

HIGHLIGHT

Managing diversity allows for adapting to uncertainties in animal production systems.

Over the past 60 years, animal production systems (APSs) have been primarily transformed through intensification, specialization and geographical concentration. Incorporating diversity in APSs is highly valued in agroecology and organic farming as it has been assumed to increase farm technical, economic and environmental performances, and to expand options for increasing system resilience to market price fluctuations, and climatic or sanitary shocks. Theoretical frameworks exist but we still lack experimental evidence on the performance of diversified farming systems. Here, we examine how the diversity of system components (resources, animal species, breeds and individual variability) and interactions among these components can increase productivity, resource-use efficiency and farm resilience in aquaculture, rabbit, monogastric and ruminant systems. Doing this, we show that managing diversity allows for adapting to a number of risks and uncertainties in APSs. It is, however, likely that managing for resilience based on the within-farm diversity of APSs will result in a greater management complexity for the farmer and require additional technical skills and sometimes high initial investments, for instance for managing a new livestock species. This can act as strong inhibitors of farm diversification.

Incorporating diversity in APSs is highly valued in agroecology and organic farming the two main forms of APSs that attempt to step away from highly specialized conventional models. Managing within-farm diversity may increase its technical, economic and environmental performances. Different theoretical frameworks in ecology (functional redundancy), economics (economies of scopes) or common to both disciplines (portfolio effect) could explain processes leading the diversity of system components and interactions among these components to increase the productivity, resource-use efficiency and farm resilience across a range of APSs (including aquaculture).

However, scientific literature remains scarce.

Here, we review a number of experimental results and model outputs that reveal the benefits of valuing the diversity of feeding resources, of breeding different animals (species, breeds) on the same farm (or valuing within herd variability), and of integrating livestock and crop production. We then discuss a typology of resilience factors (according to Darnhofer, 2014) related to on-farm diversity with examples.



Legend: Mixed cattle-sheep grazing in Salamix system experiment (INRAE Herbipôle)

This literature review reveals that the same processes can occur in very different systems. For instance, the higher performance of multi-species aquaculture or herbivore grazing systems results from the complementary feeding habits of animal species that exploit resources from different ecological niches more efficiently, and facilitation or competitive exclusion, which results in a species increasing or decreasing resource availability for another species. The benefits of diversity are observed not only in relatively extensive systems but also in intensive indoor systems. For instance, genetic diversity is associated with herd and social immunity in rabbit production and reduced mortality to a rapidly spreading pathogen, while trade-offs between life functions play a major role in dairy herd performance. Management options nested in system component diversity and their interactions can enhance system resilience. Strategic and tactical management of APS diversity can promote farm buffering and adaptive capabilities via the abovementioned processes. By stabilizing the farm financial situation and facilitating access to short supply channels, transformative changes such as the diversification of the animal species bred or development of a processing enterprise on farm, expand options for increasing the resilience of APSs to market price fluctuations and climatic shocks. However, the need for new technical skills and sometimes high initial investments can act as strong inhibitors of farm diversification.

This literature review and the typology of resilience factors related to on-farm diversity will help highlighting the novelty of our current research projects: Core Organic MixEnable on organic multi-species farms, new-DEAL research-development project on mixed-herbivore and crop-livestock systems in Auvergne, and Salamix system experiment on an innovative beef-sheep upland system. More broadly, by highlighting the benefits associated with the diversification of grazing livestock and aquaculture systems, we call for them to be better taken into account in the training and support of livestock farmers.

Learn more:

Dumont B., Puillet L., Martin G., Saviotto D., Aubin J., Ingrand S., Niderkorn V., Steinmetz L. and Thomas M. (2020) Incorporating diversity into animal production system can increase their performance and strengthen their resilience. *Front. Sustain. Food Syst.* 4:109. doi : 10.3389/fsufs.2020.00109

Cited reference:

Darnhofer I. (2014). Resilience and why it matters for farm management. *Eur. Rev. Agric. Econ.* 41: 461-484.

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