to hazards, the authors suggest that breeders anticipate global changes. Finally, they raise the question of how western breeders view these traditional systems which seem to have developed alongside agricultural notions of modernity. This could become an obstacle to the Transition.

IV – Conclusions

Addressing the challenge of adapting livestock systems to climate change (Altieri *et al*. 2016) and meeting the growing demand for animal products (Motet *et al*., 2017) is the agenda for animal scientists in the years ahead. The transition of livestock sector towards agroecology (Magne *et al*, 2019) and resilient systems (Lamine, 2015) is one of the pillars of the Farm to Fork strategy (Wezel *et al*., 2016), and it is an urgent need in particular for Mediterranean and marginal agro-ecosystems. The contributions presented in session 37 of EAAP 2020 offered a broad view on the role of diversity of resources and farming practices to ensure resilience of livestock farming systems at different scales. The researches needed to favour this process should be based on multidisciplinary approaches, considering different scales of analysis and with a strong involvement of relevant stakeholders.

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