

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

Recent knowledge on their strenghts and weaknesses

Alexandre Ickowicz and Charles-Henri Moulin, editors



of agroforestry principles in family-run farms. While this research makes it possible to produce information on the local skills of farmers, their habits and their determinants fairly quickly, it generally takes longer to contribute to changes in practices, as was shown in the work on organic fertiliser.

While the technical nature of the innovation generally signals a change in the mode of production, this change is always associated with the organisational (and sometimes institutional) changes necessary for the distribution and appropriation of the innovation by its users.

Organisational innovations to support the agroecological transition in territories and animal product value chains

M'HAND FARES, RENÉ POCCARD-CHAPUIS, ÉRIC VALL

The creation of a favourable economic and political environment is a necessary condition for the implementation of an agroecological transition in livestock systems. At the level of animal product sectors and value chains, this implies a shift towards economic systems that take greater account of the values of the circular economy in exchanges and solidarity between stakeholders. At the territorial level, this implies the implementation of a more sustainable governance of the management of agro-sylvo-pastoral resources. These changes are based on organisational innovations that mobilise stakeholders in the livestock sector and related sectors. This section of the chapter will present some supporting work:

- European livestock owners and farmers wishing to enter into contracts on new forms of crop and livestock interaction in a given territory;
- stakeholders in the dairy sector in West Africa;
- stakeholders in a West African territory who are committed to formulating a local land charter for resource management;
- and stakeholders in the livestock sector in the Paragominas region of Brazil committed to collective action to restore grazing resources.

Organisational innovations to improve stakeholder cooperation in livestock product value chains

Co-design of formal contracts for grazing in cultivated fields

Grazing cereals intended for grain harvesting or vegetation cover as in viticulture at the end of winter is an ancient technique practised in several regions around the world (Canada, Brazil, Australia, the Mediterranean basin, etc.). Abandoned in Europe in the middle of the 20th century as a result of the massive introduction of synthetic input into agriculture, it has been the subject of renewed interest in recent years on the part of certain farmers and livestock farmers faced with climate change and the need to

reduce the use of inputs, notably chemical. For farmers, it is a welcome additional fodder resource, in particular to increase their fodder autonomy; for growers, grazing cereals or plant cover has the advantage of reducing weed and disease pressure and the risk of rotting, but also of fertilising the soil and energising the plant thanks to grazing stress.

Within the framework of the European research project H2020 DiverImpacts¹⁷ on crop diversification, a farmer's association (the producer's college) and the Centre de Recherches Agronomiques en Wallonie (CRA-W) on the one hand, and Copyc (the sheep commission of the central Pyrenees), which manages development projects for farmers in the Occitanie region on the other hand, contacted us (Selmet unit, INRAE) to develop a contract between livestock farmers and crop farmers committed to agroecological practices on the same territory. Faced with the development of informal contracts (verbal agreement), the stakeholders in the sector wanted to introduce more formal grazing contracts (in writing) in order to secure the existing relationship and strengthen the cooperation between farmers and livestock farmers. As these formal contracts are quite new, we worked with the stakeholders to develop an experimental method for their design.

The Discrete Choice Experiments method is an experimental method for evaluating environmental practices (Hanley *et al.*, 2001). Contrary to other methods, it can be used to assess innovative systems that are not, or are only marginally, distributed to stakeholders. In the agricultural field, this method has recently been applied to organisational innovations such as agri-environmental contracts (Mamine *et al.*, 2020).

The aim of this method is to reveal the preferences of stakeholders confronted with an innovation, through an experiment in the form of a questionnaire consisting of choice cards. The most difficult part of the design process of this experiment is the definition of the optimal number of cards representing, in our case, the most relevant attributes or dimensions of the contract between livestock farmers and cultivators.

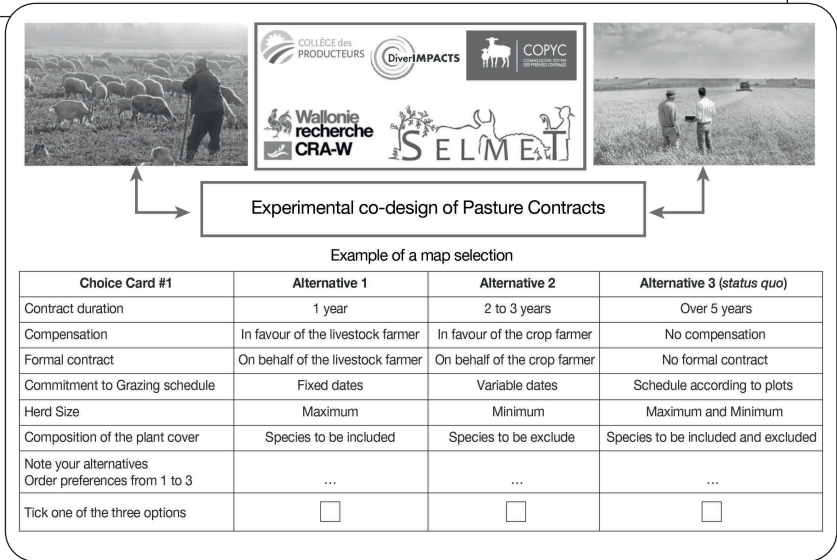
The implementation of a co-design process within a focus group, composed of experts and stakeholders in the contract, meets this constraint. The use of a Product Service Systems (PSS) approach also enabled us to specify:

- the various types of ecosystem services rendered by the introduction of sheep used as substitutes to the use of chemical (or mechanical) inputs in order to eliminate the vegetation cover (intermediate crops or weeds) of a cultivated field (Mamine and Fares, 2021);
- and contractual dimensions crucial to the relationship such as duration, monetary compensation between livestock keepers and farmers, the formal or informal nature of the contract, the size of the herd, the composition of the crop cover, etc. (Figure 4.9).

Once this experimental contract was co-designed, we tested its validity on a larger population of individuals. We conducted a survey of 10 livestock and crop farmers in Wallonia (5 cereal farmers, 5 livestock farmers) and 7 in Occitania (3 cereal farmers, 2 winegrowers and 2 livestock farmers).

17. <http://www.diverimpacts.net>.

Figure 4.9. Co-design of a formal contract between farmers and livestock owners in the framework of the Diverimpacts project (Collège des producteurs, Wallonie recherche CRA-W, Copyc, Selmet).



The results of our experiment of choice demonstrate that the barriers to adoption are not so numerous, contrary to other systems (Meynard *et al.*, 2018), and that a form of cooperation can emerge because both the farmer and the livestock producer have a joint interest. The co-design process of a formal contract is nevertheless of interest because it strengthens the development of cooperation between the stakeholders. A significant preference for more formal contracts can be observed, since 90% of the people surveyed would prefer long-term contracts (> 1 year), 60% prefer written contracts, etc. These clauses make it possible to secure the existing relationship between both parties and to base cooperation on a long-term relationship, even if these formal contracts do not necessarily give rise to monetary compensation between the parties or a firm commitment either to the grazing area/schedule or to the herd size.

There are however regional differences in the contracting choices. In Occitania, there is a preference for short-term contracts. Similarly, in particular in the wine production sector, there is more often a formal commitment to a maximum herd size or grazing schedule, as well as a request for a guarantee on the status of the food resource (before the animals pass through) or, failing that, monetary compensation.

The resulting formal contract must be seen as an organisational innovation that supports the development of innovative agricultural practices, both on the part of the farmer

(introduction of a diversified low-input system) and on the part of the herder (new form of transhumance and grazing of his herd). Certainly, the formal contract ensures the credibility of the commitments between the two partners and thus the emergence of a sustainable cooperation, which allows them to benefit over time from the mutual exchange gains generated by these innovative practices. In other words, innovations in practices and organisational innovations go hand in hand and must therefore be thought out jointly to ensure the agroecological transition.

Innovation platforms to improve local milk production and collection in sub-Saharan Africa

Currently, in sub-Saharan Africa, the demand for dairy products is increasing due to population growth and the emergence of a middle class. Many milk processing units are opening. However, these dairies face difficulties in sourcing local milk. These difficulties are related to volume, regularity and quality. Their supply is affected by multiple constraints such as the low milk yield of local cows, the seasonality of production, the fragmentation of production among small farms, high collection costs and the degradation of the microbial quality of milk during transport to the dairy. The use of milk powder is common, either temporarily during periods of shortage of local supply (dry season) or, and this is often the case, throughout the year.

In this context, a research project¹⁸ was conducted to support the co-design and implementation of technical and organisational innovations to increase and secure local milk supply, taking into account the potential for agroecological intensification of milk production and the development of efficient and inclusive collection systems.

For innovation design, the project relies on dairy innovation platforms (DIP). A DIP is a mechanism that unites dairies, milk producers, collectors, the agro-industry, stakeholders in the dairy sector and researchers who want to find solutions to the problems encountered in the production and marketing of local milk.

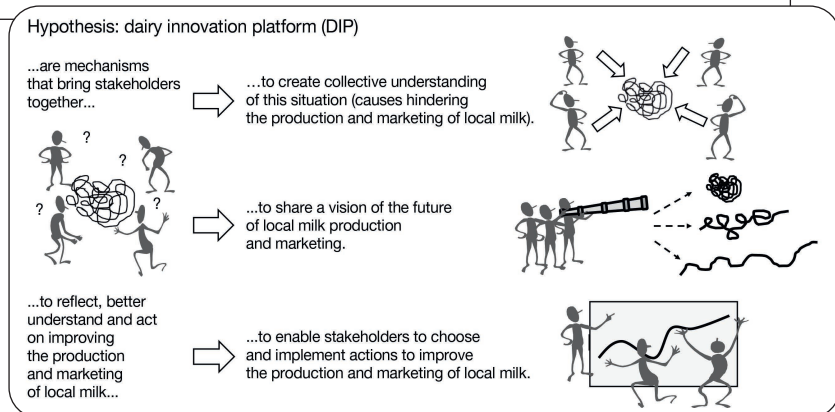
DIP stakeholders are at the heart of a challenging situation, which they strive to understand (search for intelligibility), whose possible developments they would like to foresee (search for predictability) and among which they aim to implement options chosen to guarantee the sustainability of their activity (search for feasibility) (Figure 4.10).

A board is elected to coordinate DIP and to distribute the workload, it is led by a coordinator. Research, which has no apparent conflict of interest with DIP stakeholders, provides methodological and scientific support to organise the participation, study milk production and marketing systems and provide simulation tools.

Six DIPs in 3 countries - Senegal (2 DIPs), Burkina Faso (2 DIPs) and Madagascar (2 DIPs) - have been set up. Depending on the case, the DIPs involve either a dairy or the dairies in the intervention area. The dairies are of differing sizes (including both mini-dairies with less than 500 l/d and industrial dairies with over 11,000 l/d).

18. Africa-Milk Project, <http://www.africa-milk.org/>.

Figure 4.10. Dairy innovation platforms and the questions they address through collaboration between dairy industry stakeholders and researchers.



The analysis of the initial situation is based on a diagnosis of the status of milk production systems and the milk collection system (mapping of the collection basin, study of the supply chain and collection practices, identification of local milk production and marketing issues).

Local stakeholders generally have an ongoing strategy and actions to improve milk production and marketing (installation of mini-farms in Senegal, establishment of collection centres in Burkina Faso and Senegal, improvement of milk quality control in Madagascar, establishment of milk payment systems linked to quality in Kenya, etc.). However, they sometimes have difficulty agreeing on the implementation of a strategy that reconciles the interests of all parties (producers, collectors, processors). To develop a collective vision of the future, we use modelling tools (multi-stakeholder territorial simulation tools, Cesaro, 2021; CLIFS: Crop livestock farm simulator; Le Gal, 2021; Zoungrana, 2020) to develop scenarios and discuss model outputs with DIP stakeholders during scenario-building workshops.

Local stakeholders join the DIP mainly to improve their income from milk and dairy products. The study aims to support them in this perspective, while reflecting on the implementation of environmentally friendly (green business) and inclusive (social business) practices, with a equitable distribution of the added value (fair business). It is with regard to this type of concern that participatory methods and scenario-building tools greatly facilitate interactions between stakeholders in the dairy sector (who generally interact very little) and anticipation and projection exercises for their activity in the future. DIP facilitates the inclusion and consideration of the concerns of stakeholders who are often marginalized in value chains, such as women milk producers and young people.

In theory, DIPs are invested with multiple qualities (participation, inclusion, sustainable development, etc.) (Davies *et al.*, 2016), but in reality, because the stakeholders who join do not all have the same interests, do not all speak the same language, and because there are situations of significant imbalance between the stakeholders, and because it is never easy to overcome one's own prejudices, they require a great deal of effort in terms of facilitation in order to create trust between the stakeholders, a trust which is the basis for producing the expected effects. In other words, it takes time and a lot of energy, know-how and diplomacy to achieve a result. Research is often at the origin of the setting up of such schemes. But experience shows that it is crucial for the success of a platform that field workers acknowledged by their peers assume the role of facilitator, so that all the stakeholders involved adopt the system.

Ultimately, DIPs are of interest to field stakeholders and to research, as a meeting place between a commitment to change (on the part of stakeholders) and a research intention (on the part of scientists). In our research on the agroecological transition in livestock grazing systems, DIPs can also be considered as living-labs. They enable both the testing and development of innovative farming practices and systems and the bringing together of concerned stakeholders to discuss the necessary adaptations to enable the appropriation of the innovations required by the stakeholders and their scaling up.

I Organisational innovations for concerted and sustainable management of territories incorporating livestock activities

A local land charter for sustainable management of agro-sylvo-pastoral resources: the case of the commune of Koumbia in Burkina Faso

In the western territories of Burkina Faso, as long as human pressure remained low, customary rules ensured the sustainable exploitation of natural resources. However, the unprecedented increase in population and agro-sylvo-pastoral activities in these territories has rendered these traditional arrangements obsolete. The official texts (forestry code, environmental code, pastoral code, etc.), which were not well known by the populations, were not applied. The establishment of rural communes in 2006 and the enactment of Law 034 on rural land tenure in 2009 gave local communities the opportunity to take charge of the management of their agro-sylvo-pastoral resources by drawing up local land charters (LLC).

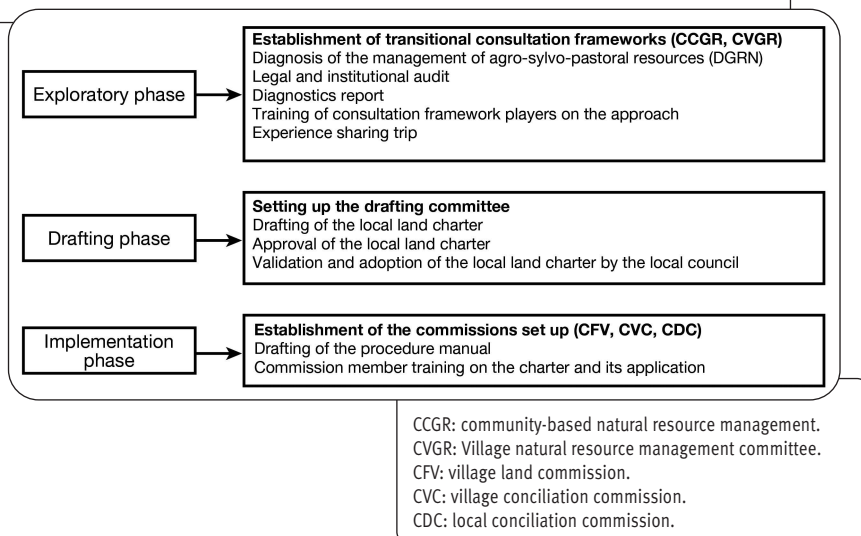
The rural commune of Koumbia, located in the heart of the cotton-growing zone, consisting of 14 villages on 1,358 km² of savannah (30% of which is protected forest), where crop and livestock farming are the two dominant activities, and which has seen its population triple over the past few decades, has been calling for measures to curb the degradation of its resources and the rise in conflicts related to their use. In 2008, the Koumbia communal council, which had included the implementation of

measures to regulate the use of the commune's natural resources in its development plan, seized the opportunity of a research and development project (Fertipartenaires, 2008-2012) to be supported in the development and implementation of an LLC (Vall *et al.*, 2015) in order to define rules for access and use of resources that are adapted to the local context, in line with the regulatory framework, and acceptable to resource users in their diversity.

The development of the LLC took two years (2008 to 2010) and required multiple negotiations between stakeholders at different decision-making levels (village, commune, province). During this process, several groups of stakeholders took part in drawing up the LLC: local elected representatives and village development councils, users (farmers, livestock owners, fishermen, hunters, loggers, etc.) - both indigenous or non-indigenous, often organised in groups - institutional stakeholders (technical departments responsible for the environment and the living environment, agriculture and livestock, etc.), private operators involved in exploiting resources (hunting concessions, gold miners, etc.), research (Cirdes and CIRAD) and a legal firm specialising in the environment.

The development of the LLC, which is based on principles of participation and inclusion, involved three main phases: the exploratory phase, the charter drafting phase and the implementation phase (Figure 4.11).

Figure 4.11. General approach to the development of the Koumbia local land charter.



At the end of this process, the communal council of Koumbia adopted the LLC in 2010. It contains 56 articles divided into 7 chapters:

1. General provisions
2. Access to land
3. Management of agricultural, hydraulic and fishery resources and spaces
4. Management of grazing areas and resources
5. Management of forestry and wildlife areas and resources
6. Bodies responsible for the implementation of the LLC
7. Final provisions and implementation modalities

The fourth chapter of the LLC, which deals with grazing resources, includes 14 items on the rules of access to and use of grazing resources (grazing land, water points, traffic routes, fire management, herding...). In these sections, local farmer know-how was taken into account, notably the nomenclature of seasons and grazing lands in Fulfulde, with the aim of improving the comprehension and applicability of the LLC. In an agro-ecological transition perspective, the recognition and valuation of local know-how is often useful to promote the appropriation of results and the change process. The aim of this charter was to ensure that the local nomenclature of seasons and spaces would be more understandable to the local population by designating entities that the population would be familiar with for the management of their daily activities.

But the establishment of the LLC has encountered several issues related to the political crisis that the country went through from 2011 to 2014. The state was unable to install the land agents and was unable to adopt all the decrees for the application of Law 034; the municipal council involved in the development of the LLC was abolished. To date, the LLC, although acknowledged in the official gazette, has not been fully implemented.

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The implementation of new collective rules may be limited by factors operating at a higher scale. This is why the development of the LLC involved stakeholders at the provincial and state levels to ensure that local rules were consistent with national and international provisions.

In the LLC development phase, research provided scientific diagnostic tools (relating to the management of natural resources, analysis of local technical expertise) and engineering tools (management of participation) to support the stakeholders (supplying information and facilitating negotiations).

The implementation of such a device, which affects the governance of a territory, is dependent on numerous contextual elements (notably political, social and regulatory). The existence of a legal framework greatly facilitated the development of the LLC, whereas the events of 2011 to 2014 suspended its application (because following the 2014 revolution, the town halls and municipal councils with whom we had worked were dismissed and the land service agents responsible for applying law 034 never operated in the field). However, by taking into account the local know-how and practice of livestock producers and farmers, as well as their involvement in formulating the LLC's provisions, it was possible to create a document in which they could identify and which made sense to them.

As noted previously, post-2012 events have not permitted the completion of the implementation of the LLC and its effects and impacts over time. However, there are more successful experiences in the Sahel that demonstrate that this type of local organisational innovation can improve the governance of a territory and the use of natural resources (Djiré and Dicko, 2007).

When rotational grazing contributes to forest restoration: a territorial innovation in the Brazilian Amazon

With its 86 million head of cattle reared on 70 million hectares of grazing land, over the past 50 years the Brazilian Amazon has become one of the world's largest livestock basins at the expense of the rainforest. Some renewable natural resources are more abundant than elsewhere, such as solar radiation, rainfall and deep soils. These can sustain high levels of soil fertility and grazing productivity, if the farmer applies appropriate techniques.

However, it is not these agronomic advantages that explain the resounding success of livestock farming, but rather its social functions, which are particularly valuable on the pioneer deforestation fronts. Extensively managed, livestock farming makes it possible to appropriate and develop large areas of land at lower cost, more quickly than other land uses, while overcoming the chronic lack of labour and the lack of infrastructure for the production, marketing, processing and transport of agricultural products. In this way, extensive livestock farming has contributed to the viability of family farms in the Amazonian pioneer fronts (Ferreira, 2001).

However, Hostiou (2003) has illustrated the other side of the coin: extensive practices do not maintain the fertility accumulated in the soil by the forest. The grasslands are then quickly invaded by shrubs and the traditional resort to fire is a remedy worse than the evil: it accelerates the exhaustion of the soil and pushes the farmer to clear more and more land to compensate for the degradation and maintain production (while increasing land holdings). During the fifty years of this race for land, deforestation was routine: forests were mere fertility reserves for ephemeral fodder production.

How do we stop this immense waste of natural resources? How can their agroeconomic potential be used efficiently, without losing the social functions of livestock, to make it a sustainable activity adapted to the Amazonian environment? The case of the municipality of Paragominas demonstrates that such a transition does not only depend on the farmers: the territorial institutions must also be organised.

The Brazilian federal government has set a milestone by preventing deforestation in the entire region from 2005 onwards: the land appropriation function of large-scale livestock farming has been disabled and soil degradation can no longer be compensated for by opening up new plots. The farmer is obliged to manage their resources, at the risk of seeing their production fall. Plassin (2018) subsequently diagnosed a fundamental shift in the spatial strategies of livestock farmers: by abandoning their extensive logic, they now take into account the capacities of the soils, to concentrate their efforts of restoration and forage intensification on the best plots. The other plots, which are too steep, poorly drained or subject to erosion, are gradually cleared: a new forest network can be reconstituted there, capable of once again producing ecosystem services based on biodiversity, the water and carbon cycle, as measured by Pinillos (2021b).

In the municipality of Paragominas, this observation has given a new impetus to forest protection: it is now understood that it is no longer incompatible with cattle ranching, but on the contrary is associated with it. Within the framework of the plan of Intelligence and Territorial Development decreed in 2019, a new territorial policy on livestock farming is being implemented on the basis of two mechanisms: green finance and municipal management (Poccard-Chapuis *et al.*, 2021).

To democratize forage cultivation and increase the scope of landscape restructuring, credit is a valuable lever if it is within the reach of the greatest number of people. The Banco da Amazônia has joined forces with Cirad and the livestock farmers union to

design and launch a new line of credit in 2021, dedicated to the ecological intensification of grazing land and focusing on a simple technique that is accessible to all: rotational grazing (Figure 4.12). In addition, for the first time, funding is based on a type of livestock farmer and is conditional to prior training: the aim is to minimize the risk of failure potentially linked to the difficult transition from extensive to managed systems.

The second axis is led by the city council, to draw up a municipal land use plan according to the aptitudes of the environment. Composed of a 1:25,000 scale map and a municipal law, this decentralized regulation is used to precisely guide ranchers in their intensification and reshaping of landscapes, as well as to measure the territory's progress in terms of forest restoration and land use efficiency at the municipal level. A regional label is envisaged to certify this progress in land use planning in a transparent manner and so attract other responsible investors in search of sustainability.

This trajectory of innovation demonstrates the value of multiple iterations based on opportunities, constraints and regulations, to transform antagonistic issues into a shared solution. Livestock development and forest protection together produce efficient landscapes, under the guidance of local governments and with the support of the financial sphere. The communal territory is the level of organisation at which these

Figure 4.12. Rotational grazing technique.



This technique, in which cattle are confined to small pens, with rapid rotation from one pen to another depending on grass growth, is only feasible on the best plots. The consequence of this key innovation is a spatial reorganisation of pastures, with less favourable plots being reforested. A new forest framework is emerging beyond the framework imposed by the law, through the process of livestock intensification. New landscapes have emerged, drawn by the aptitudes of the soil, integrating mosaics of forage parks and a recomposed forestry network.

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).