Synthèses

SUSTAINABLE FOOD SYSTEMS FOR FOOD SECURITY

Need for combination of local and global approaches

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Chapter 11

Leveraging agroecology to improve milk production and marketing: insights from case studies in Burkina Faso, France and India

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In response to the growing demand for dairy products (mainly in developing and emerging countries) as well as increasingly stringent production and marketing standards (mainly in developed countries), dairy value chain stakeholders have been redesigning their production and marketing models for some years now. The aim is to increase milk production while minimizing unwanted side effects through agroecological practices.

Altieri (1995) and Gliessman (1997) define agroecology as the application of ecology principles to the study, design and management of sustainable agroecosystems. Agroecology has begun to gain ground as the negative impacts of industrial farming (e.g., pollution, soil depletion, loss of biodiversity, contribution to global warming, producers' loss of independence, and health hazards) rise to critical levels. The realm of agroecology has grown tremendously, and is described as standing at the juncture of three interrelated fields (Wezel et al., 2009): 1) agroecology is a science for agricultural ecosystems; 2) agroecology promotes environmentally sound agricultural practices, and 3) agroecology supports a social movement promoting sustainable and equitable food and farming systems. To help operationalize the concept, the FAO has identified ten elements, grouped into three categories, to be considered in the development of agroecological food and farming systems (Wezel et al., 2020):

– Systems that promote: 1) diversity, 2) synergies, 3) efficiency, 4) recycling, 5) resilience;

– Systems that are mindful of: 6) co-creation and sharing of knowledge; 7) human and social values, (8) culture and food traditions;

– An enabling environment for agroecology: 9) responsible governance, 10) circular and solidarity economy.

In this chapter, we offer a renewed approach for agroecological transition based on case studies focusing on low-input or agropastoral milk production systems, predominantly family operated, in Burkina Faso (Haut Bassins, Cascades and Centre provinces), India (Gujarat, Bihar, Andhra Pradesh, Karnataka and West Bengal States) and France (Grands Causses area). We consider agroecology as a way to increase the production of dairy products, rather than a means of de-intensifying farming systems, while also considering the sustainability of natural resources and ecosystems. In other words, agroecology is a form of ecological intensification of dairy production (Wezel et al., 2014).

Following the presentation of our three case studies (Figure 11.4), we will discuss the role of agroecology in each of these situations from the perspective of the FAO framework. We will then conclude with a review of the challenges that remain regarding mitigation of negative environmental impacts and support for inclusive governance mechanisms for production and distribution channels in the face of market deregulation.

⏩ Milk production and marketing: current trends in three contrasting regions

Burkinabe case study

In Burkina Faso, milk is mainly produced by zebu cattle raised on pastoral dairy farms (Pdf) and agro-pastoral dairy farms (APdf), with 5 to 20 dairy cows per farm and a cultivated area between 2 and over 10 ha per farm (Figure 11.1). These farms are mainly lactating breeding systems, where milk is a valuable product to feed the family and generate income. Cows yield little milk (500 to 1,000 L/lactation). They are pasture fed and are given very little fodder or feed concentrates; these are provided mainly at the end of the dry season. Milk production costs amount to less than €0.30/L. A significant share of the milk production is consumed by the family, but the proportion being marketed is rising as demand increases (Vall et al., 2021).

Traditionally, women control the income from the sale of milk on local retail markets, at a price that varies according to the season (€0.60 to €0.90/L). Private mini-dairy processors are now being set up, collecting from 200 to 1,000 L/day. Thanks to a local delivery network (within 50 km of the dairy processors) operated by bicycle or motorbike couriers, the morning milk is delivered to the point of sale by 11 am without requiring any cold chain storage. The purchase price offered by these dairy processors is lower than that obtained from informal operators on the retail markets (€0.50/L); as a result, the share of milk collected by mini-dairy processors remains low (less than 10%). Dairy processors try to secure their suppliers' loyalty by promising them a guaranteed outlet. However, the increase in collection is limited by the lack of written contracts.

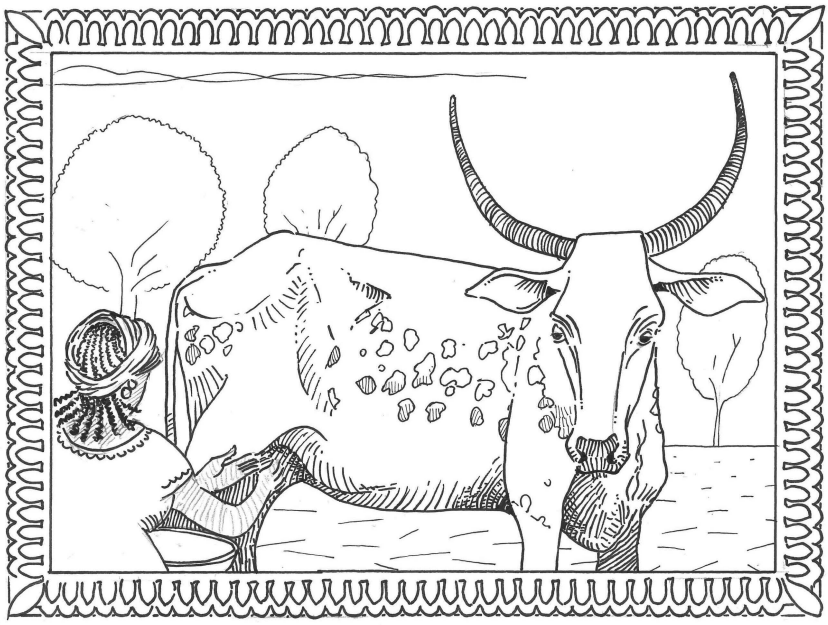

Figure 11.1. Manual milking of a Zebu female in Burkina Faso (Drawing: Éric Vall).

To meet rising demand, some dairy farmers, often from urban areas, have intensified their production at minimal cost within small units of dairy cows (1 to 5 head) or mini-dairy farms (5 to 10 head). This process involves cross-breeding cows housed in stalls (zebus crossed with exotic dairy breeds through artificial insemination). Grazing time is reduced while cows are systematically given crop residues (cereal straw, legume tops) and feed concentrates (cottonseed cake, maize bran). The stall-housing system means that a larger proportion of manure can be recycled as fertilizer. Within the household, the husband often takes over control of the milk (Vidal et al., 2020; Vall et al., 2021).

To expand collection and improve milk quality control, the Burkinabe government is setting up collection centres affiliated with dairy processors. Since dairy processors do not buy milk at prices exceeding €0.50/L, these centres offer producers lower prices to cover their costs (€0.45/L), and so are unattractive. Many dairy processors choose to use imported milk powder, which is cheaper than local milk, widely available, easy to store, and more reliable in terms of quality (Corniaux et al., 2020).

Dairies processing fresh local milk face dual competition from powdered dairy processors (whose products are cheaper thanks to less expensive raw materials) and from the informal sector that absorbs a large share of the local fresh milk (selling it directly at better prices). Dairy processors struggle to provide local milk-based products (milk, yoghurt and curd) at reasonable prices to consumers with low disposable incomes (less than €60 per month per capita) and who consume small amounts of dairy products (under 15 kg per capita per year). All of this occurs in a context where consumers are not aware of whether the dairy product they buy is made with local fresh milk or imported milk powder.

Indian case study

India has the largest bovine population in the world and is the world's largest milk producer (198 million tonnes in 2019). This production is ensured by small herds averaging three heads of cattle or buffalo (Figure 11.2). Animals are used for a variety of tasks, such as draft power, manure production and some meat production (although to a lesser extent due to religious restrictions on slaughter and consumption). Additionally, 70% of these bovines are raised on farms with less than 1 ha of cropland. Feed includes a large proportion of crop residues (wheat and rice straw), which are the main resource to feed bovine animals nationwide (Dorin et al., 2019).

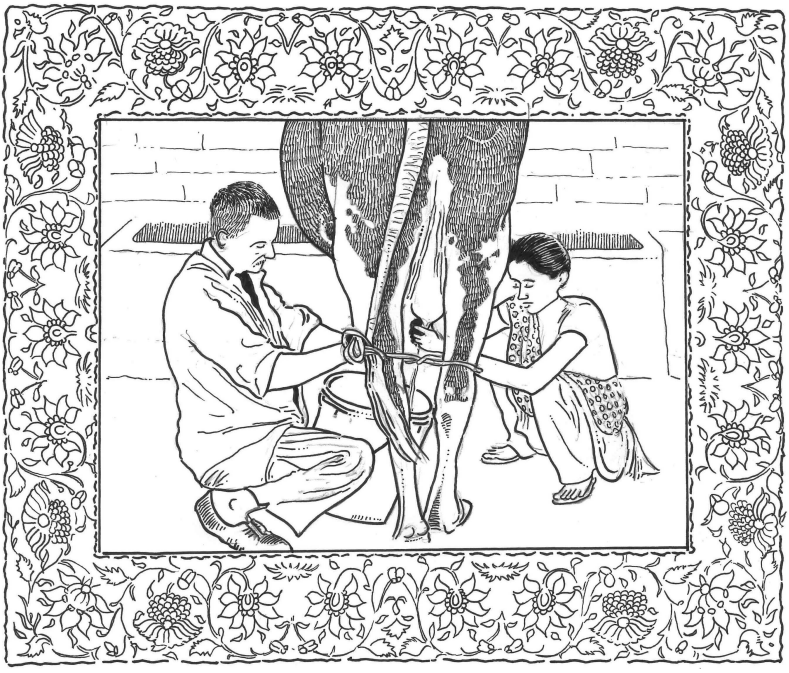

Figure 11.2. Manual milking of a dairy cow in India (Drawing: Éric Vall from a picture of Claire Aubron).

The farms that undertake livestock production are those with the most limited access to land and irrigation water resources (Aubron et al., 2019). Some still rely on the non-food functions of animals (draft power/manure; Cochetel et al., 2019) and others have found milk to be a means of supplementing crop income following improved market access. This quest for milk income has led to changes in farming practices, particularly on small, irrigated farms, in favour of breeds with higher milk yields (Holstein or Jersey crosses with local cows, Murrah buffaloes) and irrigated fodder crops harvested daily on small plots (Napier grass, berseem clover, alfalfa, sorghum, etc.). In some regions, the expansion of milk collection has also led landless agricultural labourers to set up dairy operations. For the past two to three decades dairy farmers have been increasingly using feed concentrates in addition of

spontaneous fodder that is collected daily or grazed, whether or not they have land. Usually purchased from cooperatives, these concentrates are sometimes easier to access than fodder and can make up more than half of the dry matter ration.

India has been self-sufficient in milk production since the 1990s. Its per capita average yearly consumption of dairy products has doubled since 1970 to 80 kg, although this figure is still low for a predominantly vegetarian country where milk is the main source of animal protein. This increase is credited to the development of a vast network of dairy cooperatives as part of India's White Revolution (Dorin and Landy, 2009). The National Dairy Development Board (NDDB), established in 1965 as a sui generis organization, supported the development of cooperative industrial value chains. Following the Indian liberal turn of 1991, the NDDB negotiated specific treatment for dairy cooperatives: the Milk and Milk Products Order of 1992 shielded the cooperative industry by imposing area and size limits to private investments. Following the order's repeal in 2002, the NDDB supported the cooperative sector with the promotion of a new 'milk producer company' legal status aimed at overcoming the limitations of the traditional cooperatives (Jenin et al., forthcoming). Nevertheless, since 2002 private processing capacity grew faster than that of cooperatives. Moreover, the industrialization of the dairy sector remains partial in India, with nearly 75% of the production being consumed at home or marketed in informal value chains (fresh milk and artisanal products) (Gupta, 2017).

French case study

Herds of between 200 and 800 Lacaune ewes are bred in the Grands Causses area (Figure 11.3). This breed has been selected for milk production since the 1960s. Breeding is mainly carried out by artificial insemination (a practice prohibited in organic farming, and one which raises agroecological questions due to the use of chemical hormones). Group lambing allows for milk production to run from December to July. Lactating ewes are fed hay, with feed concentrates, at a ratio of 1 kg /L of milk. Ewes graze on temporary grassland in the spring, and occasionally on rangeland in the summer and autumn, when grassland is dry. Temporary grassland is rotated with cereals, which provide straw for bedding and grains for concentrates. Sheep farmers in this region cultivate between 80 and 150 ha per year of grassland and cereals. Manure is used as a supplement to mineral fertilizer.

For several years, seven factories collected and processed milk to produce Protected Designation of Origin (PDO) Roquefort cheese. Prior to 2015, farmgate milk prices were set between processors and farmers. Steps were taken to handle the oversupply issue that emerged in the 1970s, including diversifying cheese types (1980s), introducing quotas (1987) and providing incentives to better distribute production throughout the year (2000s). Farmers were offered a guaranteed and identical base price for milk, regardless of its purpose. These decisions helped promote food self-sufficiency of farms (Aubron et al., 2014), curb the decline in the number of holdings in the area compared to the national average, and slow down the farms' enlargement and intensification process (Quetier, 2005).

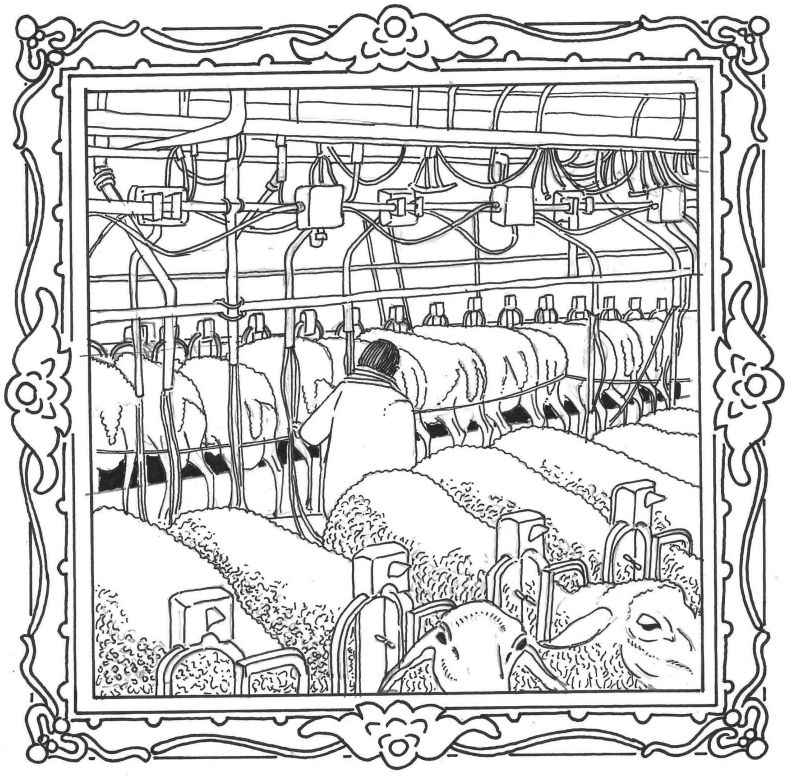

Figure 11.3. Mechanical milking of a herd of Lacaune ewes in the Grand Causses area (Drawing: Éric Vall from a picture of Philippe Hassoun).

Since the 1990s, farmers have been introducing new practices, such as diversifying the flora of cultivated pastures (mixing 10 to 15 species), growing meslin (triticale or barley, peas or vetch) and generally taking a holistic approach to plant and animal health. Others have taken the step of converting to organic farming and no longer use chemical inputs. This conversion was helped not only by the development of organic milk collection rounds, but also by the creation and development of small dairies operating outside the Roquefort inter-branch organization. These small dairies positioned themselves to meet domestic demand for ultra-fresh sheep's milk and organic products.

Farmers involved in these initiatives were and still are encouraged to spread out deliveries. Those who left the Roquefort inter-branch organization have also been able to increase production volumes. From 2015, following the introduction of the European regulation known as the 'Milk Package', the Roquefort inter-branch organization was forced to scrap the quota system and rules governing milk payments. This led to a rise in volumes of milk collected within the inter-branch organization and to further expansion and intensification.

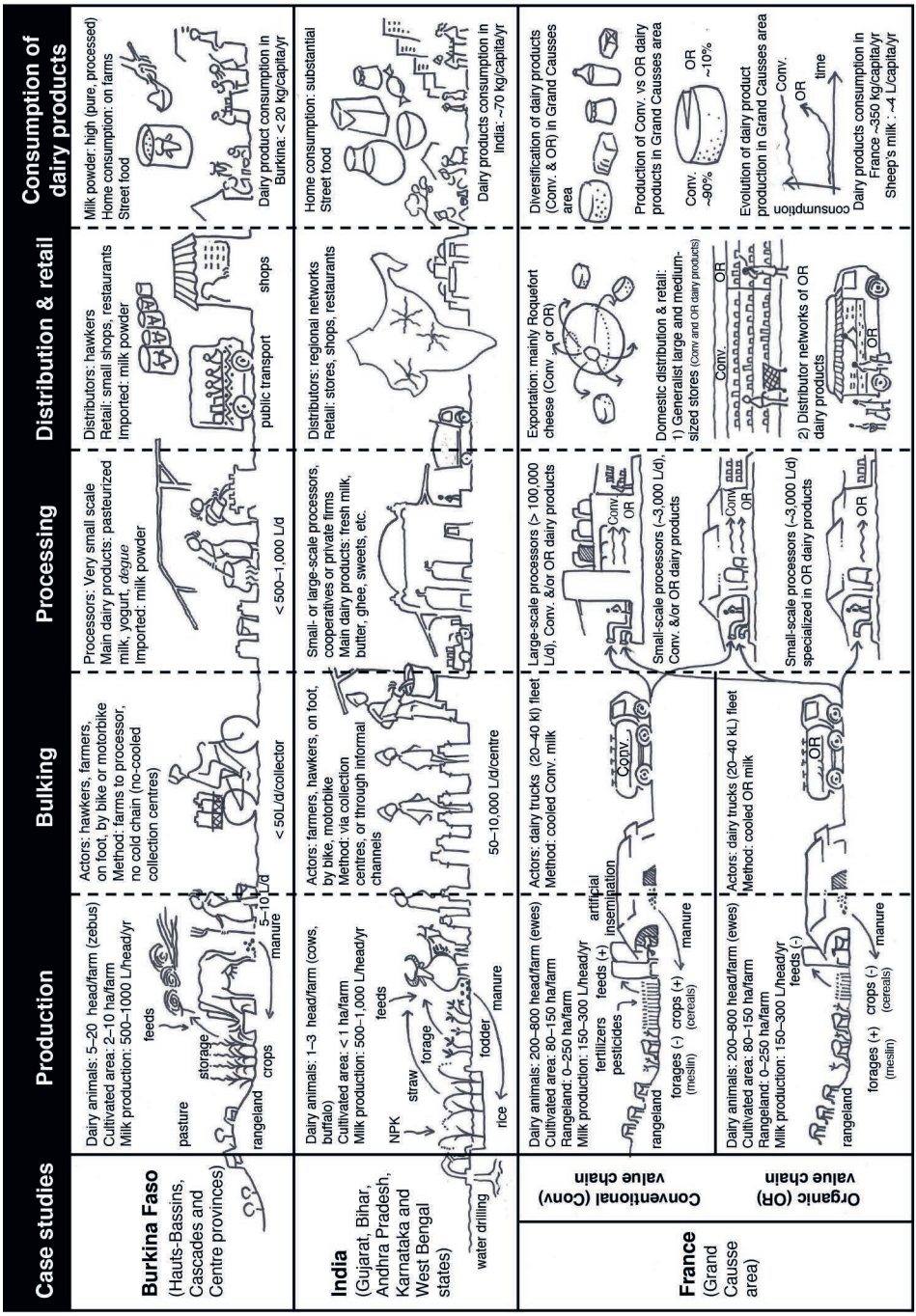

Figure 11.4. Schematic representation of the stages from production at farm level to consumption of milk and dairy products for the three case studies.

⏩ Evidence of agroecology in milk production and marketing systems

Burkinabe case study

Pastoral dairy farms and agro-pastoral dairy farms, mostly Fulani herders, have deeper local knowledge of pastoral resources (vegetation, water) used daily for cattle herding than new dairy farmers from urban areas who have established more intensive mini-dairy farms (Vall and Diallo, 2009). As such, pastoral and agro-pastoral dairy farms exploit the spontaneous pasture-grazing resources to a greater extent than do mini-dairy farms: the daily intakes for pastoral, agro-pastoral and mini-dairy farms are 4 kg, 3.5 kg and 1 kg of dry matter (DM) per cow per day, respectively. However, synergies between agriculture and livestock, as well as recycling of crop and livestock by-products, are more developed among mini-dairy farms and agro-pastoral dairy farms compared to pastoral dairy farms (Vall et al., 2021):

- Stored fodder: 2,300 kg vs 900 kg of DM per cow per year, respectively;
- Recycled manure: 450 kg vs 300 kg of DM per cow per year, respectively;
- Animal faeces lost on pasture: 200 kg vs 400 kg of DM per cow per year, respectively.

The excessive use of feed concentrates by mini-dairy farms reflects an efficiency problem with this resource: for mini-dairy, agro-pastoral and pastoral dairy farms, the figures are 6, 4 and <1 kg of DM per dairy cow per day, respectively. This excessive use also affects the environmental efficiency of these systems, both in terms of fossil fuel consumption and greenhouse gas emissions per litre of milk produced (Somda, 2020). Furthermore, the systematic reliance on artificial insemination and exotic dairy breeds, which helps mini-dairy-farms achieve higher production levels than agro-pastoral and pastoral dairy farms (2,000 vs. 900 vs. 350 L per dairy cow per year, respectively) and meet market expectations, has negative consequences in term of animal welfare: European dairy breeds have a much lower thermal comfort point than the local average temperature. As a result, mini-dairy farms and agro-pastoral dairy farms are more reliant on exogenous inputs, making them less resilient to economic shocks (i.e., sudden rise in input prices) than pastoral dairy farms, which are highly input self-sufficient. High milk prices at farmgate and all along the value chain explain why milk losses and waste are very low (<15%) in this area unlike in developed countries.

With regard to human and social values, women control the milk income on 60% of pastoral dairy systems. This figure drops to 40% on agro-pastoral dairy farms and 18% on mini-dairy farms. Many mini-dairy processors are run by women. Processors have considerable influence over the upstream part of the milk value chain and are a key entry point for tackling such exclusion issues.

Circularity and solidarity values are rarely promoted in current marketing practices. In the face of competition from large-scale milk powder imports, the Economic Community of West African States (ECOWAS), NGOs and farmers' organizations are rallying to promote local production and attempt to introduce more responsible governance practices for the dairy value chain in West Africa (CEDEAO/ECOWAS, 2019 and Corniaux et al., 2020).

Indian case study

In India, synergies between crop and livestock production are strong. Livestock farming has emerged as a powerful means of recycling crop residues, in particular wheat and rice straw, whose production has risen significantly as a result of the Green Revolution. On some farms and in certain regions, livestock farming still provides draft power and contributes to the management of cropland fertility (both through nutrients and organic matter that improve soil structure), while minimizing the use of chemical inputs and irrigation water. However, the type of agriculture with which it is associated consumes, when irrigated, a great deal of chemical fertilizers (particularly nitrogen) and fossil fuels (not least for pumping water). Overall environmental efficiency remains low, due in part to high consumption of fossil fuels, and even if livestock is mainly fed by crop residues (Vigne et al., 2021; Aubron et al., 2021). In addition, the fact that herds raised on irrigated farms are dedicated to dairy farming generally leads to a decline in the importance of other livestock functions (e.g., tractors being used instead of draft animal power), reduced breed diversity (in favour of more productive breeds, achieved by means of artificial insemination) and increased purchases of concentrates that reduce farms' self-sufficiency.

The extensive cooperative milk collection, processing and distribution network established during the White Revolution is a model of inclusiveness that has won much international praise (World Bank, 2012). This success is based both on an innovative cooperative model and on a sector-specific public policy that supports its development. The strength of the cooperative network stems from a combination of dairy producers' substantial involvement in the collection process and the search for economic efficiency at the processing and marketing stages, in particular through economies of scale and inter-site coordination. The role played by the NDDB in building and subsequently steering this cooperative network appears to be central and suggests that public bodies are able to foster the development of common industry resources and shape inclusion (Dervillé et al., forthcoming a), which is not the case in many developing countries in West Africa. However, the actual involvement of farmers in decision-making processes at all levels of the network remains limited. Furthermore, although farmers with little land and irrigation water are definitely included in this dairy market, the income generated remains very low in relation to that derived from irrigated crops: the whole system is a long way from being able to lift people out of poverty and ensure greater equity among rural families in the areas studied (Aubron et al., 2019). In addition, the spatial distribution of the dairy cooperatives is very uneven, leading to very different conditions among dairy farmers in terms of access to dairy markets and income (Dervillé et al., forthcoming b). Moreover, the dairy cooperatives played a key role in structuring industrial dairy chains, and agroecology has not been a priority so far. Initial shifts towards agroecological practices entail the development of conservation programs for local livestock breeds as well as the recent launch of a ration-balancing programme aiming at improving the efficiency of feeding practices.

French case study

Technical changes seen in the Grand Causses farms that adopted agroecological practices are based on crop diversification. The introduction of legumes helps to reduce, if not eliminate, the use of mineral fertilizers. This introduction complements the recycling process already implemented between crops and livestock through manure. Farmers diversify their crop production to boost farm resilience against increasingly frequent droughts (because crops grown on the same farm do not all have the same sensitivity to drought). Crop diversification also helps to improve the protein autonomy of herds and therefore the overall efficiency of the livestock systems. Conversion to organic farming by some farmers is largely based on this diversification approach, in addition to other zootechnical or agronomic practices, such as false seeding for weed control (Vidal et al., 2020).

However, these holdings, even under organic farming, are still highly fossil fuel intensive (motorized fodder production and harvesting, milking equipment). Additionally, volume increases and production time lags lead to reduced use of rangelands. In order to feed lactating ewes, particularly in summer, farmers favour cultivated resources over rangelands (Aubron et al., 2014). This contributes to the closing over of these rangelands, threatening the biodiversity of open habitats, despite their importance being recognized by the EU with their designation as Natura 2000 areas, as well as by UNESCO (Vidal, 2019).

As the oldest French cheese to be awarded PDO status (1925), Roquefort remains a symbol of food culture and tradition, even though its consumption is steadily declining. Alongside it, the range of products made from sheep's milk has expanded greatly, with the production of other types of cheese, partly derived from local cheese-making traditions and increasingly produced under organic farming standards, as well as ultra-fresh dairy products. These products meet the needs of consumers concerned with healthy eating (alternatives to cow's milk proteins for people who are allergic, products free of chemical residues) and environmental issues (pollution from chemical inputs, biodiversity conservation).

The emergence of other dairy processors operating outside the Roquefort inter-branch organization and the introduction of the EU Milk Package in 2015 destabilized governance and put an end to the price guarantee for producers. However, recent dairy industry restructuring should help strengthen producers' bargaining power, which is often undermined in highly competitive and deregulated environments. The impact of these changes in the sector for the agroecological transition of farms remains in question. Finally, the development of production under organic specifications, supported by dairies both inside and outside the Roquefort system, contributes to the establishment of some agroecological practices, although the role of spontaneous vegetation in animal food systems is often weakened.

⏩ Discussion and conclusion

The one aspect common to all three case studies is an increase in milk production, either at farm or collection pool level, for a variety of reasons: 1) a rise in the overall

demand for milk, due to population growth and greater individual consumption (Indian and Burkinabe case studies); 2) a willingness on the part of some dairy farmers and processors to promote local milk production in the face of competition from imported milk powder (Burkinabe case study); 3) a growing consumer appeal for organic, ultra-fresh dairy products and sheep's milk dairy products (French case study); and 4) efforts to achieve higher delivery volumes at farm level to ensure income. Analysis of the above case studies shows that while agroecological practices have indeed been introduced as part of this process of increasing production and marketing, a number of challenges remain, particularly from an environmental and social point of view.

Crop-livestock integration is often central in dairy farms (Figure 11.4), and this was true in the three case studies. Crops provide feed for livestock via straw (Indian and Burkinabe case studies), fodder crops (Indian and French case studies) and cereal crops (French case study). Livestock contributes to land fertility through plant biomass recycling and manure production, involving in some cases animal movements between rangeland and cultivated areas (Burkinabe, French, and occasionally Indian case studies). Crop-livestock integration can also provide energy for transport and farming (Indian case study, and sometimes Burkinabe case study). In the Indian and Burkinabe case studies, dairy farming is often associated with intensive cropping systems (cotton, irrigated rice) on the same farm. Dairy cows benefit from the by-products of these crops (stems, hulls, straw), such as fodder and bedding – by-products that are available in large quantities because of the inputs applied to these crops (mineral fertilizers, pesticides, irrigation). The cows recycle this raw material into organic manure, which is returned to the fields and thus improves soil fertility. Crop-livestock integration promotes several elements of agroecology (diversity, synergies, efficiency and recycling), therefore contributing to overall system resilience. However, these farms can also be highly fossil-fuel intensive (motorized equipment in the French case study, water pumping and use of synthetic fertilizer in the Indian case study) as well as heavy users of agrochemicals (the pesticides used on crops like cotton and cowpea not only negatively impact insect populations such as bees, but also the quality of cowpea tops fed to livestock in the Burkinabe case study).

The primary technical means for increasing production is genetics (both animal and plant), with the selection of pure Lacaune breeds (French case study) or the use of exotic dairy breeds crossed with local cattle through artificial insemination (Indian case study, and increasingly in the Burkinabe case study). These crossbred animals may be less suited to their local environment and thus require more veterinary care (e.g., to prevent trypanosomiasis in the Burkinabe case study). The second technical means, which helps optimize the first one, is increased use of feed concentrates (Indian and Burkinabe case studies). Their production requires chemical inputs and energy, and when purchased, they must be transported. These processes contribute to the negative environmental impacts of livestock farming (GHG emissions, pollution). In some mini-dairy farms (Burkinabe case study), their excessive use can also be a problem for dairy cow health (risk of acidosis). The transition to organic farming (French case study) has generally led to a further increase in milk production per ewe, as well as a shift in the production period as requested by dairies. However,

for many farmers, this change has resulted in a decrease in the use of rangeland spontaneous vegetation, with a reduction in the maintenance of open environments.

From a social point of view, greater milk production and marketing does not automatically lead to social inclusion and equity. Farms with fewer resources for dairy intensification (land and irrigation water in the Indian case study, arable land in the French case study) produce less than the larger farms with which they compete. As a result, their numbers continue to fall rapidly (French case study) and their income from milk is very low compared with that from irrigated crops (Indian case study). Due to their isolation, some farmers are also excluded from dairies' collection routes (pastoralists and agro-pastoralists during certain seasons in the Burkinabe case study, and farmers in certain parts of the Causses region in France). Finally, in the Burkinabe case study, women tend to lose control over milk income as volumes and dairy sales increase (milk marketing brings into question the balance between multiple milk uses at farm level: household self-consumption vs women's income vs calf feeding). The results gathered from this study suggest that inclusion can be promoted in a number of ways, such as establishing a vast cooperative network for the collection, processing and distribution of milk under the supervision of a public body (Indian case study), introducing inter-branch collective action and standards to manage competition between farmers and between dairies (French case study), or promoting corporate social responsibility actions among dairies (Burkinabe case study). The first two approaches seem to have been undermined by economic deregulation and are in the process of being redefined (producer companies in the Indian case study, producer organizations in French case study).

In these contrasting situations, it seems that, in order to combine the increase in milk production with a virtuous process of agroecological transition, trade-offs must be made and a holistic approach is required at the value chain level, with efforts being spread across all its segments.

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References

Altieri, M. A. (1996). *Agroecology: the Science of Sustainable Agriculture, 2nd Edition*. CRC Press.

Aubron, C., Bainville, S., & Philippon, O. (2019). Is dairy farming benefiting the poor? Compared economic assessments at the farm level. International seminar 'Milk and Dairy in India's Development Path. Lessons, challenges and perspectives', India International Centre, New Delhi, 17-18 December.

Aubron, C., Peglion, M., Nozières, M.-O., & Boutonnet, J.-P. (2014). Quality schemes and pastoralism in France. Synergies and paradoxes. *Journal of Alpine Research, Revue de géographie alpine*, *102*(2). https://doi.org/10.4000/rga.2450

Aubron, C., Vigne, M., Philippon, O., Lucas, C., Lesens, P., Upton, S., Salgado, P., & Ruiz, L. (2021). Nitrogen metabolism of an Indian village based on the comparative agriculture approach: How characterizing social diversity was essential for understanding crop-livestock integration. *Agricultural Systems*, *193*, 103218. https://doi.org/10.1016/j.agsy.2021.103218

CEDEAO, & ECOWAS (2019). Offensive régionale pour la promotion des chaines de valeur du lait local en Afrique de l'Ouest. Strategic document. Commission de la CEDEAO, Département de l'Agriculture, de l'Environnement et des Ressources en Eau.

Cochetel, C., Phlippon, O., Aubron, C., & Ruiz, L. (2019). Resilience of draught power and manure: insights from 3 case-studies in South India. International seminar 'Milk and Dairy in India's Development Path. Lessons, challenges and perspectives', India International Centre, New Delhi, 17–18 December.

Corniaux, C., Chatellier, V., Dia, D., & Duteurtre, G. (2020). De l'huile de palme dans le lait : comment l'Union européenne renforce sa présence sur le marché laitier Ouest africain en vendant un succédané de poudre de lait. 3R, 25e éditions. https://agritrop.cirad.fr/597717/

Dervillé, M., Dorin, B., Aubron, C., & Raboisson, D., forthcoming a. Scaling inclusive business: 20 years of statistical insights into the success of Indian dairy cooperatives. Submitted to *Journal of Cleaner Production*.

Dervillé, M., Dorin, B., Jenin, L., Raboisson, D., & Aubron, C., forthcoming b. Inclusiveness approach of the Indian dairy sector. *Journal of Economic Issues*.

Dorin, B., Garoyan, D., Mahadevan, A., Mondal, S., Morel, C., & Sehgal, A. (2019). Feeding over 500 million livestock units in India. A tentative retro-prospective model (1966–2050). Provisional results, International seminar 'Milk and Dairy in India's Development Path. Lessons, challenges and perspectives', India International Centre, New Delhi, 17–18 December.

Dorin, B., & Landy, F. (2009). Agriculture and food in India: A half-century review, from independence to globalization. CSH. https://agritrop.cirad.fr/552205/

Gliessman, S. R. (1997). *Agroecology: Ecological Processes in Sustainable Agriculture*. CRC Press. https://knowledge4policy.ec.europa.eu/publication/agroecology-ecological-processes-sustainable-agriculture_en

Gupta, P. R. (2017). *Dairy India Yearbook… serving the dairy industry since 1983. 7nd Edition*. New Delhi. (http://dairyindia.in)

Jenin, L. M., Dervillé, J., Bogue, S., Onakuse, A., & Gallegos, A., forthcoming. New generation cooperatives as inclusive business models: lessons learnt from the Indian dairy industry. Submitted to *Journal of Co-operative Organization and Management*.

Quetier, F., Marty, P., & Lepart, J. (2005). Farmers' management strategies and land use in an agropastoral landscape: roquefort cheese production rules as a driver of change. *Agricultural Systems*, *84*(2), 171–193. https://doi.org/10.1016/j.agsy.2004.05.005

Sombda, B. D. (2020). Évaluation des émissions de gaz à effet de serre par la méthode ACV avec une prise en compte de la multifonctionnalité des systèmes de productions animales ouest-africains. Cas de la commune rurale de Koumbia et de la zone périurbaine de Bobo-Dioulasso. [Mémoire pour l'obtention du Master II en Gestion Intégrée des Ressources Naturelles (GIRN), option Système de Production Animale, spécialité Elevage, Environnement et Développement Durable (EEDD). Université Nazi Boni (UNB), Institut du Développement Rural (IDR), Bobo-Dioulasso, Burkina-Faso].

Vall, É., & Diallo, M. A. (2009). Savoirs techniques locaux et pratiques : la conduite des troupeaux aux pâturages (Ouest du Burkina Faso) [Analysis of practices using local technical knowledge: the case of livestock grazing management in western Burkina Faso]. *Natures Sciences Sociétés*, *17*, 122–135. https://doi.org/10.1051/nss/2009024

Vall, É., Sib, O., Vidal, A., & Delma, J. B. (2021). Dairy farming systems driven by the market and low-cost intensification in West Africa: the case of Burkina Faso. *Tropical Animal Health and Production*, *53* (288). https://doi.org/10.1007/s11250-021-02725-z

Vidal, A. (2019). Les transitions agroécologiques des élevages laitiers en territoires agro-pastoraux en France et au Burkina Faso [Doctoral thesis, Montpellier SupAgro, ED GAIA]. https://agritrop.cirad.fr/595320/

Vidal, A., Lurette, A., Nozières-Petit, M.-O., Vall, É., Moulin, C.-H. (2020). The emergence of agroecological practices on agropastoral dairy farms in the face of changing demand from dairies. *Biotechnologie, Agronomie, Société et Environnement*, *24*, 163–183. https://doi.org/10.25518/1780-4507.18645

Vigne, M., Dorin, B., & Aubron, C. (2021). Is feeding the Indian dairy cow sustainable? A tentative multiscalar answer. *International Journal of Agricultural Sustainability*, *0*, 1–13. https://doi.org/10.1080/14735903.2021.1920237

Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainaible Development*, *29*, 503–515. https://doi.org/10.1051/agro/2009004

Wezel, A., Casagrande, M., Celette, F., Vian, J.-F., Ferrer, A., & Peigné, J. (2014). Agroecological practices for sustainable agriculture. A review. *Agronomy for Sustainable Development*, *34*(1), 1–20. https://doi.org/10.1007/s13593-013-0180-7

Wezel, A., Gemmill Herren, B., Bezner Kerr, R., Barrios, E., Rodrigues Gonçalves, A. L., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. *A review. Agronomy for Sustainable Development*, *40*, 40. https://doi.org/10.1007/s13593-020-00646-z

World Bank (2012). Exporting India's Dairy 'Revolution' to Help Feed Children in Africa, South-South Facility. World Bank.