

# Livestock grazing systems and sustainable development in the Mediterranean and Tropical areas

Recent knowledge on their strenghts and weaknesses

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iterations could bear fruit and lead to this new paradigm for sustainable development in the Amazon. But in order to sustain the interest of industries and investors, the experiment must reach a critical mass and involve neighbouring municipalities: a higher level of organisation must be considered, such as that of communities of municipalities.

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The creation of an appropriate environment for the agroecological transition in livestock production at the scale of territories (responsible governance) and animal product value chains is certainly as important as the development of inventions and innovations of a more technical nature that offer livestock farmers more profitable performances than conventional livestock practices. However, numerous levers need to be activated (setting up infrastructures, organisations, training and financing flows, new regulations, etc.), involving a large number of stakeholders in the innovation system (Figure 4.1); this represents a long-term task. As a result, one of the questions that arises concerns the role of research in these organisational innovation dynamics, which are particularly complex to implement.

## Discussion and conclusion

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### **■ In what way does this research on invention and innovation in livestock grazing systems contribute to the agroecological transition?**

Referring to the FAO's Agroecology Values Grid (Wezel *et al.*, 2020), the eleven case studies just presented highlight the following contributions of livestock grazing systems to the agroecological transition (Table 4.1):

- Research on inventions is positioned on five values of agroecology, foremost among which are co-creation, knowledge sharing and efficiency, followed by the values of diversity and resilience. The sharing and co-creation of know-how are embodied in objects that combine the expertise and know-how of field workers with the latest digital advances for more efficient management of animals, herds and pastoral resources. One of the common objectives of these inventions is to improve the efficiency of herd management and the use of the diversity of resources in livestock agroecosystems (animals, plants, soil, water, etc.). The aim is to avoid overuse and depletion of these resources, without increasing the burden on farmers. This is achieved through:

- rapid access to useful information on resources;
- automated data collection for decision making;
- and tools to reduce the use of synthetic inputs, or even remove them from farming systems (e.g. elimination of hormones through the use of ewe heat sensors).

- Research on the step-by-step co-design of innovative livestock systems, applied to technical innovations involving the recycling of organic manure and the biodiversification of fodder systems, is based on six agroecological values, the most important of which are co-creation and knowledge sharing, efficiency and synergies, followed by the values of resilience, diversity and recycling. In this study, the co-creation and knowledge sharing are conducted in participatory research mechanisms designed to enhance the value of the local practices and expertise of farmers and to involve them in the construction of technical innovations (tree fodder reserves, manure pits at the edges of fields). In the work presented, the objective is more efficient management of the farm's resources (agricultural and livestock co-products, tree plantations, labour) and increased efficiency and resilience to economic shocks (volatility of livestock feed and mineral fertiliser prices), through increased synergies between on-farm livestock and agricultural activities, biodiversification of forage systems and recycling of agricultural and livestock co-products into organic manure.

Research on organisational innovations in livestock grazing systems, both in value chains and in territories, largely reflects six of the values in the FAO agroecology grid. Four of them, namely the co-creation and sharing of knowledge, the enhancement of diversity in the broad sense (resources, stakeholders, etc.), and the strengthening of synergies (between the components and stakeholders of agricultural and food systems), are values common to these case studies. Their mobilisation is intended to bring about the emergence of animal value chains or agropastoral land management systems that are more efficient in terms of resource use and more resilient to economic and environmental shocks. However, a fundamental characteristic of these case studies on organisational innovations is that they take into account other values such as human and social values (inclusion of stakeholders, notably the smallest livestock farmers, minorities and women), responsible governance of territories and collective action through the construction of a solidarity and circular economy at the level of a territory. This reflects the significance attached by these case studies to supporting territorial and sectoral stakeholders in building an environment conducive to the agroecological transition in livestock farming.

### **■ Limitations, points for improvement and research prospects for invention and innovation for the contribution of livestock grazing systems to the agroecological transition**

The case studies presented (Table 4.1) reveal that research efforts are required on innovations that improve the contribution of livestock grazing systems to certain agroecological values such as recycling (of livestock co-products and effluents such as excreta and GHGs), human and social values (such as issues of inclusion of women and youth in value chains), culinary and food traditions (such as valorisation of local animal products in value chains) and finally circular and solidarity economy (development of value chains related to the valorisation of livestock co-products and strengthening the place of women and youth in the governance of animal product chains).

**Table 4.1. Analysis of the eleven case studies through the lens of the ten elements of agroecology defined by the FAO (Wezel *et al.*, 2020).**

Elements of agroecology as suggested by the FAO	Part 1: inventions					Part 2: technical innovations			Part 3: organisational innovations			
	Case study(*)	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10	EC11
Case study(*)		x				x	x		x	x	x	x
1. Diversity		x	x	x	x	x	x	x	x	x	x	x
2. Co-creation and knowledge sharing							x	x	x	x	x	x
3. Synergies		x	x	x	x	x	x	x	x	x	x	x
4. Efficiency								x		x	x	
5. Recycling						x	x	x	x	x	x	x
6. Resiliency										x	x	x
7. Human and social values												
8. Cultural and nutritional traditions									x	x	x	x
9. Responsible governance									x	x		
10. Circular and inclusive economy												

Caption: (\*) case study headings

EC1. A digital device for studying the social behaviour of sheep and its applications in grazing management and animal health

EC2. Near infrared spectrophotometry to facilitate the determination of forage value and the management of animal manure

EC3. Electronic ewe overlap detector to eliminate the need for hormonal heat synchronisation in artificial insemination

EC4. Sheep self-weighing platform for monitoring the nutritional status of animals with minimal supervision

EC5. Web portal for sharing information on weed management in grazing land

EC6. Shrub fodder banks for improved dry season feeding of dairy cows in Burkina Faso

EC7. Manure pits at the edge of fields to improve manure recycling and reduce workloads in Burkina Faso

EC8. Co-design of formal contracts for grazing in cultivated fields

EC9. Innovation platforms for more environmentally friendly and inclusive local milk production and collection

EC10. Local land charter to manage access and management of agro-sylvo-pastoral resources in the commune of Koumbia in Burkina Faso

EC11. Rotational grazing to help restore forests in the Brazilian Amazon

As regards the distribution of innovative recycling practices in livestock grazing systems, it is essential to develop individual advice tools on good recycling practices at the farm level and modelling tools for innovative collective practice scenarios at the territory level. The modelling work by Grillot (2018a) carried out in West Africa on the agropastoral territories of the Serrer country has revealed the interest of modelling to simulate and better comprehend the effects and impacts of the reorganisation of the nutrient cycle at the territory scale. In 2022, research was also underway in Burkina Faso and Senegal to use models to provide guidance to producers (advice on feeding dairy cows and on the management of agricultural and livestock co-products). These models use little input data and can be used to quickly provide advice adapted to the requirements of producers (quantified advice on the composition of rations including grazing, information on the proportion of unused co-products and advice on how to improve the use of these unused co-products as fodder and manure). In addition, there could be information systems for producers of these farms to help them manage the times and places for spreading manure and slurry according to weather conditions and the topography of the subsoil in order to avoid polluting groundwater and watercourses.

With regard to the implementation of the principles of a circular economy in livestock grazing systems, modelling to support territorial stakeholders plays an essential role in the development of scenarios for the implementation of innovative collective practices based on circular economy schemes. This notably applies to the management of biomass produced by livestock and agriculture in a territory such as on the island of Reunion using the Ocelet software (Vigne *et al.*, 2021a).

The agroecological transition will also depend to a large extent on the downstream part of the supply chains and consequently on consumption patterns. With regard to animal products, consumers, notably urban dwellers, often have high expectations of regaining access to traditional animal products of satisfactory health quality at an affordable price. Adding value to these products will require the implementation of organisational innovations in the traditional livestock sectors in order to meet the new demands for animal products (payment for milk based on quality, for example, geographical indications, etc.).

Finally, the inclusion of human and social values such as dignity, equity, inclusion and justice is not very evident in the case studies presented, even though these dimensions are well present in the current vision of the agroecological transition (Wezel *et al.*, 2020). Women and the young are often more sensitive to the effects of these downturns, and their place and role in the food and farming systems related to livestock and livestock products should be taken more into account (Quisumbing *et al.*, 2014). More agroecological livestock production methods, which often require less financial resources than conventional livestock production methods, can help women in rural areas to acquire more autonomy and power within the household, by giving them the possibility of joining producer groups, women's trade associations, etc., in order to better maintain control over the sale of their products, such as milk (Valdivia, 2001).

## **■ Lessons learnt from the case studies for the design and support of the agroecological transition applied to livestock grazing systems**

In the case study presentation, innovations are divided into two main categories: technical innovations and organisational innovations. Technical inventions and innovations were primarily analysed at the animal, herd or production system level, according to the farmer's constraints. Organisational innovations were mainly examined at the level of the value chain or livestock territory to address the issues of farmers, but also of other stakeholders in the territory or value chains. In reality, technical innovations necessarily imply organisational innovations, and vice versa, through a cascade effect. For example, the practice of insemination generates changes in the organisational field of reproduction management. In supporting the agroecological transition, the technical and organisational dimensions of innovation must be taken into account simultaneously.

Analysis of the process of designing technical or organisational innovations in livestock farming confirms the central role of participatory and iterative dimensions. The involvement of the end-user in the design process is essential to adjust, calibrate and test innovations based on the problems for which they are designed and which may evolve over the course of the project. Depending on the stage of development and the characteristics of the innovations, the main stakeholders involved and the methods used in the design cycle differ. Inventions are mainly based on a prototyping stage. The involvement of end-users comes later, when the invention evolves into an innovation. The exploration of solutions can be based on participatory approaches or result from experimentation or similar experiences from research. Experimentation, as practised in the biotechnical sciences, can be complicated and expensive. In the case of new value chains and organisational tools, choice experiments or simulation methods are alternatives to explore a wider range of solutions. The assessment stage is always part of the process, but differs in terms of the object being assessed (innovation, process, impact).

Depending on the characteristics of the livestock systems, these case studies also indicate that the design of innovations often needs to be implemented at different scales in order to capture the relationships between the components of the livestock systems and their environment. For example, herd mobility implies taking into account other territorial resources and activities (multi-use of spaces, multifunctionality of livestock) or the renewal of spontaneous vegetation (rangelands). Livestock systems also involve designing innovations over the long term, depending on the selection time of the livestock and the reproduction cycles.