Characterising the dairy value chain from an agroecological perspective in the peri-urban area of Bobo-Dioulasso, Burkina Faso's 'Agroecological Living Landscape' focus area

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1 Introduction

Dairy consumption is growing strongly in Burkina Faso, particularly in urban areas (Ouagadougou and Bobo-Dioulasso) (Hamadou et al., 2007; Ouédraogo and Doanio, 2007), even though it remains relatively low compared with other parts of the world (around 25 kg of milk equivalent/capita/year according to the FAO). Despite significant potential (over 1.6 million dairy cows according to the FAO, for a national production of over 300,000 tonnes per year according to Vias 2018), local production can barely meet demand due to its weakness, seasonality, insufficient local milk collection and competition from imported milk powder. Most of the local milk production comes from extensive pastoral and agro-pastoral systems, with semi-intensive and intensive systems also contributing to a lesser extent (Vall et al., 2021). According to the study conducted by Vias in 2018, most of the milk produced is consumed by livestock farmers themselves (80%). Most of the milk marketed is sold directly at the market (94%), and the proportion of milk collected by processors only accounts for an estimated 6% of marketed milk. In Burkina Faso, processors tend to be mini-dairies (processing between 200 and 1,000 litres of milk a day), numbering around 200 and primarily located in cities. A significant proportion of locally processed dairy products consumed in Burkina Faso are made using imported milk powders (around 100,000 tonnes per year according to the 2018 Vias study). Recent upward trends in the price of imported milk powder provide an opportunity to intensify and develop local production, better organise the collection system and increase local milk processing capacity (Orasmaa, 2017; Sib et al., 2017; Duteurtre and Vidal, 2018; Vall et al. 2021, Sodré et al. 2022).

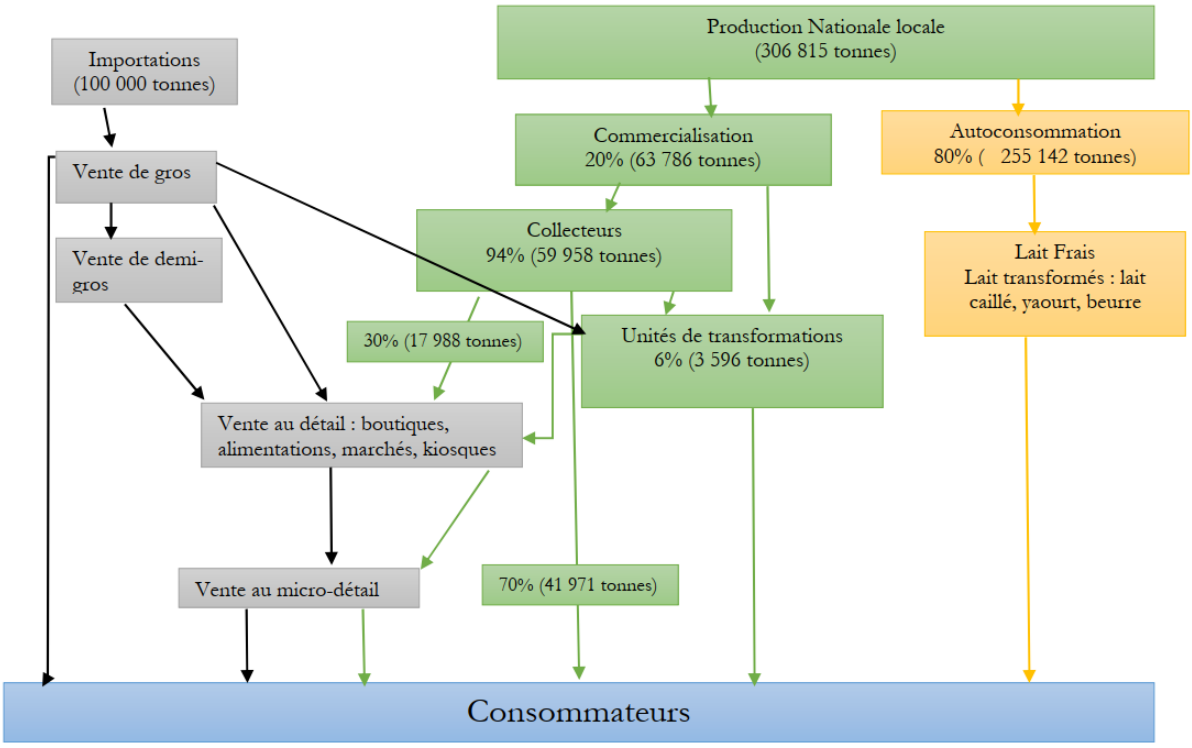


Figure 1. Milk production, distribution and consumption channels in Burkina Faso (source: Vias, 2018)

In Burkina Faso in general, and in Bobo-Dioulasso in particular, the local dairy value chain is currently being structured, with several industry bodies working to promote the value of locally produced milk: 1) the 'Interprofession lait du Burkina Faso' (IPROLAIT/BF), which has been active since 2001, 2) a large

number of farmers' cooperatives (such as the 'Coopérative des Producteurs de Lait' (COPROLAIT), set up in 2003 by a group of 20 private farmers from the Ouagadougou region); 3) and the UMPL/B ('Union Nationale des Mini laiteries et Producteurs de Lait'), set up in 2007, which now includes some forty mini-dairies and is behind the launch of the FairFaso label designed to promote local dairy products made from local milk). For the past ten years or so, the government and its partners have been supporting the creation of Milk Collection Centres (MCCs) on the outskirts of major cities, and in particular Bobo-Dioulasso, in order to extend the collection area and ensure a more regular milk supply to processors, both in terms of volume and quality. In these centres, collection activity is steadily increasing, but much assistance and support is still needed if they are to fully play their part and integrate successfully into the milk collection system. In Bobo-Dioulasso, local dairy industry stakeholders (farmers, collectors, processors) established a Dairy Innovation Platform (DIP) in 2020, which brings together all the local players with a view to fostering the integrated and sustainable development of the local dairy value chain.

Today, DIP stakeholders are well aware that local milk production, collection and promotion practices need to be changed and improved if they are to meet demand in a sustainable way. As part of the 'Agroecology Initiative' project, we are working on the assumption that to be sustainable, this change must meet key agroecological requirements, in particular in economic terms (ensuring a decent income for those involved, based on acceptable workloads and fulfilling work, and placing value on local production), in environmental terms (sustainable use of ecosystem resources, co-product recycling, bio-diversification of food resources, reduction in GHG emission intensity, etc.), and in social terms (inclusion of women and young people in the dairy value chain, limiting conflicts and competition for access to animal feed resources, etc.).

The overall purpose of this background paper is to provide a review of current knowledge on the local dairy value chain in the Hauts-Bassins region (Bobo-Dioulasso) in relation to the principles of agroecology. The study involved a review of available literature, followed by interviews with managers of Bobo-Dioulasso's dairy platform, as well as managers of Dairy Processing Units (DPUs), Milk Collection Centres (MCCs) and farmers' cooperatives. Documents reviewed include journal articles, graduate theses and dissertations, and study reports on Burkina Faso's dairy value chain, with particular emphasis on the Bobo-Dioulasso region.

2 A brief recent history of Bobo-Dioulasso's dairy value chain

In the Bobo Dioulasso region, milk collected by women on Fulani farms was traditionally intended mainly for household consumption. Over the years, women started selling unconsumed surplus milk by the roadside in villages or from door to door in concessions, and then at the market in town. This marketing approach is still in use today. However, dairy processing units have now entered the dairy market.

Their story more or less began in 1991, when the BKF 93/011 'Dairy production development' project led to the creation of the Faso Kossam dairy. Until 1999, this project was financed by the UNDP and implemented by the FAO and the Burkina government. The dairy operated from 1991 to 1999 with a commercial capacity of 1,000 l/day. This Dairy Processing Unit (DPU) marked the beginning of an organised dairy value chain in Bobo-Dioulasso's dairy production area. The aim of the project was to ensure the development of a regular and income-generating milk production activity for farming families, and to increase their annual production from 100 to 160 litres of marketed milk per cow. In order to achieve these goals, the project set out to organise Fulani livestock farmers from 14 villages and established farmers' groups (8 groups) as well as eight women's groups to ensure regular milk

collection and supply to the dairy. The dairy's activities included milk collection, treatment and processing, as well as the sale of products such as fresh pasteurised milk, sour milk, yoghurt, cream, pasteurised butter and cheese under the 'Faso Kossam' label. The new organisation driven by Faso Kosam was expected to enable industry players to benefit from the sale of milk by encouraging farmers to group together for more efficient milk collection. However, the dairy's business model was not viable, and income was not sufficient to cover its expenses. The dairy ran into major financial difficulties, leading to its decline and eventual closure.

Following the closure of Faso Kossam, things reverted back to the original situation, with milk sold on an individual basis. However, the collection system was still in place, with most Faso Kossam staff having set up mini-dairies and started collecting and processing milk privately, establishing producer and processor associations with the support of the Livestock Department. A milk collection group was thus set up by livestock farmers in Bama, Farakoba, Yéguérésso and Dafinso. Milk was collected under trees and delivered to the Bonnet Vert dairy, one of the pioneering dairies still in operation to this day.

From 2014 onwards, aware that a network of small private dairies was emerging but that they had difficulties collecting large quantities of milk, the Ministry of Livestock Resources supported the setting up of milk collection centres with a view to extending the collection area and securing supplies for these dairy processing units (DPUs). Around 2014, the World Bank-funded Agricultural Productivity and Food Security Project (PAPSA), which sought to improve the capacity of low-income farmers to increase food production while ensuring improved availability of food products in rural markets, funded the creation of Milk Collection Centres (MCCs) to enable livestock farmers and livestock farmer groups to market their milk more effectively. Today, around ten MCCs operate in Bobo-Dioulasso's dairy production area. But their activity remains somewhat modest and is limited to milk collection.

Yet milk collection centres, operating as an interface between farmers and processors, have the potential to provide a major boost to the local dairy value chain, enabling more milk to be collected, milk quality to be better controlled and useful services to be provided to farmers. This is a key point that will receive particular attention as part of the 'Agroecology Initiative' project in Burkina Faso in order to gain a better understanding of the obstacles involved and to co-design organisational changes with stakeholders so as to overcome them. However, at this stage we must gain a better understanding of the way the local dairy value chain operates and is run.

3 Bobo-Dioulasso's dairy value chain at a glance

Two recent studies offer very similar views of the way in which the local dairy value chain is organised (Figure 2, Figure 3).

Dairy products consumption: In Bobo-Dioulasso, the local dairy industry is experiencing significant momentum as a result of the growing demand for milk and dairy products, itself fuelled by a steadily rising population (more than 1.2 million inhabitants in Bobo-Dioulasso in 2022) and a burgeoning middle class eager to consume more dairy products. This momentum is marked by the emergence of milk collection centres, the proliferation of mini-dairies, the gradual organisation of direct stakeholders and the development of milk processing.

According to the study conducted by Hamadou et al in 2007, milk and dairy product consumption was influenced by many socio-cultural and economic factors, and consumers' purchasing decisions were primarily driven by such considerations as hygiene, price, taste, availability, packaging, ease of use and shelf life. Ethnicity, age and marital status also played a secondary role in purchasing decisions. The study also showed that the influence of religion on the level of expenditure on dairy products was

relatively small, pointing out that in cities, dairy consumption habits were spreading to communities that did not previously consume such products. According to the study, Burkina Faso's local dairy industry was fairly competitive compared with Senegal's as prices acceptable to consumers varied between 250 and 375 CFA francs for half a litre of natural sour milk, and between 255 and 350 CFA francs for half a litre of sour milk powder.

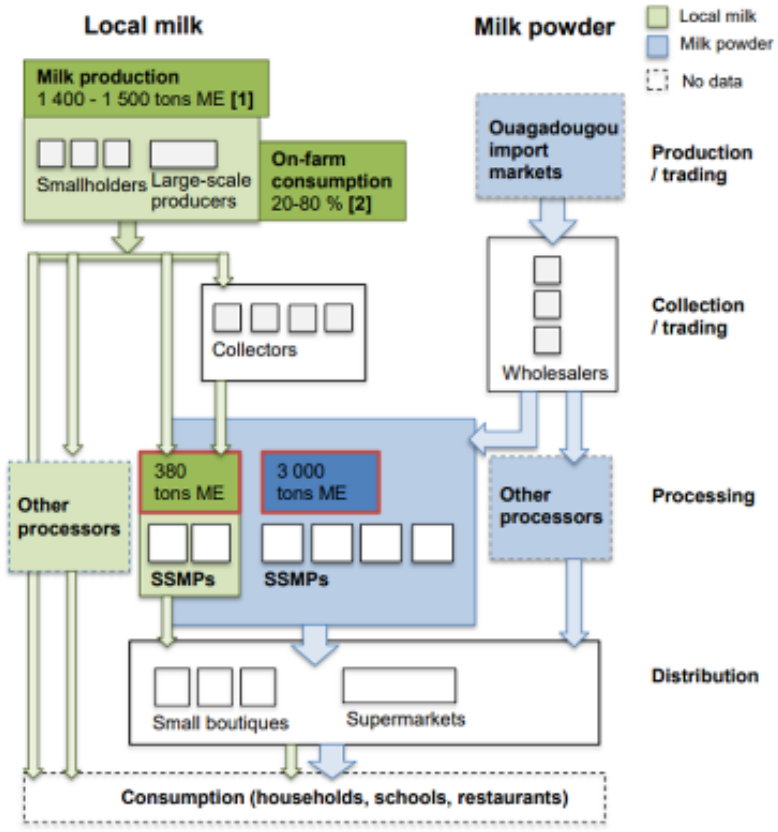
Sale of dairy products: Dairy consumers buy their products via two channels: 1) either from women livestock farmers selling their farm-produced dairy products (mainly fresh milk and sour milk) door-to-door in streets and markets around town. Prices for these products are high (often in excess of 500 F/l) and retail volumes sold are very low (less than 10l/d/farmer). However, these products are very popular with consumers who often buy them from their own dedicated women suppliers; 2) or in retail outlets as pasteurised milk, yoghurts or sour milk, packaged in very small portions and sold relatively cheaply (Orasmaa, 2017; Duteurtre and Vidal 2018). A large proportion of yoghurts consumed in Bobo-Dioulasso are made from powdered milk.

Dairy processing: Over the past thirty years, the city of Bobo-Dioulasso has witnessed a surge in the number of dairy processing units (DPUs) of varying sizes (Corniaux et al, 2014). These are primarily small-scale artisanal and semi-artisanal units that process between 40 and 1,000 litres of milk per day (GRET, 2019). In 2017, the city of Bobo-Dioulasso boasted around 30 DPUs, which then joined forces to set up a cooperative in 2018 (the 'Neema' Cooperative). These DPUs have two sources of milk supply: most of them use imported milk powder (which is more readily available, often cheaper than locally produced liquid milk and stable in terms of biological quality); but some dairies wishing to use local milk to meet demand for dairy products with a more distinctive taste (Hamadou et al., 2007) buy from local farmers (and supplement their supplies with powdered milk at certain times of the year, such as at the end of the dry season). See section 4.3 of the document on page 4 for more details on how Bobo-Dioulasso DPUs operate.

Collection of locally produced milk: A significant proportion of locally produced milk is either collected by private operators on motorbikes or bicycles or delivered directly to the dairy by the farmers. This system has one drawback, in that it precludes any large-scale collection of milk deep inside the production area where many livestock farmers who could potentially contribute to the dairy value chain are based. Drawing on the experience gained from the Banfora dairy platform in organising local milk collection from farmers around the city, the government and its partners promoted the creation and outfitting of Milk Collection Centres (MCCs) in dairy production areas. In 2019, there were 6 MCCs around Bobo-Dioulasso. Today, in 2023, this figure has risen to 10. But their activity remains somewhat modest and is limited to milk collection. See section 4.2 of the document page 21 for more details on how MCCs and the collection system operate.

Milk production*:* Today, milk is primarily produced by agro-pastoral livestock farmers who see dairy farming as a sideline (their main activity being livestock sales, i.e. these are mainly suckler cattle farming systems) and by a few dairy farms specialising in milk production (i.e. commercial and relatively intensive farming). Overall, this stage of the production chain has barely changed over the last 20 years, as the situation described by Hamadou et al (2003) is virtually the same as that prevailing today: more than 90% of agro-pastoral farms with suckler cattle farming systems and less than 10% of dairy farms with a dairy production unit. For the time being, the call of the market has barely filtered down to this level, although our recent studies show that a growing number of farmers are responding to the emerging demand of the dairy market (Sib et al., 2017; Vidal et al., 2020; Vall et al., 2021; Sodré et al., 2022). For more details on milk production systems, please refer to section 4.1 on page 12 of this document.

Figure 4. Milk value chain in Bobo-Dioulasso



Source: SSMP survey, distribution survey, interviews with milk powder importers
1 Hamadou et al. (2003)
2 Hamadou et al. (2003); Hamadou & Sanon, 2005

Figure 2. Schematic diagram of Bobo-Dioulasso's dairy value chain, as suggested by Orasmaa (2017)

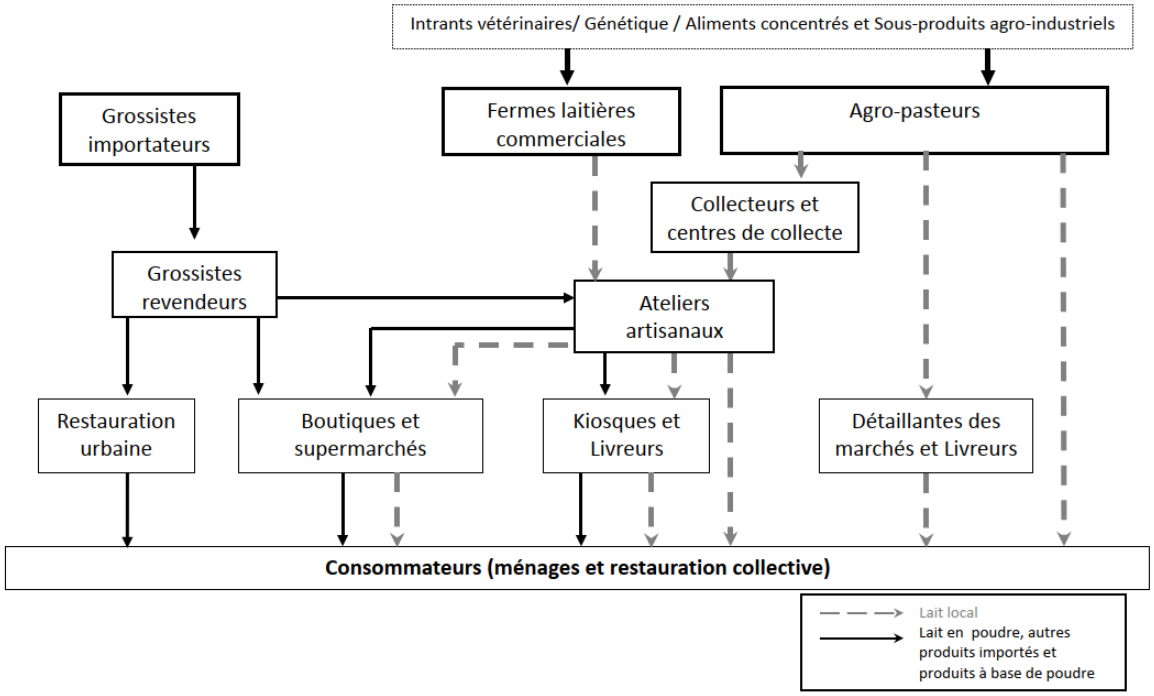


Figure 3. Schematic diagram of Bobo-Dioulasso's dairy value chain, as suggested by Duteurtre and Vidal (2018)

This whole organisational momentum helps to meet the growing demand for local milk and dairy products from individual consumers and institutional markets (school and hospital catering, military barracks and civilian prisons). It underpins the transformation of dairy production systems so that farmers can benefit from the dairy business while meeting the challenge of supplying DPUs.

Intensifying milk production has implications for the organisation and governance of the value chain. There is evidence that women are excluded from managing dairy-related income when this activity becomes economically important to the household (Vall et al., 2021). Among Fulani agro-pastoral dairy farmers, income from milk traditionally goes exclusively to women. However, this seems to change when farmers decide to sell their milk to a processing unit. This pattern is not specific to Burkina Faso and West Africa. Studies conducted in other parts of Africa show that women's workload tends to increase with intensive production and marketing of dairy products, leading to their being sidelined and men assuming more power in the marketing chain. Beyond production, the dairy value chain is largely male dominated, with men acting as collectors, processors, animal health officers, AI service providers and extension staff. Policies introduced to promote women's inclusion in value chains have been slow to produce results. These policies seek to increase women's involvement in the management of dairy cooperatives and improve their access to credit and training.

Figure 4 provides an updated overview of Bobo Dioulasso's dairy value chain stakeholders and Figure 5 details their roles and responsibilities in that value chain.

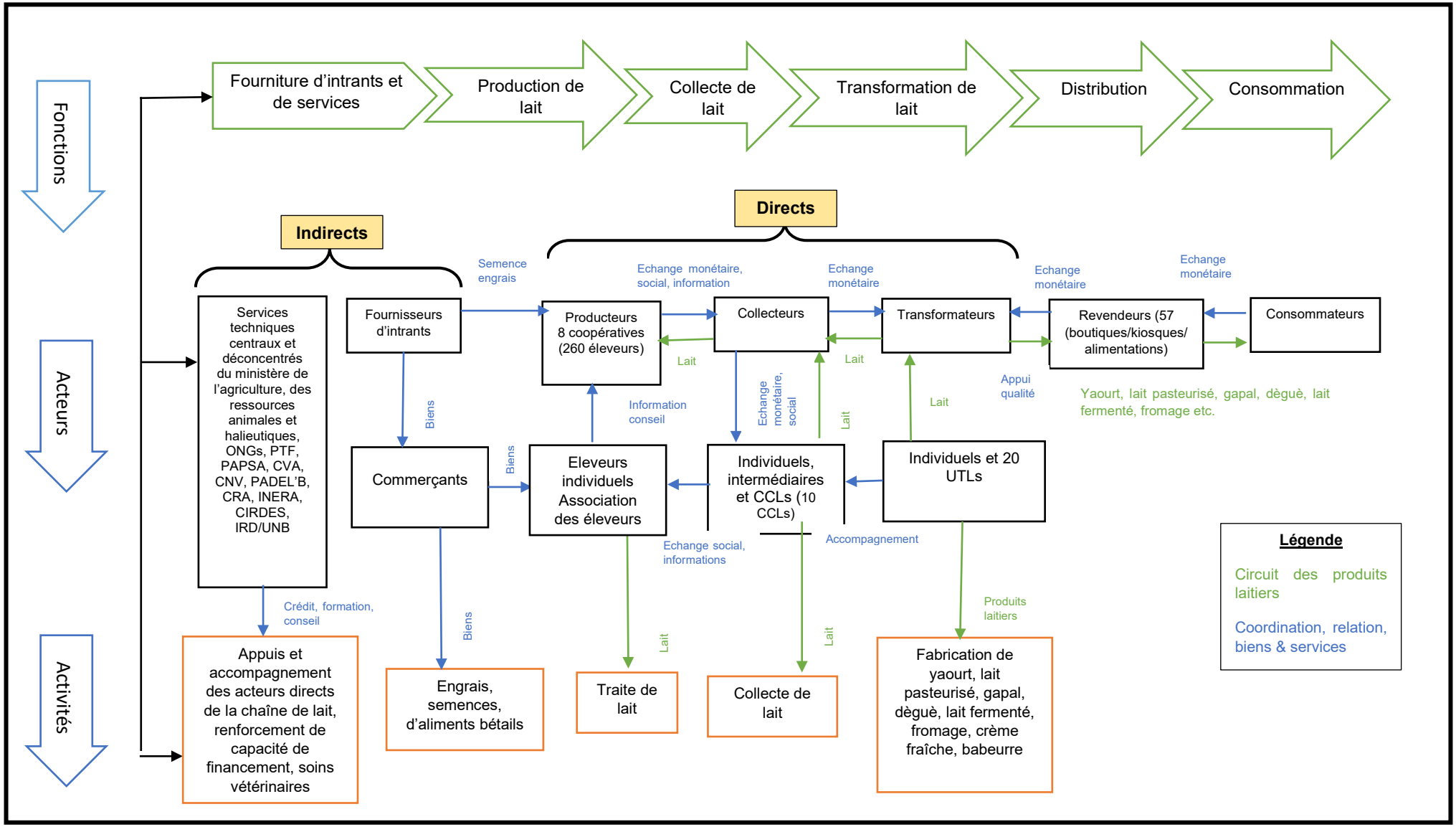


Figure 4. Overview of Bobo Dioulasso's dairy value chain stakeholders

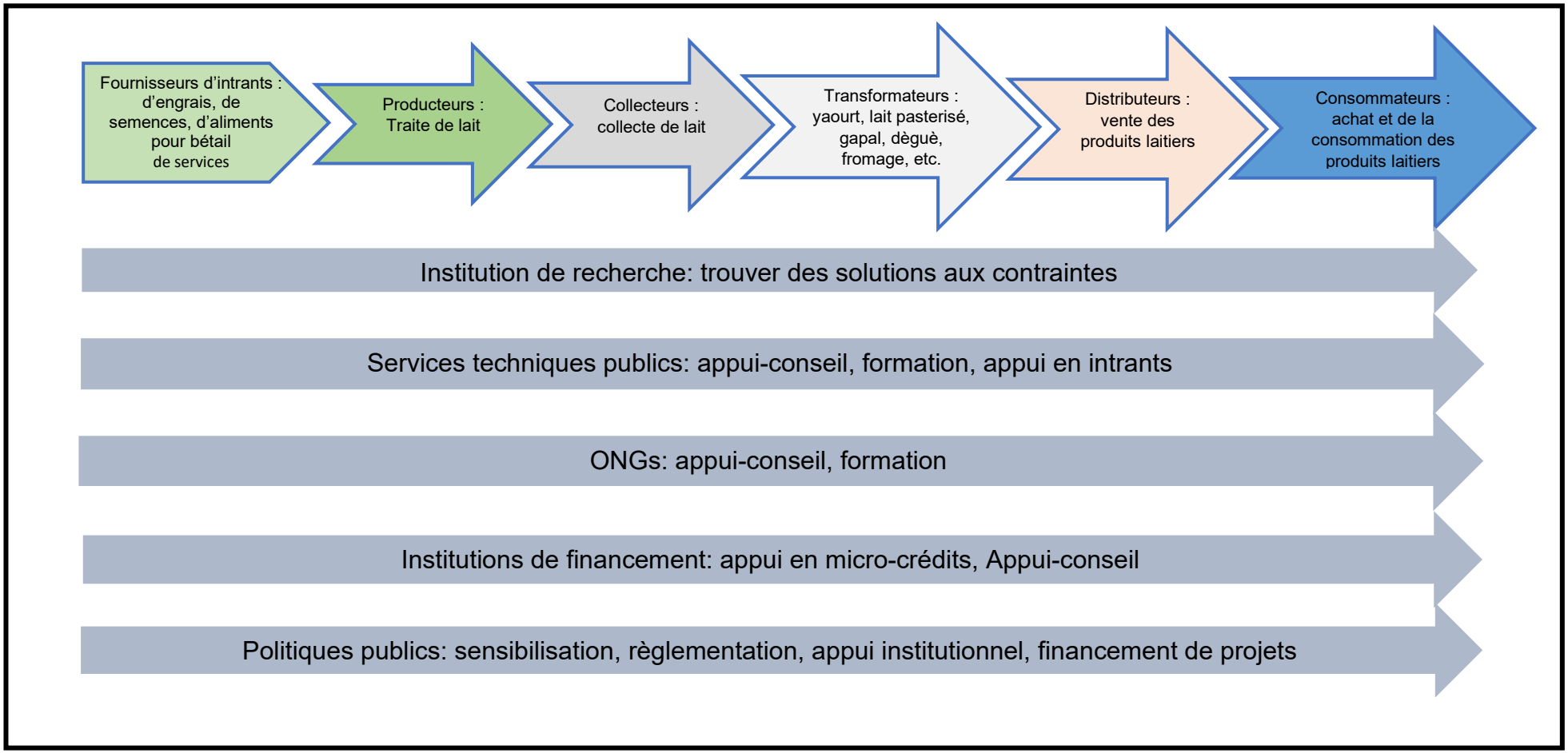


Figure 5. Roles and responsibilities of Bobo Dioulasso's dairy value chain stakeholders

4 Bobo-Dioulasso dairy industry stakeholders

4.1 Dairy cattle farmers

Bobo Dioulasso's dairy production area covers all areas within a 50 km radius of the city. The city relies on two supply channels for dairy products: local production of fresh milk from local cattle farms, and imported dairy products (primarily powdered milk and various dairy products).

The soil and climate conditions of this Sudanian area, conducive to agriculture, attract a working population of which 75% engage in farming (GRET, 2019). Agriculture is thus the main economic activity in Bobo Dioulasso's dairy production area, followed by livestock farming. In Bobo Dioulasso's dairy production area (Houet Province), livestock farming is mostly traditional, with a few attempts at modernisation. The potential cattle population was estimated at 1,633,910 heads in 2018 (INSD, 2018) in the Hauts-Bassins region. As shown on the map of Bobo-Dioulasso's dairy production area (Figure 6) produced in 2018 by Duteurtre and Vidal, dairy farms whose primary commercial purpose is to sell milk are located near the city and close to major thoroughfares. However, this map clearly shows that the vast majority of dairy cattle farmers are based in hamlets scattered throughout the Houet Province, often with poor road access.

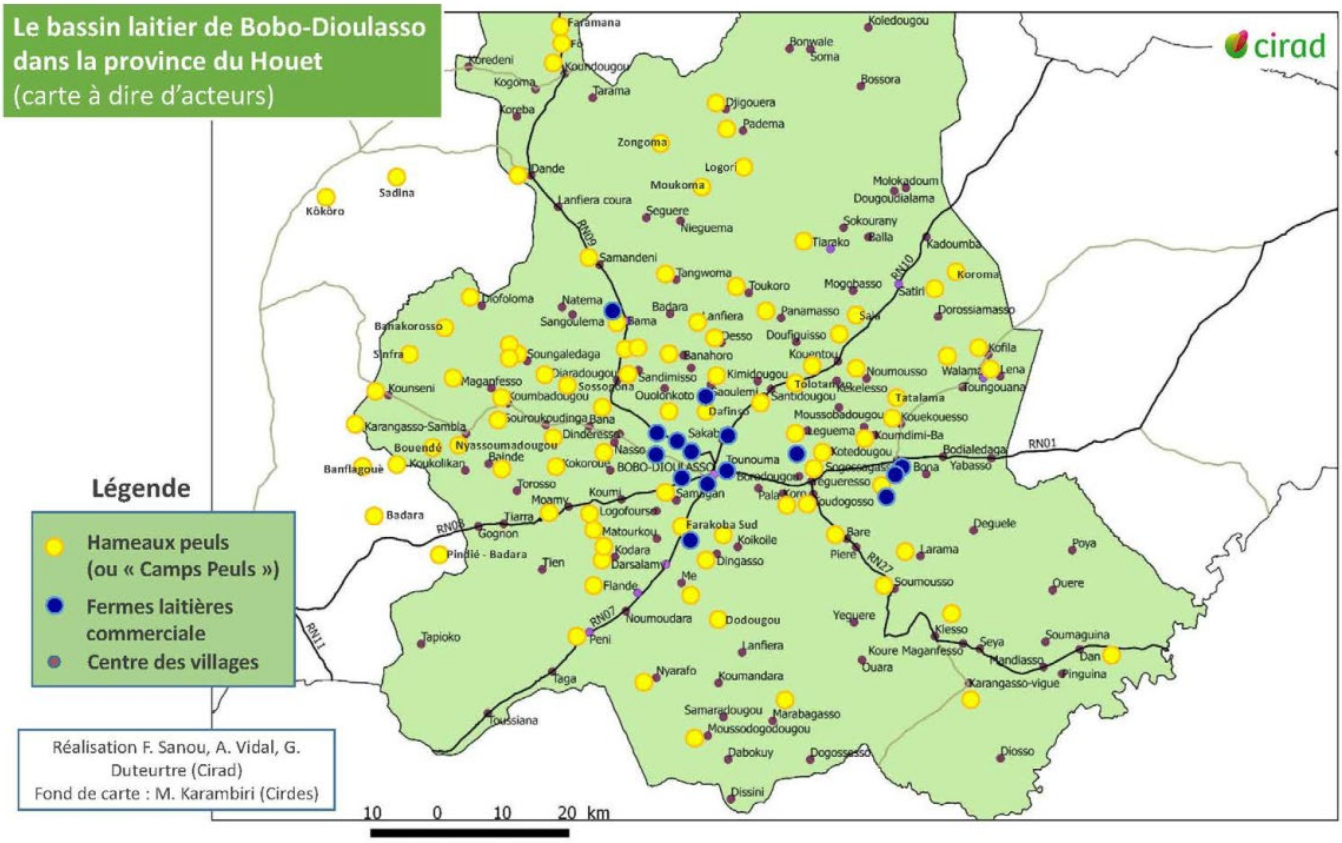


Figure 6. Map of Bobo-Dioulasso's dairy production area (source: Duteurtre and Vidal, 2018)

Over the past twenty years, this region has been witnessing a significant shift in its dairy industry, affecting a small number of livestock farmers (Sib et al., 2017). The study by Hamadou et al (2008) revealed that 98.5% of dairy farmers in Bobo-Dioulasso's dairy production area were extensive livestock farmers with low input methods, low production levels and little milk trading activity, including: a) transhumant herders with no expenditure on livestock feed; and b) sedentary farmers more inclined to provide their livestock with supplementary feed. According to this study, only 1.5% of milk-producing farmers were in the process of specialising in commercial dairy farming. For these livestock farmers, who could be described as 'intensive' (Sodré et al., 2022), milk production was more of a stated objective, warranting efforts to acquire land in order to ensure production sustainability and the implementation of more intensive practices (forage crops, breed improvement, artificial insemination), whereas for traditional low-input livestock farmers, the main goal was meat production following a rather 'extensive' approach. But with rising demand for dairy products, and in particular local products, these extensive farmers are increasingly showing interest in farming a selection of dairy cows to sell milk.

According to the Africa-Milk Project study, milk-producing farms can be divided into two major types according to feeding practices (in particular the role of grazing), health management practices, cattle breeds farmed, levels of farm equipment and technical performance of cows: i) agro-pastoral dairy farming systems (Figure 7); ii) dairy farming systems moving towards more intensive practices, including agroecological ones (Figure 8).

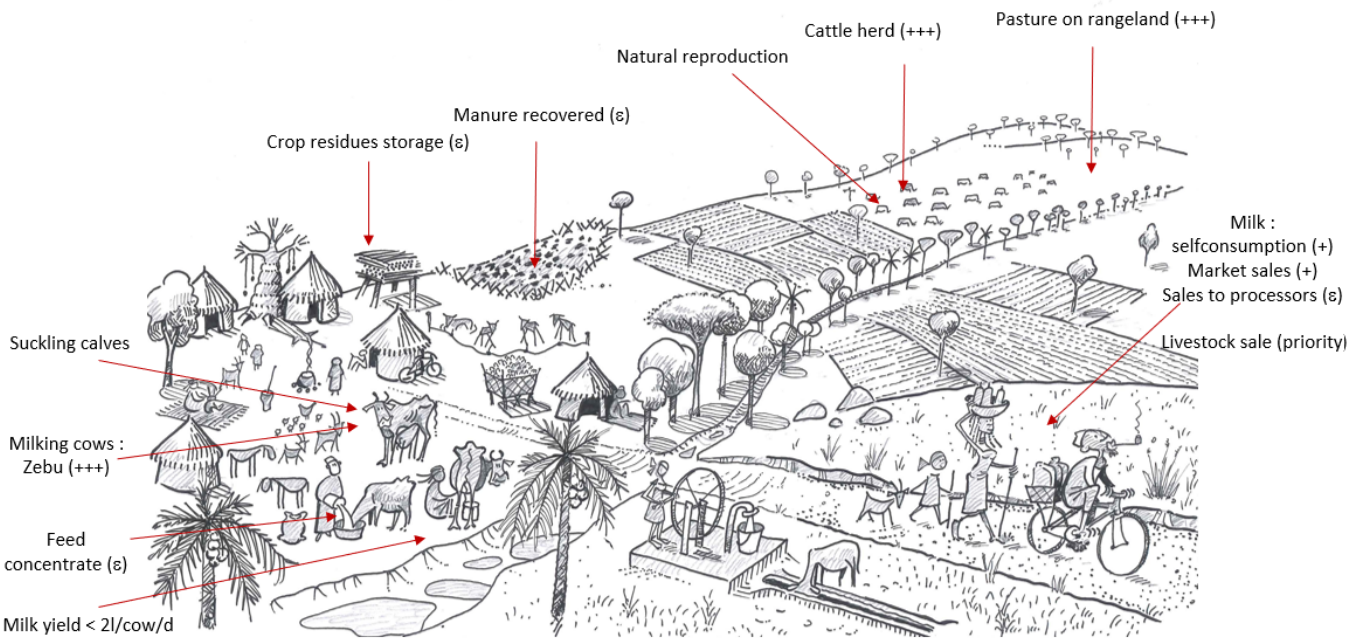


Figure 7. Agro-pastoral dairy farming systems

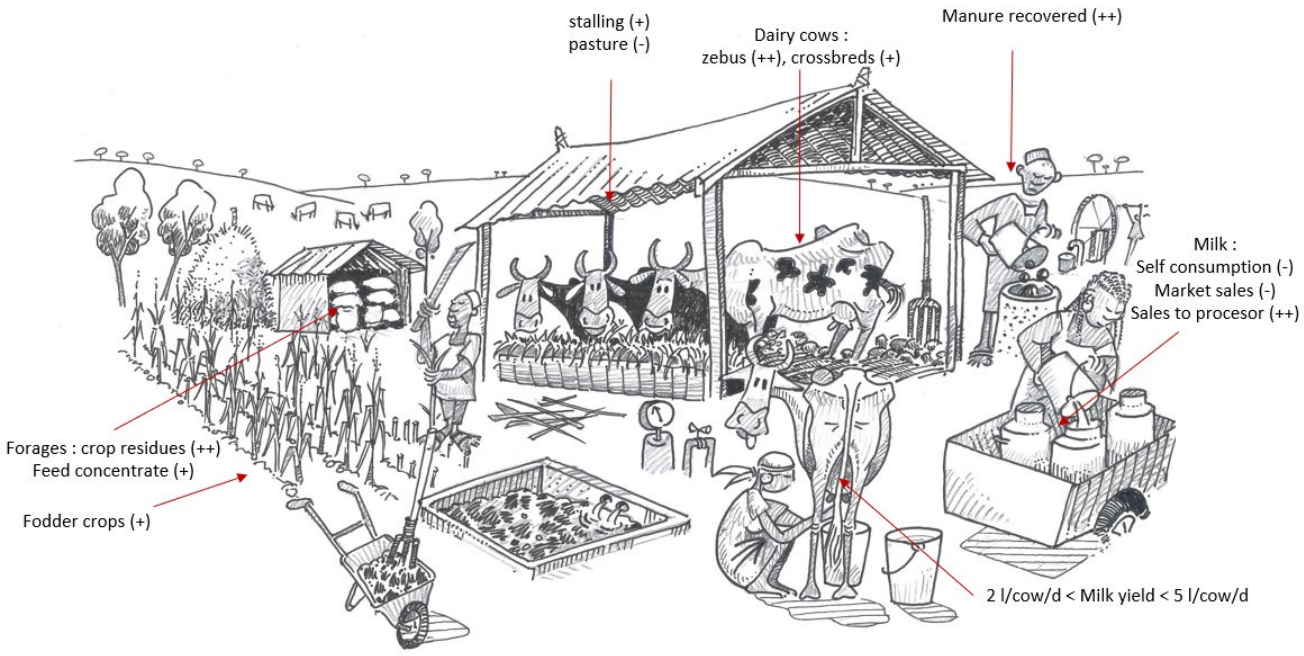


Figure 8. Dairy farming systems moving towards more agroecological intensive practices

4.1.1 Agro-pastoral dairy farms

These are mainly livestock farmers, originally pastoralists, who settled down and started farming to a greater or lesser extent, as well as some farmers who established a livestock production unit on their farm (Box 1). This farming system features extensive livestock herding based on rangeland grazing, with high animal mobility (short and long transhumance) as a resilience strategy (Gonin, 2018). In these systems, milk is generally used for own consumption and is not the main source of household income. Milk is almost seen as a by-product of a predominantly suckler farming system designed to continuously increase the number of livestock. Traditionally, milk was mainly farmed by women, who derived most of their income from it. For women in livestock farming households, milk is therefore a key source of income.

Box 1:

In the Hauts-Bassins region, the sedentary pastoral system arose from the government's decision to secure and increase livestock production by encouraging Fulani pastoralists to settle down after the droughts of the 1970s and 1980s through the development of agro-pastoral areas (Gonin and Bernard, 2012; MRAH, 2018). At the time, livestock farmers in these areas were provided with close support in order to help them expand their business more effectively (Kamuanga et al., 2000). Technical groups were set up to raise farmers' awareness of the need to improve their understanding and ability to apply a range of technical principles related to feed (forage crops, bush hay production), upkeep of agro-pastoral areas (reforestation, firebreak maintenance) and health. Although cows were local breeds, as in the case of the traditional pastoral system, they produced slightly more milk as a result of those changes introduced in farming practices (Hamadou and Sanon, 2006).

Figure 9 (from the Africa-Milk project) shows the organisation and operation of milk production units in these agro-pastoral dairy systems with grazing livestock.

These dairy cattle farmers invest very little in livestock farming infrastructure. Livestock facilities are usually reduced to sheds/haybarns and pens for animal housing. At night, the animals are housed in fixed or mobile pens made of shrub branches. By day, they are led to pasture. At certain times of the year, a small number of newly calved cows are kept at the farm and fed at the trough.

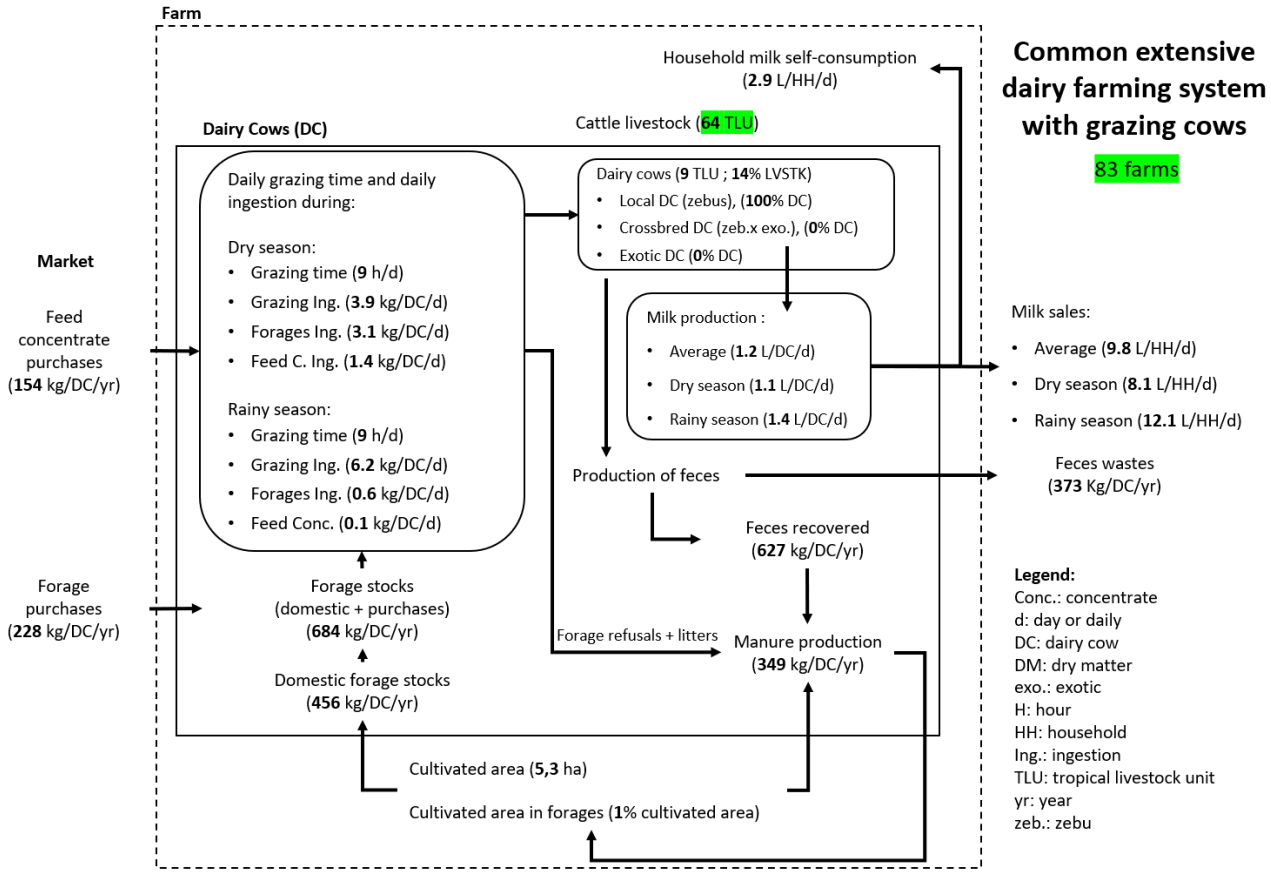


Figure 9. Extensive dairy farming system with grazing cows

On these farms, the main breed raised is the Sudanese Fulani zebu, with some animals crossed with local bull breeds (Nougtara et al., 2021). These animals produce little milk (peak production is less than 5 to 7 l/d). Male calves are raised for a long time on mother's milk, allowing milking to continue for many months, but volumes milked per day and cow are low (between 0.5 and 2 l/day/cow). On these farms, milk production falls sharply in the dry season due to forage shortages on rangelands, which form the basis of cows' diets (Kagoné, 2000; Coulibaly et al., 2007; Sib et al., 2017). Cows produce an average of 1.2 to 1.3 l/cow/day in the rainy season and 0.6 to 0.8 l/cow/day in the dry season (Sib et al., 2017). Despite this low productivity per cow, these farms account for 95% of total annual milk production (Ministry of Animal Resources, 2010).

On these farms, pastures provide cows with their basic feed throughout the year. Feed supplementation is provided to some extent, but mainly in the dry season. Supplementation with crop residues and feed concentrates (3 kg DM/TLU/day in total) is relatively low. Some farmers combine rangeland grazing with stall housing in varying proportions.

Healthwise, the level of care provided is relatively low and is usually limited to vaccination of all or part of the herd against diseases prevalent in the area, as well as the odd treatment via self-medication and traditional therapy.

4.1.2 Dairy farms moving towards more intensive practices

With the gradual organisation of the milk collection system, some farmers are now better connected to the market and more closely involved in milk production and marketing, which has consequences on how livestock farming is organised and run. Some agro-pastoral farmers have therefore gradually intensified their milk production unit while keeping livestock on pasture (Figure 10). These livestock farmers are mostly based on the outskirts of small towns and large urban centres (the so-called traditional peri-urban system; Berd, 2010). They are either pastoralist farmers who settled there or newcomers to livestock farming, i.e. active or retired farmers, shopkeepers and civil servants. The latter, for the most part, hire herdsmen to look after herds. Livestock management remains traditional, with herds mainly made up of local breeds as well as a small proportion of Goudali, Gir, MBororo and Azawak zebus and their crossbreeds (Gnanda et al., 2016; Zampaligré et al., 2019). Lactating cows receive feed/mineral supplementation primarily based on maize bran, oil cakes and cottonseed to the tune of 0.55 kg and 4.78 kg DM/day/cow. This supplementation helps to maintain relatively high milk production in the dry season, enabling farmers to earn significant income from milk sales (Hamadou and Kiendrébéogo, 2004). However, these farms struggle to achieve high milk production targets because of the very low genetic potential of the dairy cows farmed, the high cost of concentrates and low availability of crop residues. From an agroecological point of view, there have been some significant changes in these systems, namely the development of forage crops to replace livestock feed, more extensive fodder storage and distribution practices, and improved recycling of organic manure.

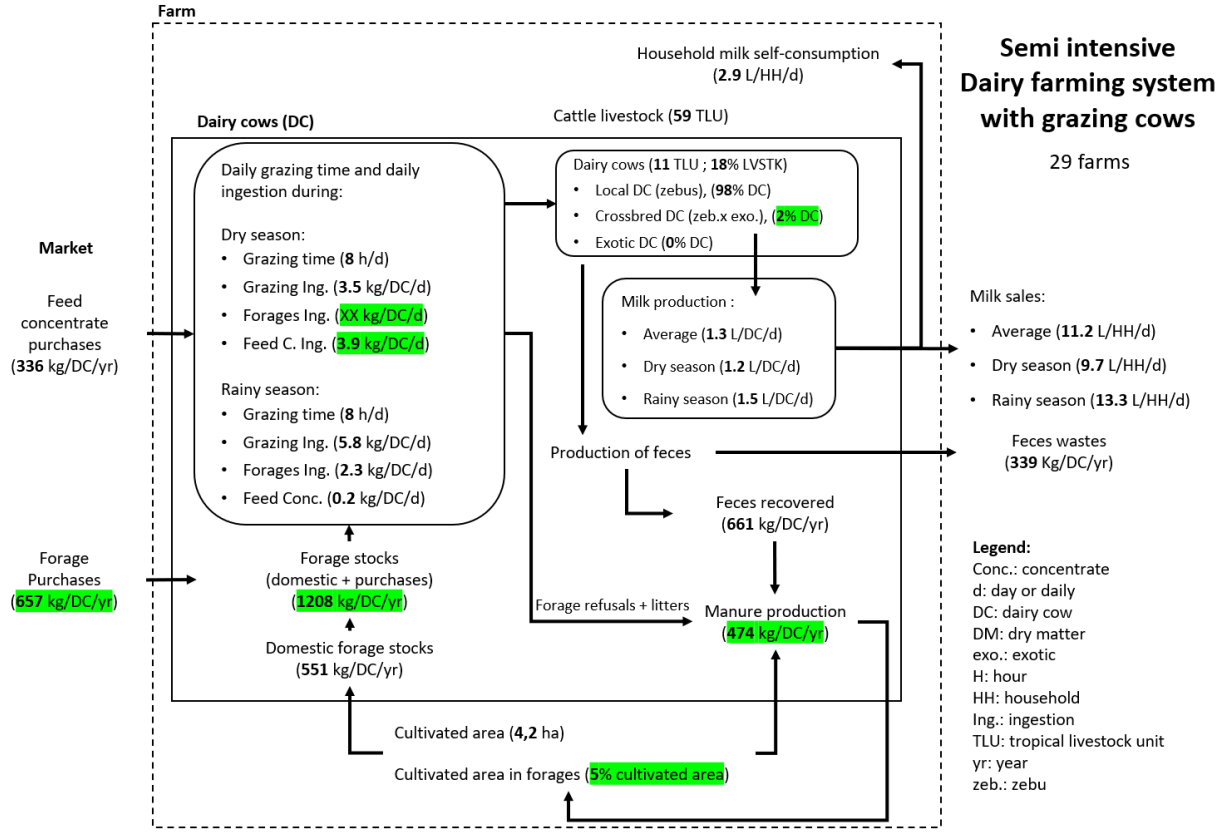


Figure 10. Semi-intensive dairy farming system with grazing cows

Dairy farms moving towards more agroecological intensive practices are only marginally represented in Bobo-Dioulasso's dairy production area. Figure 11 shows the characteristics of this system's milk production units and the way they operate. These are well-equipped farms with barns for animal housing, haybarns/sheds and/or warehouses for feed input storage, and livestock equipment (feed troughs, water troughs, scythes, carts, milk collection cans, etc.). This system combines advanced agroecological practices (crop and livestock co-product recycling, pasture grazing) with conventional intensive farming (use of feed concentrates, exotic crossbred and purebred dairy cows, artificial insemination). Most of the dairy cows are crossbred and exotic (Tarentaise, Brune des Alpes, Montbéliarde, Gir, Girolando, Jersiaise, Holstein and Limousin). In this system, the animals spend less time grazing and more time in stalls. However, daily outings to pasture are maintained for all or part of the year (Hamadou and Sanon, 2006). This type of livestock farming, based almost entirely on stall housing, promotes and increases crop and livestock co-product recycling. In this system, livestock farmers build up substantial feed reserves through scything and preserving natural forage, storing crop residues and purchasing agro-industrial by-products (oil cakes, cereal bran, brewer's grains, etc.). Milk yields are significantly higher under this system, as are milk volumes delivered to processors. This 'Made in Burkina Faso' system is a highly interesting type of intensive agroecological dairy farming approach that provides large quantities of milk to dairy processing units.

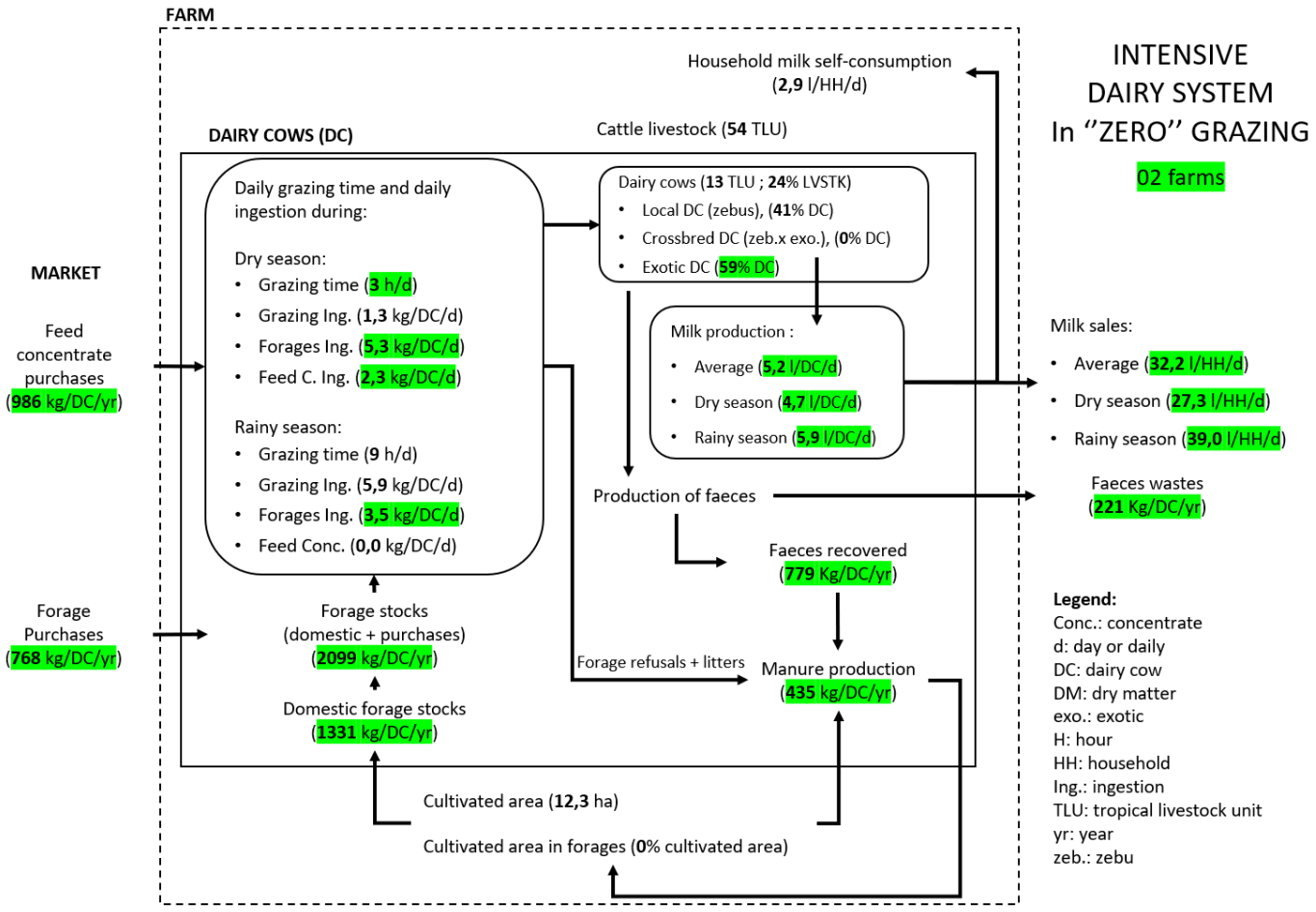


Figure 11. Small-scale 'intensive' agroecological dairy farming systems

4.1.3 Dairy farming systems viewed through the lens of agroecological elements and principles

The study by Vall et al (2021) shows that, unlike forage and feed concentrates, the role of pasture in feed rations diminishes as milk becomes more economically significant to the farm. For example, in emerging semi-intensive dairy farms, grazing is significantly reduced compared with extensive agropastoral dairy operations, but still remains an important part of the diet. Reduced grazing combined with a greater commitment to milk production and trade is a general trend that leads to the adoption of stalling. Feed concentrates are widely used by emerging semi-intensive dairy farmers, who often tend to provide their dairy cows with an abundance of them (5.7 kgDM/TLU/day) and see them as a simple and reassuring way of increasing milk yields. Yet such excessive use is neither effective nor without risk (acidosis), hence the need to provide these farmers with better support in formulating efficient rations.

Greater use of forage crops in rations (dual-purpose legumes, herbaceous forage, woody forage (Sib et al., 2017; Sodré et al., 2022)) means better recycling of crop residues (maize and sorghum straw) and animal faeces. This leads to greater self-sufficiency in forage and manure for dairy farmers, more efficient use of resources and preservation of soil fertility, i.e. greater sustainability for the farm. This is partly due to heavy land pressure in peri-urban areas where dairy farmers who supply processing units are based.

Interest in exotic breeds and artificial insemination (AI) is growing, but remains limited. These practices can sometimes have limitations in a farming environment when they are not properly managed. They also raise serious animal welfare issues when it comes to breeds ill-suited to tropical heat (Ageeb and Hayes 2000; Kahi et al. 2000), and AI protocols are subject to debate owing to the conditions under which hormones are produced (Grimard et al. 2003). Artificial insemination of local zebus (Sudanese Fulani) with exotic dairy breeds (Montbéliarde, Holstein, Brune des Alpes, Tarentaise) leads to a rapid increase in milk production, which is welcomed by dairy farmers. However, in order to stabilise this increase over time, it is vital to supplement AI with selection programmes targeting promising heifers and young bulls among the offspring of crossbred dairy dams, so as to achieve a lasting increase in milk yield in future local cows (around 10 l/day; improvement provided by exotic dairy breeds) while maintaining their capacity to adapt to hot savannah climates (feature provided by hardy local zebus). A much better alternative would be to introduce a community-based selection system for animals that perform well in dairy production, using local breeds whose potential is in no way insignificant (Ouédraogo *et al.*, 2020).

Based on the 13 elements of agroecology identified by Wezel et al (2020), none of the dairy systems described here fully satisfies all of the principles. According to these criteria, intensive and agroecological dairy systems (Figure 11) are those that implement more agroecological elements in their operation (Table 1).

Table 1. Analysis of dairy farming systems in Bobo-Dioulasso's dairy production area based on the 13 elements of agroecology (Wezel et al., 2020)

13 elements of agroecology	Agro-pastoral dairy systems	Agroecological intensive dairy systems
1. Recycling: crop residues, manure	+	+++
2. Input reduction: livestock feed...	+++	+
3. Soil health: organic manure production	+	++

4. Animal health • Animal care • Animal welfare	- ++	+++ +
5. Biodiversity: animal breeds	+	+++
6. Synergy: agriculture/livestock farming	+	+++
7. Economic diversification: livestock (male and female calves, dam culling) and milk marketing	+	+++
8. Co-creation of knowledge	+	+++
9. Social values and diets: the role of milk in household consumption	+++	++
10. Fairness: milk income distribution	+++	+
11. Connectivity: to the market	+	++
12. Land and natural resource governance: managing land and access to resources	-	+
13. Participation: irrelevant criterion	nr	nr

Key: nr: non-relevant

4.2 Milk collection operators

In Bobo Dioulasso's production area, high milk availability is recorded between May and January - which corresponds to the rainy season (May to October), a period that sees many calvings and during which natural pasture is abundant - and in the cool dry season (November to January), when crop residues are grazed in the fields and natural pasture remains plentiful. During that period of high production, independent collectors and MCCs occasionally struggle to sell milk because of the retail market (weaker demand for milk in the rainy season) and DPUs' limited daily storage and processing capacity (usually less than 500 l/d).

Two collection networks operate in Bobo Dioulasso's dairy production area: 1) Door-to-door collectors or individual/private collectors delivering directly to the dairy or selling directly on the market and to private individuals; 2) Collection centres (Duteurtre and Vidal, 2018).

4.2.1 Individual collectors

In the first system, local milk is collected by independent individual collectors. They collect milk in plastic cans, which were originally used for fats. They are not equipped with any milk quality control equipment. Once collected, milk is transported by motorbike or bicycle. Most of this milk is sold directly to consumers without any prior quality control. Such sales usually begin on the road after collection, door-to-door, and at the market. Some collectors deliver their milk to Dairy Processing Units (DPUs) or dealers. In terms of quality control, DPUs maintain a bond of trust and have established routine procedures with their collectors (e.g. no antibiotics in milk for yoghurt production, etc.). According to Duteurtre and Vidal (2018), most of the milk collected goes through this network of independent individual collectors. But today, with the advent of organised Milk Collection Centres, things are beginning to change: individual collectors are increasingly turning to MCCs for delivery. Bobo Dioulasso's collection area keeps expanding, with new collection centres being set up within 50 km of the city.

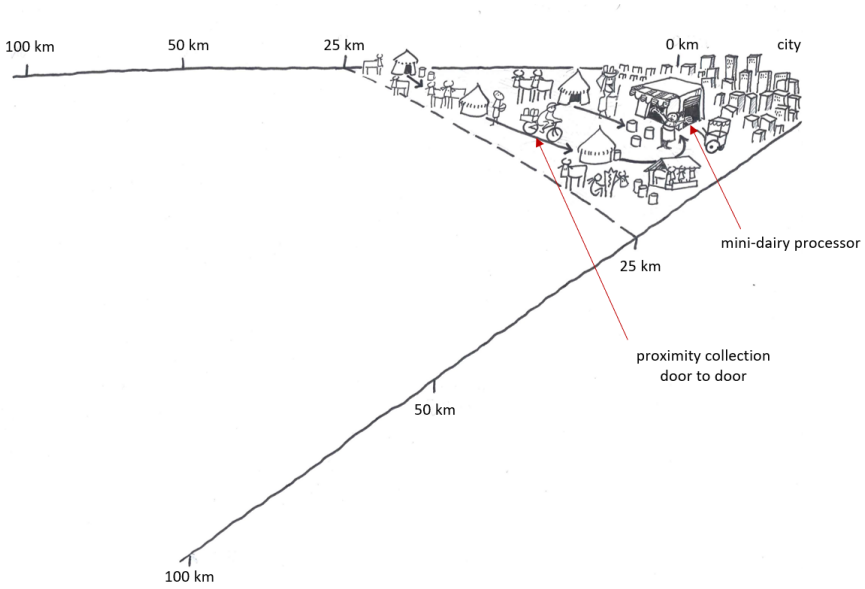


Figure 12. Schematic diagram of the door-to-door milk collection system without collection centres (source: Africa-Milk)

4.2.2 Collection centres

The second collection system involves PAPSA-funded collection centres. A first batch of 7 MCCs were built on the outskirts of Bobo Dioulasso in Dafinso, Yegueresso, Bama, Farako-Ba, Bana, Satiri and Sogossagasso. Working on motorbikes or bicycles, collectors affiliated to these MCCs collect an average of 10 litres of milk per farm in the rainy season and 2 litres per farm in the dry season. Milk prices to farmers are 250 CFA francs between May and October and 300 CFA francs between November and April. For livestock farmers, these prices are significantly lower than the retail price of milk (500 FCFA/l or more), but MCCs offer them the guarantee of larger and more regular purchasing volumes. These collectors have no control equipment and use traditional control procedures. Milk is sent to the MCCs, which in turn supply the DPUs. These MCCs are equipped with PAPSA project cans offering a maximum capacity of 40 litres, as well as 20-litre plastic cans. According to the GRET study (2019), these MCCs collect between 60 and 190 litres a day in the rainy season and between 60 and 100 litres in the dry season. Milk is also transported by tricycle or motorbike from MCCs to DPUs.

The impetus provided by the creation of MCCs and DPUs has led to a reshuffling of milk-related roles and responsibilities. It also prompted, in August 2018, an overhaul of laws and regulations governing cooperatives in the local dairy value chain, in line with the OHADA law. Today, around ten MCCs and twenty mini-dairies based in the dairy production area use local milk.

MCCs have started working towards organising dairy cattle farmers into cooperatives as their economic activity and viability depends on their being well connected to the farmers who supply them. In Bobo-Dioulasso, dairy cattle farmers who broadly fit the description of 'small-scale, ecologically intensive dairy farms' (Figure 11) have set up the 'Benkadi' cooperative. The organisational drive continues with the setting up of new MCCs around Bobo-Dioulasso. To strengthen their economic viability, MCCs are also looking at providing farmers with a range of support services (animal feed and medication outlets, dairy farming equipment, training, etc.) and monitoring the smooth running of the collection process (milk quality control, statistics, etc.).

4.2.3 Pros and cons of both collection systems

There are pros and cons to both collection systems, as summarised in Table 2.

Table 1. Pros and cons of milk marketing systems in Bobo-Dioulasso's dairy production area

System type	Pros	Cons
Individual collectors	- Higher milk price for farmers, especially in the dry season - Milk price set by farmers - Customer loyalty, with the ability to plan sales	- Potential fraud on quality - Longer time to market - Higher risk of poor sales
Network involving collection centres	- More structured value chain, with contractual arrangements between farmers, collectors and Dairy Processing Units (DPUs) - Better quality management of collected and processed milk - Guaranteed purchase of part of the production	- Lower milk prices for farmers - Difficulty for farmers to negotiate sales price - DPU's low processing capacity to capture more milk, especially in the rainy season - Marketing difficulties for processed products

Today, the system involving collection centres grows in strength and seems to be the most promising for ultimately ensuring steady supplies to DPUs in terms of both quantity and quality.

According to figures from the Bobo-Dioulasso DIP, MCCs supplying DPUs affiliated to the DIP collected 411,362 litres of milk (i.e. 1,127 litres/day) in 2020. In 2021 and 2022, volumes of milk collected by MCCs increased: 504,567 litres in 2021 (i.e. 1,382 litres/day) and 780,794 litres in 2022 (approx. 2,139 litres/day). Collection volumes remain low, and according to the DIP, growth has come at the expense of collections handled by independent collectors.

4.3 Milk processing operators

The city of Bobo-Dioulasso boasts around thirty Dairy Processing Units (DPUs). These are mainly family run mini-dairies, processing between 200 and 500 litres of milk a day. According to Orasmaa et al. (2022), the annual production of the 31 dairy processing units surveyed in 2018 by these authors is reported in Figure 13. This map underlines the contribution of all processing units in the provision of milk to the city, including those using powder milk exclusively. The map also shows the spatial repartition of those processing units: they appear to be well distributed in all quarters of the city, but preferentially along the main roads.

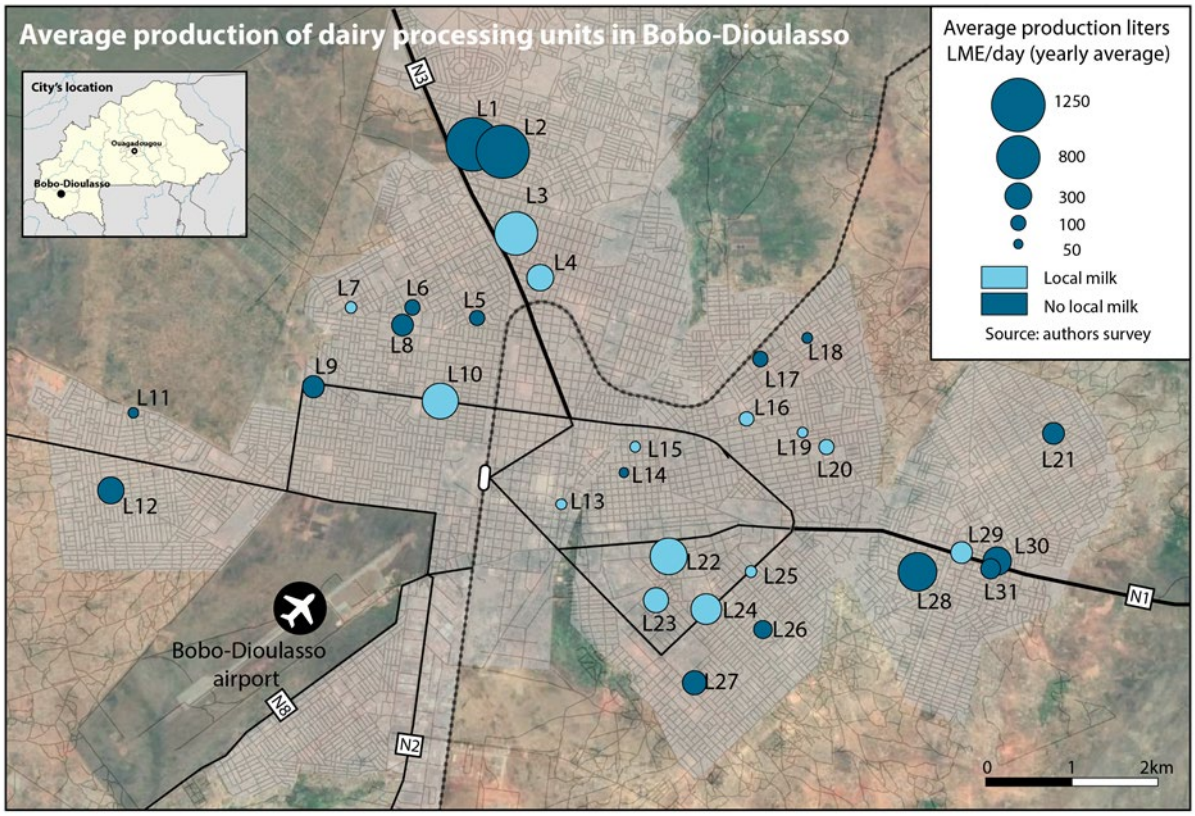


Figure 13. Map of the annual production of the 31 surveyed dairy processing units (Source: Orasmaa et al. 2022)

It is important to point out that these DPUs are involved in mixed processing, i.e. processing both imported milk powder and fresh milk collected from farms. Some 72% of them use powdered milk exclusively. DPUs use powdered milk partly because of the seasonal nature and quality of local milk, and partly because it is easier and more profitable to process. During periods of high milk production (rainy season), DPUs only use local milk for processing, while during low production periods, dairies make up the shortfall with powdered milk. Based on Orasmaa et al. (2022) results, local milk processing units in Bobo-Dioulasso contributed to an estimated 4,143 tons, milk equivalent per year (Table 3). This included 3,730 tons made from imported milk powder, and around 413 from local milk (Table 3). This estimation of 413 tons of milk processed in the city is coherent with the work of Duteurtre and Vidal (2018) reporting that in 2018, around 375 tons of local milk was collected annually around Bobo-Dioulasso. This represents only 11% of the milk processed in Bobo-Dioulasso by dairy processing units, while powder milk accounts for 89%.

Table 3. Contribution of the milk processing units to the provision of milk products in the city of Bobo-Dioulasso

	Processors using powder milk exclusively	Processors using local milk (and milk powder)	All milk processors
Number of surveyed processors	17	14	31
Total processed in ME per processor (liter/day) *Including local milk (liters/day)*	240.2 -	196.5 *75.57*	220.4 *34.12*
Total processed by the surveyed units (in liters ME/year)	**1,490,268 (total)**	**1,003,860 (total)** = 617,700 (milk powder) *+ 386,160 (local milk)*	**2,494,128 (total)** = 2,107,968 (powder) *+ 386,160 (local milk)*
Total pop of small-scale processors in Bobo	35	15	50
Estimation of total processed in Bobo (in liters ME/year)	**3,068,199**	**1,075,564 (total)** = 661,821 (milk powder) *+ 413,743 (local milk)*	**4,143,763 (total)** = 3,730,020 (powder) *+ 413,743 (local milk)*

Most of the DPUs in Bobo Dioulasso's dairy production area are small-scale processors with unsophisticated technical facilities. Their technical equipment consists mainly of hermetically sealed vats, buckets, saucepans, mixers, pasteurisers, filling machines, heat sealers, bag sealers, tables, chairs and gas cylinders. DPUs face challenges in preserving milk and by-products due to power supply instability. Most of them rely on the state-owned utility as their primary source of power supply. Overall, DPUs have low processing capacity.

Pasteurised milk and yoghurt are the two main dairy products made from processed milk. DPUs also produce other dairy products such as butter, sour milk, gapal, etc., but this is less common and usually made to order for private customers. Local milk is more commonly processed into pasteurised milk in Bobo-Dioulasso's dairy production area. Yoghurt is generally produced from imported milk powder or a combination of both. Other products made from processed milk include dèguè, fermented milk, cheese, cream, buttermilk, etc.

In 2018, the market for dairy products was estimated to 16,640 tons, milk equivalent. Local processing units accounted for only 25% of this total. However, the market share of local processors was estimated to around 28% of the liquid milk, and to 80% of the fermented milk (Table 4).

Table 4. Market share of local processing units in the Bobo-Dioulasso market

	Annual per capita consumption (kg/hab.)	Annual total consumption (ton, milk equiv.)*	Annual production from local processing units (tons, milk equiv.) (market share in %)	
Powder milk and concentrated milk	19.2	10,560	-	
Fermented milk consumed fresh or in *Degue*	8.4	4,620	3,730	80%
Liquid milk	2.6	1,460	413	28%
Butter and cheese	-	-	Less that 1 ton	-
TOTAL		16,640		25%

Estimations for a total population of 550,000 people in Bobo-Dioulasso.

The milk 'value creation' system based on locally produced milk offers a major economic advantage over the system based solely on processing imported milk powder: it creates local jobs. According to Orasmaa (2017), the system based on local milk provides an average of 9.1 jobs, compared with 4.5 in the other system, i.e. twice as many. Of these 9.1 people, 4.8 are employed in DPUs, 0.4 in collection, and 3.9 work on the farms. The study also shows that women are much more involved in the system based on local milk (Figure 14). The development of mini-dairies is therefore an opportunity to create jobs for the region's youth, particularly in milk production, collection, processing and distribution. All these segments of the local dairy value chain should therefore be supported so as to make that chain sustainable.

Figure 11. Overall employment impact of SSMPs

The average number of people to whom SSMPs create employment in SSMPs that use local milk (left) and those that use only milk powder (right). All values are n. people gaining income per 100 litres ME produced. Below, the proportion of female and male heads of unit.

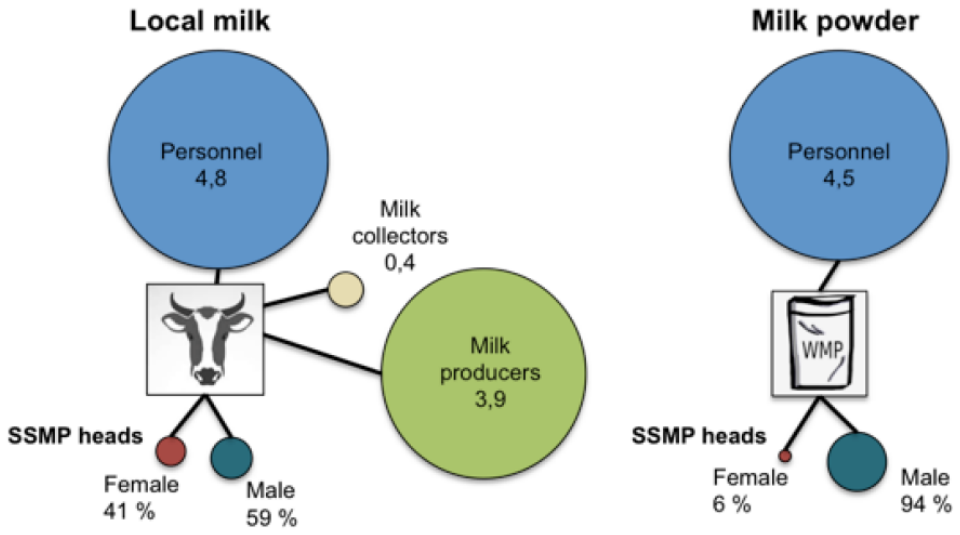


Figure 14. Employment levels in local milk-based system (left) compared to powered milk-based system (right) (source: Orasmaa, 2017)

4.4 Marketing and distribution stakeholders

Milk and its by-products are marketed through local and regional distribution channels. The distribution network for dairy products produced by processing units is made up of around fifty dealers/distributors. These products end up in grocery stores and other sales outlets (shops and kiosks) in the city of Bobo-Dioulasso and surrounding areas such as Waterfalls and Mouhoun Loop.

4.5 Presentation of Bobo Dioulasso's Dairy Innovation Platform (DIP)

Since 2020, Bobo Dioulasso's dairy industry players have established a multi-stakeholder Dairy Innovation Platform (DIP) bringing together all the players involved in the various segments described above.

Composition of the DIP. Bobo-Dioulasso's multi-stakeholder dairy platform includes dairy farmers, collectors affiliated to milk collection centres, private collectors, dairy processing units, government support services (local departments of the Ministry in charge of livestock, farming research, technological research) and private providers (livestock feed suppliers, artificial insemination service providers, microfinance institutions). The platform can build partnerships with any other structure wishing to support it in achieving its goals. The DIP is headed by an elected executive board. Details of the stakeholders and partners involved in the DIP are provided in Appendix 2.

The DIP's vision. Bobo-Dioulasso's multi-stakeholder dairy platform has set out its vision as follows: **"By 2024, Bobo-Dioulasso's dairy production area will be producing, collecting and processing 18,000 litres of local milk a day".**

The DIP's objectives. The overall objective is to increase the daily production, collection, processing and marketing of local milk in Bobo-Dioulasso's dairy production area to 18,000 litres. The DIP's specific objectives are as follows:

- Increasing milk production at farm level and ensuring regular production through better feed and health care for dairy cows;
- Strengthening livestock farmers' intellectual and technical abilities;
- Ensuring proper monitoring of milk quality and quantity at collection points using appropriate tools;
- Securing a uniform price for milk from collectors;
- Improving the milk collection, storage and distribution system;
- Marketing a wide range of dairy products made from quality processed milk, using appropriate equipment and techniques.

The DIP: our 'Living Landscape'. The DIP meets the main criteria of a Living Landscape:

- It is a multi-stakeholder system
- That forms part of the local food system and, in this case, the dairy value chain
- That operates within a focus area, i.e. the city of Bobo-Dioulasso and the surrounding dairy production area
- In which stakeholders have defined a common vision and shared objectives
- And who are determined to promote change at all levels of the dairy value chain in order to guarantee its development and sustainability in a spirit of cooperation, new ideas experimentation and knowledge sharing

Furthermore, the DIP's specific objectives are compatible with the elements and principles of agroecology (Figure 14)

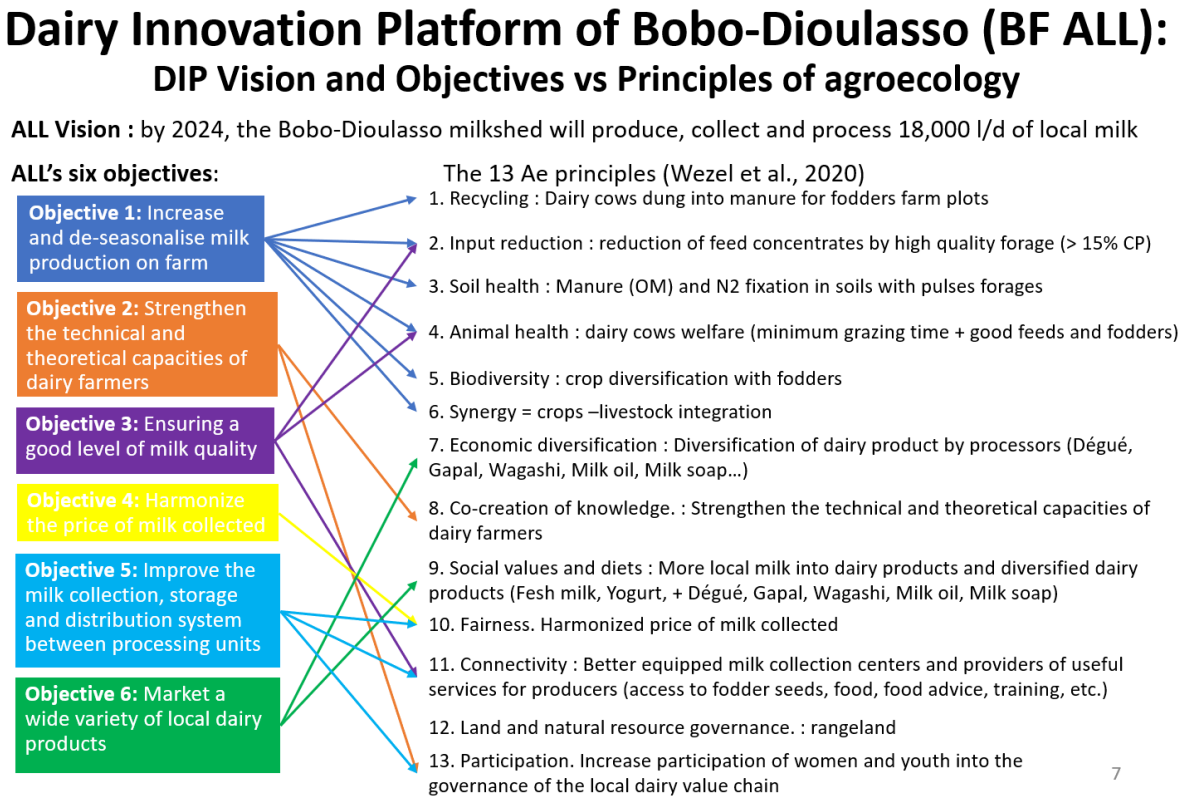


Figure 15. Correlation between the DIP's objectives and the principles of agroecology

5 Bobo Dioulasso's dairy value chain viewed through the lens of agroecological elements and principles

In this section, we look at Bobo Dioulasso's dairy value chain from the perspective of the agroecological elements and principles described by Wezel et al. in 2020.

1. **Recycling.** In milk production systems, improved crop residue recycling as fodder and animal dung recycling as organic manure goes hand-in-hand with the transition from extensive agro-pastoral systems with little dairy specialisation (Figure 9) towards more intensive systems retaining significant agro-pastoral features (Figure 10) or evolving towards mini-dairy farm models (Figure 11), thereby reducing production costs and reliance on various inputs (livestock feed, mineral fertilisers).
2. **Input reduction.** Agroecological practices, such as producing organic manure to fertilise plots of land, storing crop residues for fodder purposes, or growing forage crops to improve fodder self-sufficiency, enable livestock farmers to produce more milk while using fewer off-farm resources. Sound management of available resources can boost the efficiency of livestock production systems and increase farmers' income.
3. **Soil health**. Good soil health and fertility is the cornerstone of any sustainable farming system. In agro-pastoral systems, the production and use of organic manure, the practice of rotating paddocks within plots and the growing of leguminous crops help to enrich the soil, thereby limiting the use of synthetic fertilisers. For dairy cattle farmers, soil fertility is also an important issue as these systems are based on forage biomass produced on farms, i.e. on agricultural land, but also on spontaneous biomass produced on rangelands. In systems that tend to specialise in milk production, reducing livestock mobility clearly helps to increase the

proportion of dairy animal dung recycled as organic manure (Figure 10, Figure 11). However, this reduced mobility has a slightly negative impact on the organic fertilisation of rangeland soils, which are used less frequently and therefore receive less manure.

4. **Animal health.** A major feature of livestock farming conditions in the Bobo-Dioulasso area is the reduced mobility of dairy animals (compared with pastoral farms) due to morning and evening milking routine and the need for farmers to stay close to the collection centre or dairy where milk is sold. This raises important animal welfare issues related to reduced mobility and pasture grazing. Nowadays, even in the most intensive local production systems, livestock farmers tend to maintain regular grazing times throughout the year (Figure 10, Figure 11), which seems to be very important not only to ensure a balanced diet, but also for the animals' general well-being.
5. **Biodiversity.** For dairy cattle farmers, biodiversity issues mainly revolve around dairy livestock composition. To date, herds are mostly made up of local zebus (which are highly adapted to local conditions, but produce very little milk). In systems moving towards more intensive and specialised practices, a growing number of animals are being crossed with exotic dairy breeds (Montbéliardes, Holsteins, Brunes des Alpes, etc.). This shift towards crossbred animals that retain the hardy nature of local breeds whilst offering dairy features that boost milk yields seems to be a promising way forward. It is a path that has indeed been taken by many East African countries, which are nowadays self-sufficient in milk. The viability of dairy cattle farmers in the Bobo-Dioulasso region also depends on having diversified agro-ecosystems (pastures, crops) to guarantee access to varied and affordable feed resources throughout the year (Vall and Diallo, 2009).
6. **Synergy.** In the region's dairy production systems studied, synergies mainly relate to the integration of crop and livestock farming (animal traction, production of organic manure and forage). In the region, the increase in crop residue storage and recycling of draught cattle manure has been accompanied by some degree of specialisation and agro-ecological intensification of milk production. (see Figure 9, Figure 10, Figure 11).
7. **Economic diversification**. For dairy cattle farmers in the Bobo-Dioulasso region, diversifying production is all about male and female calf management, milk promotion and dam culling. Most young male calves are raised for a long time on mother's milk and are sold when they reach the age of 3 (bull calves). As for female calves, they generally join the herd's core group of breeding cows. Some of the milk produced is kept for household consumption, with the surplus sold directly on the local market or to a dairy. Income from the sale of milk goes to women. However, we found that women often lost control of milk revenues to their husbands when milk was sold to a dairy. Traditionally, milk is sold as liquid milk or sour milk products. On the local market, it commands a very good price (0,8 to 1 €/l depending on the season), but volumes are generally small (a few litres a day per household).
8. **Co-creation of knowledge**. Regional Chambers of Agriculture, NGOs and a wide range of partners provide young livestock farmers with training courses covering various products (production, processing). The UMPL/B organisation, via its various branches, runs training courses aimed at improving milk quality. These courses provide stakeholders with an opportunity to share their experiences. Agricultural researchers also play an important role, increasingly conducting experiments with farmers on animal production, fodder production and conservation, and animal care techniques.
9. **Social values and diets**. In the Bobo-Dioulasso region, as in Western Burkina Faso more generally, most people do not consume large quantities of dairy products, other than Fulani herders for whom milk is a staple diet. Average consumption (in liquid milk or yoghurt form) is low (< 25 l/capita/year). However, some consumers are keen to purchase dairy products

made from local milk, which have a different taste from those made from powdered milk (which make up the bulk of yoghurts and sour milk products consumed today). These consumers also wish to have access to a wider range of traditional dairy products (Dèguè, Gapal, Wagashi cheese, milk soap, milk oil). A key objective would therefore be to replace a large proportion of the imported milk powder with locally produced milk, while producing quality products that are affordable to as many households as possible in order to meet consumer demand.

10. **Fairness.** In 2016, the UPML/B set up the FairFaso advocacy brand. FairFaso is the brand name through which some UMPL/B member mini-dairies sell their milk. The purpose of this label is to provide farmers with a better income: in addition to the price paid to the farmer by the cooperative, a proportion of the price paid by the consumer is passed on to the farmer by the cooperative. In Bobo-Dioulasso, we will be working with the Dairy Innovation Platform on two key initiatives designed to ensure fairer trade between dairy farmers and processors: 1) To secure a uniform price for milk from collectors; 2) To improve the distribution system for collected milk in line with processors' day-to-day requirements.
11. **Connectivity.** The setting up of milk collection centres (MCCs) on the outskirts of towns aims to improve connectivity, provide greater proximity and increase trust between farmers, processors and consumers. This system promotes a fair and short distribution network that benefits every player in the dairy value chain and boosts the local economy. At this stage, it's still in its infancy and we believe that its development ought to be supported as it shows great promise.
12. **Land and natural resource governance.** The management of natural resources (pasture and water) at local level is an important aspect of their conservation. Resource management requires the input of all local agricultural stakeholders to define access and usage rules. Such responsible governance helps to ensure the sustainability of resources and to prevent conflicts and competition for access to resources. In the areas where dairy cattle farmers are based, securing land is a major priority as farmers need arable land for forage production, as well as secure access to pastures and watering points in all seasons (this is indeed a national priority highlighted by IPROLAIT/BF). Securing land is a vital prerequisite for ensuring a better future for peri-urban livestock farming. It requires good space planning, taking into account several parameters. The available space, the city's demographic and spatial dynamics, as well as those of the villages, the specific nature of livestock farming (especially traditional) and the presence of other activities need to be considered. This will prevent set-aside areas from being decommissioned after 10 or 20 years. Areas set aside for livestock farming must have adequate infrastructure. This primarily involves establishing water points and creating cattle tracks to ease access to forage and water resources. With regard to the management and improvement of genetic resources, IPROLAI/BF favours genetic improvement through an increase in imports and wider use of breeds with high milk production potential, i.e. through the market. Meanwhile, domestic research efforts are focusing on setting up a community-based selection programme for dairy cows based on the local breed, with a view to improving milk yields while preserving the hardy nature of local stock.
13. **Participation.** In Bobo-Dioulasso, the introduction of the Dairy Innovation Platform encourages local value chain stakeholders to get organised, and farmers, collectors and processors to play a greater part in decision-making in support of the local dairy value chain's governance.

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Appendix 1. Definition of key concepts related to agroecology and the dairy value chain

Agroecology: Agroecology is a farming approach that focuses on environmental, economic and social sustainability using environmentally sound farming practices based on biodiversity, local knowledge and available natural resources. It aims to strengthen the resilience of agricultural ecosystems and improve living conditions for farmers and local communities.

Value chain: The value chain is defined as all the activities involved in the production, processing, distribution and marketing of a product or service. It includes all the players involved in these activities, from farmers to consumers, as well as the institutions and infrastructure supporting these activities.

Dairy production: Dairy production covers all of the activities involved in raising and milking dairy animals, as well as milk collection, processing and marketing activities.

Sustainability: Sustainability refers to the ability to maintain an activity over the long term through the responsible use of natural, economic and social resources. A sustainable activity is one that minimises negative impacts on the environment and society, while generating economic benefits for all stakeholders involved.

Milk quality: Milk quality refers to the physical, chemical and microbiological properties of milk that affect its nutritional value, food safety and processing capability. Milk quality criteria include fat content, bacterial load, protein and lactose content, and the presence of contaminants.

Appendix 2. Bobo-Dioulasso DIP members and partners

Sectors	Stakeholders
Members	Farmers (9 dairy cooperatives)
	Processors (20 DPUs)
	Collection centres (10 MCCs)
	Dealers/Distributors (57)
	Consumers
Partners	
Public sector (support partner)	Direction régionale de l'agriculture, des ressources animales et halieutiques (DRARAH)
	Direction provinciale des ressources animales et halieutiques (DPRAH)
	Direction régionale des services d'hygiène
	Chambre régionale de l'agriculture (CRA)
TFP	Caisse Populaire Bobo-Dioulasso
	Express Bank
	Microfinance plus
Local businesses	AGRODEV Services
	AgriGrowth Management
NGOs	SNV Helvetas
	GRET
Industry bodies	Fédération des éleveurs du Burkina (FEB)
	RECOPA
	Interprofession lait
Research bodies	UNB
	INERA
	Centre Muraz
	CIRDES
	CIRAD
Input suppliers	SOGEA Faso
	SN-CITEC
	Entreprise Kaboré
Political players	Bobo-Dioulasso City Council
	Regional Council
Association	Association des vendeurs d'herbes fauchées

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