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Applying agroecological principles to redesign and to assess dairy sheep farming systems

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Abstract. In Roquefort-cheese region, a few farmers' groups are increasing grazed resources in the ewe diet to reduce cost and to improve the efficiency of the farms. A project between researchers and dairy sheep farmers was developed to analyse innovative livestock farming systems and to understand how farming management integrates the agroecological principles. Twenty-seven farmers' interviews about practices, farming management, animals' performances and economic results were carried out and analysed. Four types of farming management were described based on (i) the duration of milking period and the supplementation of the flock, (ii) the diversity of resources, (iii) the genetic gains use. The practices identified can be linked to the agroecological principles. They are implemented by farmers to reach a compromise between three targets: productivity, self-sufficiency and economic efficiency. This study highlighted these practices as levers for action used by farmers to increase their farm's adaptability. Results could be used to design and to assess new farming systems.

Keywords. Agroecology – Livestock farming system – Feed self-sufficiency – Diversity – Milk ewe.

Appliquer les principes de l'agroécologie pour reconcevoir et évaluer des systèmes ovins-lait

Résumé. *En zone Roquefort, quelques groupes d'éleveurs envisagent d'accroître les ressources pâturées dans l'alimentation des brebis pour réduire les coûts de production et améliorer l'efficacité des élevages. Un projet de recherche associant chercheurs et éleveurs a été développé pour analyser des systèmes d'élevage innovants et pour expliquer comment leur fonctionnement intègre les principes de l'agroécologie. Vingt-sept enquêtes menées auprès d'éleveurs sur leurs pratiques, le fonctionnement de l'élevage, les résultats zootechniques et économiques ont été analysées. Quatre types de fonctionnement ont été décrits sur la base de (i) la durée de lactation et la complémentation de l'alimentation du troupeau, (ii) la diversité des ressources, (iii) l'utilisation du progrès génétique. Les pratiques identifiées peuvent être directement reliées aux principes agroécologiques et leur mise en œuvre par les éleveurs conduit à des compromis entre trois objectifs « productivité » - « autonomie » - « efficience économique ». Cette étude montre que les pratiques sont des leviers d'action mobilisés par l'éleveur pour accroitre les capacités d'adaptation de l'élevage. Ces résultats pourraient être utilisés pour concevoir et évaluer des élevages agroécologiques.*

Mots-clés. *Agroécologie – Système d'élevage – Autonomie alimentaire – Diversité – Lait de brebis.*

I – Introduction

The intensification of livestock production and the development of larger and more specialized farm units have resulted in a decrease in grassland use (Kristensen *et al.,* 2005), including in mountain and less favoured areas (Quetier *et al.,* 2005). Such a model of development based on agriculture intensification weakens the sustainability of farms and jeopardise their adaptation to global change (Darnohfer *et al.,* 2010; Tichit *et al.,* 2011). Agroecology is a theoretical and conceptual framework suggested to address the challenges of global change adaptation of agricultural systems: on one hand to increase and on the other hand to secure food production (Gliesman, 1998; Altieri, 2002). Agroecology involves (i) designing farming systems based on biological reg-

ulations and interactions between the components of the farm, (ii) increasing local feed resources and self-sufficiency for inputs, and (iii) working with local actors (farmers, farm advisors,…). Altieri (2002) proposed five agroecological principles based on key ecological processes to (re)design sustainable crop systems. The transposition of these principles to design livestock systems (Dumont *et al.,* 2013) and integrated crop-livestock systems (Bonaudo *et al.,* 2013) is recent. However two main limits must be noticed about these studies: (i) these principles differently described by authors are not clearly linked to farmers' practices and the whole farm management; (ii) these principles do not suggest elements to analyse, to re-design and to assess the farms. Thus, to support the agroecological transition of farms, critical issue is to turn these principles into operational levers for action usable by farmers to re-design their livestock farming system. Based on a participatory approach with dairy sheep farmers, the aim of this study is to translate agroecological principles into levers for action. Firstly these levers for action must be directly linked with the farmers' management practices and secondly they must be used to assess the farm's performances. In this paper, we focus on (i) our approach to build a research project intended to testing innovative sustainable practices, (ii) the diversity analysis of some innovative farming systems and (iii) the farm assessment through agroecological properties.

II – Methodology

1. A participatory research with a group of dairy sheep farmers seeking alternative practices

The research project takes place in southern France where is produced the Roquefort cheese. This PDO[1] cheese is made with raw ewe's milk, traditionally sheep grazed local grassland regarded as less-favoured pastures (dryness in summer and cold weather in winter). To overcome the constraints of the area, for many years the milk production has increased the food purchases and inputs in farms. Until the year 2000 the intensification has increased forages harvested use to the detriment of grazing. A wide gradient of resources are used by farmers (Thénard *et al.,* 2013), mainly intensive meadows. Therefore to limit the development of this intensive farming model, the PDO specifications have included new requirements. Since 2000, ewes should be fed with forage coming for 75% from the PDO area and ewes should graze two or three months during the grazing period.

In this region, the farms' economic performances are directly depending on fluctuations in input prices and climate variability. In such a context, for a few years, groups of farmers have shared perspectives and ideas to test innovative sustainable practices to improve their farms adaptability. We worked with one of these farmers' group (composed of 10 farmers) and supported by a farm advisor. These farmers called themselves "Economical and Locally grown Farms[2]" (ELF): they seek to use the local forage resources and to reduce farm input requirements. The research project was built to analyse their innovative sustainable practices.

2. Methods to analyse the diversity of farming systems in an agroecological perspective

The project employed agroecology framework, and was carried out in two steps. The aim of the first one was to translate agroecological principles into levers for action. That means we should draw a comparison between the principles of agroecology, the farmers' practices and the objec-

[1] Protected Designation of Origin.
[2] Elevages Economes et de Terroir.

tives of production in the farmers' group. During two work sessions, farmers, advisors, and researchers have shared different points of views about the practices used to explain three notions "self-sufficiency farming", "economical farming", and "local grow farming". Finally, the knowledge shared has permitted to identity three levers for action linked with the principles of agroecology: (i) Managing diversity, (ii) Renewing resources, and (iii) Limiting inputs (Fig. 1).

The aim of the second step was to use these levers for action to describe the diversity of innovative dairy sheep farms and to assess their performances in an agroecological perspective. We used three agroecological properties: "self-sufficiency" as the synthesis of balance between flock-fed-needs and farm-fed production, "productivity" as the synthesis of the animal performances, "efficiency" as the synthesis of economic results. During spring 2013, semi-directive interviews were carried out among 27 farmers. Farmers surveyed were those of the "ELF" group and about 20 farmers who were identified by farm experts as seeking to increase input self-sufficiency (SSF) and/or to improve local natural resources use (LRF). Interviews focused on farmers' flock and forage management practices. Data about animal performances and economic results were also gathered from respectively milk recording and farm management centres.

Data were analysed with a method to classify the diversity of farmers' practices (Girard, 2006). We built a set of variables and their modalities based on the diversity of the farmers' practices and we classified them according to the levers for action identified in step one. We used a Multivariate Component Analysis (MCA) and Clustering method (CAH) on this set of variables to perform livestock management patterns. Principal Component Analyses (PCA) were performed to identify groups from animal performances and economic results. All statistical analyses were computed with the FactoMineR-Package of R software (R Core team, 2012).

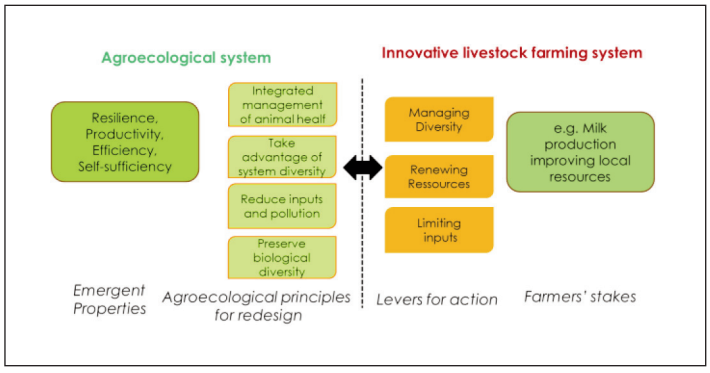

Fig. 1. Translation of agroecological principles into levers for action.

III – Results and discussion

Ten practices were identified. They concern flock management and genetic selection, grassland organisation or animal feeding. Respectively, three and four of them referred to the levers for action "Managing diversity", "Renewing resources" and "Limiting inputs" (fig. 2).

The diversity of practices was structured by MCA on three major axes (50% of inertia). The first one (22%) compared flocks based on a short milking period (less than 6 months) and feed based on grown farm forages *vs* flocks based on a long milking period (between 6 and 8 months) and feed based on forage and concentrate purchases. The second one (14%) compared forage systems with a large diversity of resources and flock based on natural service *vs* forage systems with

limited diversity and flocks based on artificial insemination. The third one (13%) compared farmers using “milk yield” as single selection criteria and indoor management for young ewes *vs* farmers using various selection criteria and outdoor management for young ewes.

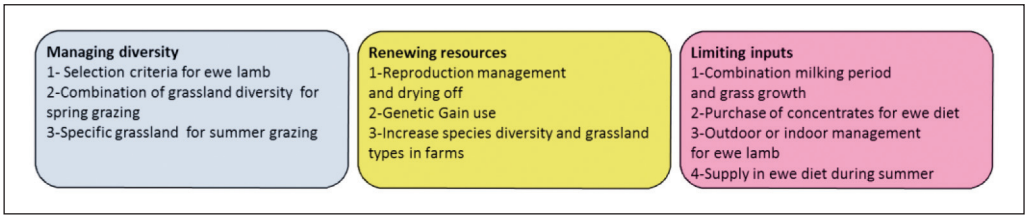

Fig. 2. Classification of the farmers’ practices among the three levers for action to develop agroecological livestock systems.

Four types of dairy sheep farming systems were identified by (CAH): **Economical and Locally grown Farming:** a short length milking period (average 5 months) during the grazing period (including summer); local and natural resources use and limitation of inputs. **Intensive Farming:** a short length milking production during spring; selection based on milk yield; sown pasture use and concentrates purchase. **Organic Farming:** Milk production during the grazing period; local resources with a large diversity of grassland; concentrates purchase with protein content. **Alternative Farming:** a long length milking production during the grazing period (including summer); a large diversity of forages and grazed resources combined with concentrates purchase.

Based on the PCA, the four types of farming management could be assessed according to three properties selected: self-sufficiency, productivity and efficiency. The four farming management types could be analysed as various combinations to reach a compromise between three targets: productivity, self-sufficiency and economic efficiency. Diversity is an important way to increase efficiency. The Organic Farming type could increase the efficiency with a higher milk-price. Intensive farming has a high productivity but efficiency is limited because of higher costs. Finally, alternative farming, under the study conditions (availability of grazing resources), reaches the higher productive and efficient values.

IV – Conclusion

This work is the first stage to design and to assess new farming systems based on agroecological properties. In further work, self-sufficiency will be studied with more attention including from the agronomical and environmental aspects. Farms will be especially regarded through the concept of resilience.

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