

Analysis of the milk value chains in Ghana and Senegal: What can we learn?

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ABSTRACT

In the absence of a significant increase in domestic milk production, Ghana and Senegal heavily depend on milk powder and other dairy products imports from EU member countries. Actors in the West African dairy sector have come under increasing pressure to compete with the cheap imported milk powder on their local markets. Therefore, this research study was intended to map and compare the structure of two milk value chains in Ghana and Senegal. For the collection of primary data, in-depth interviews were conducted with key informants. A total of 59 actors along the milk value chains were sampled and interviewed and the data was descriptively analyzed. The study results reveal that the local fresh milk value chain in Ghana is entirely separated from the milk powder value chain. Ghana's local milk value chain is informal, simple, and not well-developed compared to the imported milk powder value chain. The main actors in the fresh milk value chains are the input suppliers, producers (intensive, semi-intensive, extensive), collectors, processors, street vendors, financial and other services providers. The value chain that depends on imported milk powder is extensive compared to the local milk value chain. Its key players are importers, re-packagers, re-constitutors, processors, distributors, wholesalers, and retailers. In Senegal, the key actors are limited in number and include input suppliers, producers (pastoral, agro-pastoral, peri-urban), collectors, processors, importers, wholesalers, small retailers (small kiosks, shops etc.). Overall, the value addition practices were low as compared to the potential available for dairy production. Traditional milk processing is more dominant in both countries, and herders' wives transform fresh milk into butter cheese (known as wagashi) or curdled milk. The primary constraints identified in both countries are an insufficient supply of fresh milk in the dry season, high transport fares due to long distances to the milk collectors, lack of storage facilities, lack of credit facilities to the dairy value chain actors, insufficient extension support, poor road networks, and competition from imported milk. Nevertheless, the strong preference of consumers for fresh milk-based products in both countries presents a great opportunity to the local dairy value chain actors.

Keywords: dairy sector, local milk, imported milk powder, Senegal, Ghana

1 Introduction

In West Africa, the livestock subsector plays a significant economic and social role in rural livelihoods, and 60 percent of the total population makes their living from livestock (Ly et al., 2010). The percentage of households owning live-stock in rural areas in Senegal (Kazybayeva et al., 2006) and Ghana (Pica-Ciamarra et al., 2011) are 67 and 50 percent, respectively. The marketing of local fresh milk is one of the most important sources of household income for rural subsistence farmers.

Rapid population growth, rising per capita income, and fast-growing urbanization have led to large increases in the demand for milk and dairy products in West Africa, and this trend will inevitably continue. Between 1996 and 2018, per capita consumption of milk increased from 3.9 kg to 9.9 kg milk equivalent in Ghana and 25.9 kg to 47.7 kg milk equivalent in Senegal (Zamani et al., 2021). Nevertheless, the increased demand has not stimulated the growth of the local dairy industry. Local milk production has been woefully insufficient to meet the increasing demand, and present-ly, both countries rely heavily on imports, mainly from the European Union (EU).

Figure 1 also shows that, in the last two decades, there has been a steady increase in the number of dairy products imported by Ghana. The self-sufficiency rate in Ghana has decreased fairly steadily from 52 percent in 1996 to 15 percent in 2018. Ghana compensates for deficits in self-sufficiency by importing fluid milk and dairy products from EU member states, mainly from the Netherlands, France, Portugal, and Germany, and followed by Nigeria and New Zealand (Zamani et al., 2021). Ghana is more dependent on dairy imports from the EU compared than other West African nations (Matthews and Soldi, 2019).

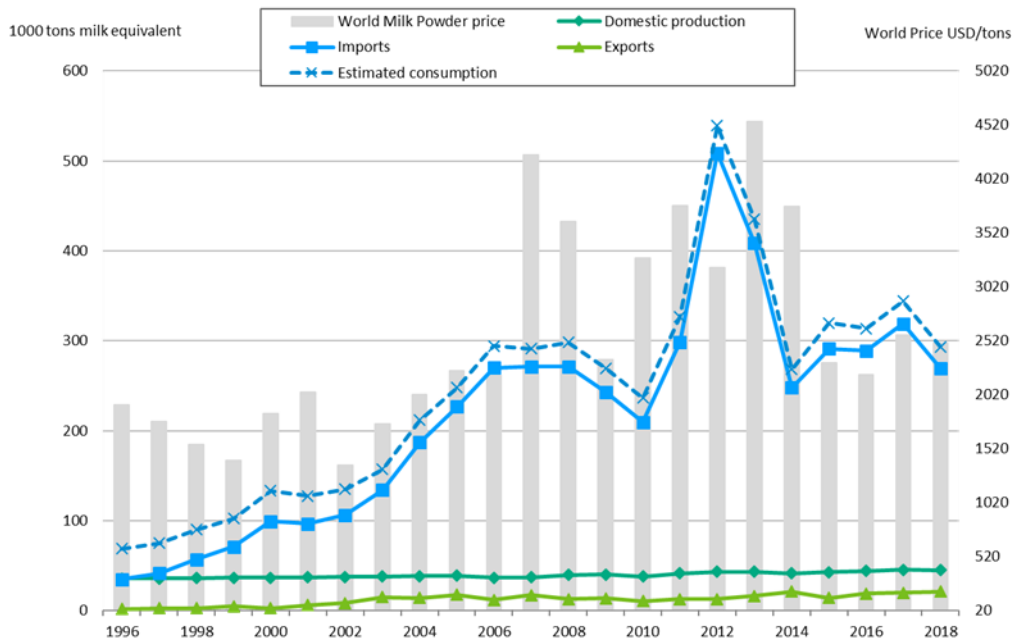


Figure 1. Development of the Dairy Sector in Ghana from 1996 to 2018 (in 1000 tons, milk equivalent)

Note: The domestic consumption is estimated based on imports + production - exports. Storage was not considered.

Source: Zamani et al., 2021.

Senegal also imports large quantities of dairy products to fulfil domestic demand (Figure 2). In 2018, the total dairy imports amounted to about 595 million tons of milk equivalent, accounting for about 85 percent of the milk powder and full-fat milk by value (UN Comtrade, 2017). According to Zamani (2021), between 2000 and 2018, the self-sufficiency rate of the Senegalese dairy sector steadily declined from 41 percent to 20 percent. It appears that the dependency on imported milk and milk products will continue to increase in the future.

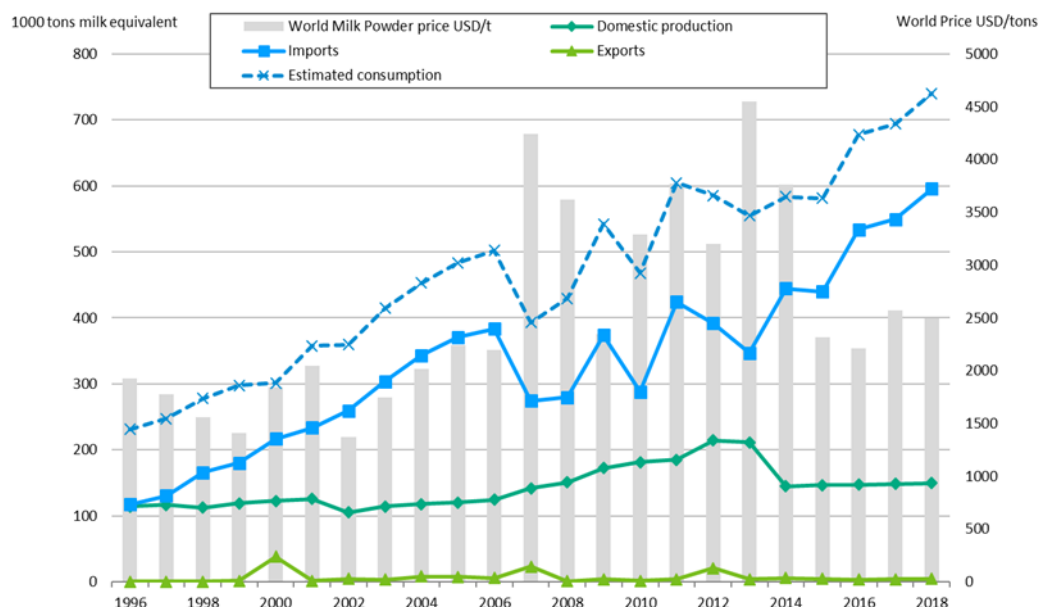


Figure 2. Development of the Dairy Sector in Senegal from 1996 to 2018 (in 1000 tons, milk equivalent)

Note: The domestic consumption is estimated based on imports + production - exports. Storage was not considered.

Source: Zamani et al., 2021.

On the upside, imported milk powder fills supply gaps and serves the growing demand, particularly in the urban areas. Following the abolition of the European Union (EU) milk quota system in 2015, European milk powder imports to West Africa have continued to accelerate. European dairy companies continue to expand their operations in Africa, with a significant presence in West Africa (Corniaux, 2017; Orasmaa et al., 2016; CTA, 2014) largely due to the high demand for dairy products in this region.

On the downside, the imports compete heavily with local milk and deteriorate the demand for local milk, possibly resulting in adverse effects on local dairy value chain actors (Oppong-Apene, 2016, Vielajus, 2006). Against this background, this research was conducted to assess the local dairy value chains in Ghana and Senegal as a part of a large project examining the "Impact of Meat and Milk Product Exports on African Countries". The research questions investigated in this study are:

- 1 Who are the actors involved in the dairy value chain of Ghana and Senegal?
- 2 What is the overall structure of the dairy value chain in both countries?
- 3 What differences exist in the use of milk powder and fresh milk?
- 4 What barriers and challenges confront the dairy sectors?

1.1 Description of the study area

This study was carried out between February 2020 and May 2021 in areas with the highest cattle population and great market potential. In Ghana, the data was mainly collected from Bondase, Abokobi, Adalakope, Agbogba, Tema, Tamale, Shai Osudoku, Amrahia, Pokuase, Tulakuu, Awdodome regions. In Ghana, the average annual temperature varies between 18°C and 40°C across the country. Rainfall is concentrated in a major (April-July) and a minor (September-November) season in Southern Ghana with only one season occurring in the North from May to October, followed by a long dry season from November to April (AfDB, 2018).

The climate of Senegal is tropical, with a long dry season that runs from October till June in the North and from November to May in the South. In the North, the rainy season lasts from June to October, whereas in the South, it lasts July to September due to the African monsoon. The average mean temperature. The average annual temperature for Senegal is 27.8°C, and the temperature often exceeds 40°C in the innermost parts of the country during the hottest seasons (World bank, 2011b). The data was mainly gathered from Dakar, Kolda, Mbetet, Keur Ndiaye Lo, Fass De-lorme regions.

1.2 Data and method of analysis

The data were gathered from both primary and secondary sources. Secondary data was based on desk reviews of relevant literature (e.g., reports, articles, etc.). For the primary data, a snowball sampling procedure was employed to identify key actors in both the fresh milk and milk powder value chains in Ghana and Senegal. A total of 59 key actors at different levels of the value chain were selected and interviewed either face-to-face or via telephone and included - input suppliers, producers/farmers, collectors, processors, street vendors, and marketers (hypermarkets, supermarkets, and street vendors) (Table 1).

Farmers were selected purposively to represent the typical production systems of fresh milk in Ghana (intensive, semi-intensive, and extensive) and Senegal (intensive, agro-pastoral, and pastoral). In Ghana, six producers of fresh milk based on the cattle rearing systems and three milk collectors with capacities of 25, 300, and 2000 litres per day were interviewed. Based on the average volumes processed per month, four groups of dairy processors are identified - large (240 tonnes), medium (120 tonnes), small (15 tonnes), and mini (7 tonnes). The various actors interviewed are presented in Table 1.

The data was collected using semi-structured personal face-to-face interviews. The interviews were recorded, transcribed and analyzed using content analysis to objectively and systematically identify specified characteristics and patterns in responses (Holsti, 1969).

Table 1.
Value chain actors and stakeholders interviewed

Actors/stakeholders	Ghana	Senegal
Actors: local fresh milk		
Feed supplier	2	2
Cattle supplier	1	1
Producers/farmers	6	6
Milk collectors	3	3
Processors	6	4
Street vendors	4	2
Actors: imported milk powder		
Large-scale processor	1	1
Medium-scale processor	3	2
Small-scale processor	4	1
Mini processor	2	1
Retailer (Hypermarket)	2	2

2 Results

2.1 Milk value chains in Ghana

2.1.1 Local Fresh milk value chain

The local fresh milk value chain in Ghana is entirely separated from the milk powder value chain. An overview of the local milk value chain is depicted in Figure 3. The main actors in the local milk value chain are input suppliers, farmers, milk collectors, processors, wholesalers, retailers, and consumers. The major product in the local milk value chain is fresh milk, and other value-added dairy products. These products take various routes from farmers to consumers.

Key products in the fresh milk value chain are milk, wagashi (cottage cheese), burkina, fula, and yoghurt. Wagashi* (local cheese) is made when there is surplus milk for which no market and other means of preservation such as refrigeration is available. This study estimates that about 40% of milk produced per day is converted into wagashi. Because of the lack of refrigeration facilities in the villages, the production of wagashi is the available means of preservation of surplus milk. Surplus milk usually abounds in the wet season because of the abundance of feed (forage) and water which are key in milk production on the farms.

Marketing channel: The flow of milk along the marketing channels shows the highest amount of 67% of milk flow from dairy farmers to milk collectors, followed by 20% flow to wagashi processing and street vendors as well as direct flow from dairy farmers to consumers (1%). The study further estimated 12% flow of milk to mini and small-scale processors, and only 1% flow of fresh milk goes to street vendors. The marketing linkages also show a flow of milk from milk collectors to wagashi processors and vendors of both fresh milk and wagashi as well. Figure 2 provide details in the flow of milk in the milk value chain.

Input suppliers and service providers: Input suppliers supply feed, milking equipment, and veterinary inputs. Main inputs such as heifers and bulls are usually obtained from government research institutions (Amrahia Dairy Farm, Livestock and Poultry Research Center, and Animal Research Institute), Tulaku cattle market, or from other cattle farmers. Agro feed manufacturers, including cassava processors, wheat processors, and rice millers supply mainly agro by-products (cassava peels, wheat bran, rice bran, etc.) to intensive and semi-intensive dairy farmers. In addition, farmers usually buy minerals such as salt lick, and veterinary drugs from veterinary shops.

Producers/milk production: milk production in Ghana is mostly from indigenous cattle breeds kept by Fulani herdsman. The production system of dairy is broadly classified into three systems: intensive, semi-intensive, and extensive.

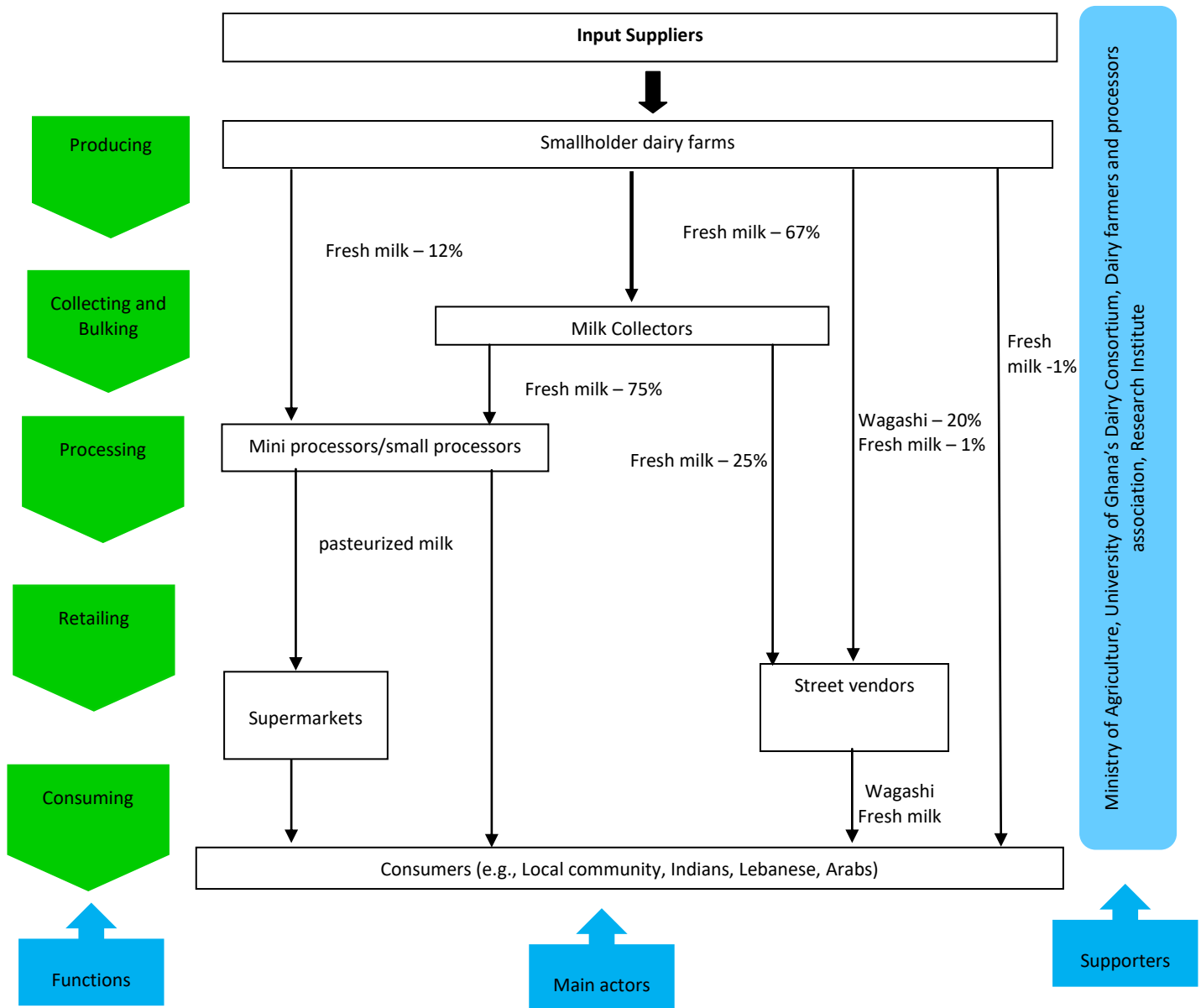
The **intensive** system employs zero-grazing and is mainly managed with few cattle in the backyard in urban areas of the Eastern and Greater Accra Regions of Ghana. In this system, an average of three cows, three calves, and occasionally a bull, generally Jersey breed, Friesian-Sanga crossbred, and local breeds are raised. Milk production is of the highest interest in this system with around 13.0 litres per cow per day.

The **semi-intensive** dairy production system usually provides housing, crop residues and feed supplements as an add-on to grazing. Few farmers are engaged in this system, with the cattle owned mainly by businessmen who are largely absentee farmers. This system generally has crossbred cows from Jersey, Nigerian, and local breeds of cows. The average milk production per cow per day is 3.0 litres and 1.5 litres in the wet and dry seasons respectively.

The **extensive** production system is the dominant system practiced by smallholder farmers where grazing is done extensively on a free range. These farms typically keep on average 27 milking cows and three bulls, of which are crossbred cows from the West African shorthorn, and white Fulani called Sanga. The Sanga cattle breed is well adapted to the arid conditions of Northern Ghana. On average milk produced per cow per day is 4.0 litres and 0.8 litres in the wet and dry seasons. The main objective for raising cattle in the extensive system is for meat (beef), therefore, milk collected is first shared between the Fulani herdsman and calves. The surplus milk after consumption by the household and animals is processed by the wives of cattle producers or is sold to collectors/middlemen and processors for extra income. During the wet season, when there is a surplus of fresh

* Wagashi is milk that has been processed into cheese. It is a very popular delicacy in the Fulani and northern culture in Ghana.

milk, the family makes and sell wagashi (Wagashi is milk that has been processed into cheese) at € 0.33 per block.



Source: Own calculations.

Figure 3. Overview of the local milk value chain in Ghana

Milk collectors: Milk collectors perform the function of assembling/collecting milk supplied in small amounts by a large number of rural dairy farmers/Fulani Herdsmen and supply to mini and small-scale processors as well as vendors. The collectors gather the milk from producers only (100%). They collect milk from several producers at the farm gate and bring it directly to processors such as Emadom Yoghurt, Nanee Yoghurt, Dafa Dairy Products, and the general public. They sell 75% of the milk to mini and small-scale processors and the remaining 25% to fresh milk street vendors. The collectors usually gather the milk bought using Jerry cans. They usually do not have milk storage facilities such as refrigerators and as a result, they sell the fresh milk directly to processors and vendors. The purchased price of fresh milk ranges between € 0.40 and € 0.60. Milk collectors mainly utilize their motorbikes as a means of transportation. The current selling price per litre of milk ranges between € 0.80 to 0.86.

Processors: Mini and small-scale processors use fresh milk for processing wagashi, burkina, yoghurt, and fula. Some of these processors especially those processing yoghurts use their own vans to transport dairy products to retailers. To a large extent, the local small/mini-scale processing sector is not well formalized and as a result, applicable standards for certification are not usually followed as required by the Food and Drugs Authority (FDA) because of the level of informality. This situation was confirmed in the study because only two of the small processors (9%) out of the total study sample had products certification from the food regulatory authority. Because these categories of processors are formalized and regulated, their products are also neatly packaged and well labelled. Therefore, their dairy products have earned trust by standards and are accepted and sold directly in supermarkets, local shops, hotels, and restaurants. Other mini processors produce pasteurized milk, wagashi, yoghurt, and "burkina," which are directly sold in open markets, on the streets and in communities usually by female hawkers. These categories of mini processors do not follow standards and are therefore not certified. Most of these products are easily identified with no labels of products and traceable information. Therefore, largely, the local small-scale milk processing sector is not well regulated with a well-established mechanism for quality control and quality assurance of the small/mini local milk processing sector.

Street vendors: There are two types of street vendors, fresh milk street vendors and wagashi street vendors. These street vendors mainly buy milk and wagashi from Fulani herdsmen and milk collectors to resell them to consumers. Of the total fresh milk obtained, 25% comes from milk collectors and 1% from Fulani herdsmen. Usually, wagashi street vendors mainly buy their products from Fulani herdsmen (20%) and sell them directly to consumers without packaging. The study further established that women play the dominant role in the processing and marketing of wagashi.

Supermarkets: Very few supermarkets retail local dairy products in the country. The main product sold is pasteurized local milk in gallons. Two main brands of local pasteurized milk are found in these supermarkets – Emadom and Nana milk. Meanwhile, the shelves of these supermarkets are filled with numerous brands of a diverse range of imported dairy products. Moreover, the price of these branded local milk is comparatively higher than those of the imported products. Pasteurized local milk in supermarkets is therefore patronized by the "upper class" customers.

2.1.2 Imported milk value chain

The main actors in the milk powder value chain are importers, re-packagers, re-constitutors, processors, distributors, wholesalers, retailers and consumers. Milk powder imported into Ghana is either re-packaged, re-constituted or processed into other products (e.g., yoghurts) (Figure 4).

Re-packagers are largely multinational companies with a subsidiary in Ghana involved in the importation of milk powder in larger units such as sacs and re-package them into smaller units (e.g., sachets and tins) with either local or international brand names. Milk powder is therefore the most common dairy product on the Ghanaian market. In few cases, some value is added to the milk powder in the form of flavouring or an added beverage (e.g., chocolate, coffee). **Re-constitutors** just like re-packagers are multinational companies involved in the production of liquid milk from milk powder. Evaporated milk and flavoured milk drinks are their main products. **Processors** are those who transform milk into other products and are the main focus of the discussion in the milk powder value chain. Processors in Ghana transform milk powder into other products such as yoghurts, ice cream, Burkina, etc.

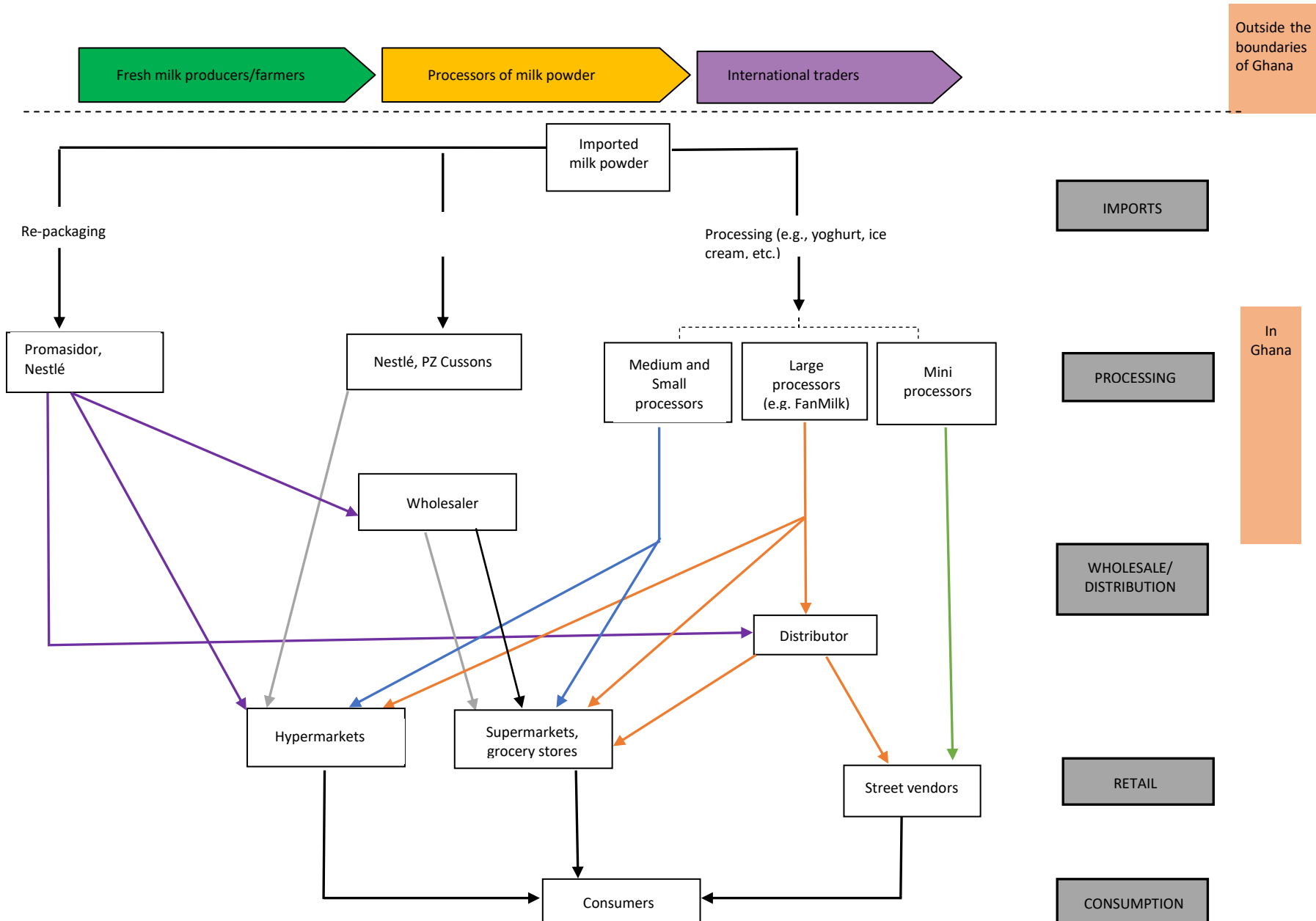


Figure 4. The value chain of imported milk powder in Ghana

2.2 Milk value chain in Senegal

An overview of Senegal's local milk value chain is depicted in Figure 5. The key players in the milk value chain are input suppliers, farmers, milk collectors, processors, wholesalers, retailers, and consumers.

Input suppliers and service providers: This is the first stage of the milk value chain and many participants are involved in this activity. Bulls are usually obtained from other neighbouring farms or from the National Association for the Intensification of Milk Production (ANIPL). Agro feed manufacturers, including cottonseed processors (e.g. SODEFITEX - Société de Développement et des Fibres Textiles), SEDIMA feed mill, and The New African Flour Mill (NMA), supply cattle feed primarily for intensive farms. In addition, farmers buy salt, minerals, and veterinary drugs from veterinary shops. The Senegalese Institute of Agricultural Research (ISRA), ENDA-ENERGY, Agronomes et Vétérinaires Sans Frontières (AVSF), also offer farmers professional skills, training and other services to dairy value chain actors.

Producers/milk production: The Senegalese dairy livestock comprises indigenous and exotic cattle breeds and their cross-breeds. The country has three major dairy production systems: the pastoral extensive system, the agro-pastoral system, and most recently, the intensive system.

The **pastoral extensive** system presents in two areas in the north and north-central regions of the country (Ferlo and the Senegal River area). The principle cattle breed utilised is the Gobra zebu which contributes about 38% of the national milk production (Ba Diao, 2003). The average milk production per cow per day is 3.0 litres and 1.5 litres in the rainy (Aug-Oct) and dry (Nov-July) seasons, respectively.

The **agro-pastoral** dairy production system is centred on the exploitation of the Gobra and Djakoré breeds in the groundnut zone and Ndama in the south. It represents 67% of the national herd. On average, milk produced per cow per day is 2.5 litres in the rainy (Aug-Oct) season and 1.5 litres in the dry (Nov-July) season. Cottonseed is utilised to feed milking cows during the dry season when there are no green fodders.

The **intensive peri-urban** production system is encountered mainly in the Niayes area of Dakar-Thiès. It represents less than 1% of the cattle herd and is mainly based on the use of exotic cows (Montbéliarde, Jersey, Holstein, and Gir) in permanent stabling for milk production. Moreover, this system is characterized by enclosing animals in a shed for 24 hours while supplying feeds such as concentrates (sugar cane, cereal, by-product), hay from rice, maize silage (i.e. zero grazing). The average daily milk yield per cow is considerably high compared to the other two systems and is the highest with production of 30.0 litres in the rainy season (Jan-Mar) and 15.0 litres in the dry season (April-Dec).

Milk collectors: Milk collectors collect fresh milk from different farmers and directly sell them to the mini and small processors. The collection capacity of fresh milk per day ranges from 80 litres to 400 litres. Like in Ghana, bikes and motorbikes are used to transport milk from the farm gate to milk processing units. The current purchase price and selling price per litre of fresh milk varies between €0.53 to €0.76 and €0.61 to €0.91, respectively.

Mini and small-scale Processors (Fresh milk): The processor is a vital player in the dairy value chain. Mini and small-scale processors buy fresh milk mainly from milk collectors or intensive farmers for processing cheese, butter oil, curdled milk (sweetened and unsweetened), and fresh pasteurized milk. Mini and small-scale processors' milk purchasing capacities range from 250 to 2000 litres monthly. These processors don't utilise imported milk powder as input and depend entirely on local fresh milk. These processors mainly supply their dairy products to restaurants, shops, and kiosks.

Women retailers: Many women buy milk from pastoral and agro-pastoral farmers and sell them directly to restaurants, shops, and kiosks without packaging. However, there are no specific quality control regulations or standards to protect consumers.

Medium, large-scale processors (Fresh milk and imported milk value chain): The processing industry of Senegal produces pasteurised milk, yoghurts, curdled milk, Thiakry and cottage cheese. Small, medium and large-scale processors produce under hygienic conditions and use modern equipment. Their products have good packaging (tetra packs, bowls, and small buckets) and labeling detailing product composition including certification stamps. End products of these processors i.e., small, medium and large reach consumers through hypermarkets, supermarkets and boutiques. Mini processors also process yoghurt and curdled milk from milk

powder. These firms do artisanal (traditional) processing with the use of unmodernized equipment. Furthermore, mini processors operate under poor hygienic conditions and their products are usually marketed in open markets, streets, and in boutiques (small grocery shops). Their products do not have traceable information such as dates of production and expiry.

Wholesalers and distributors: Wholesalers and distributors supply products of large, medium and small processors to retailers in Senegal (hypermarkets, supermarkets, supérettes, and boutiques). Meanwhile, some processors do direct delivery to their customers (retailers).

Retailers: Retailers in Senegal - hypermarkets, supermarkets, and boutiques are involved in the retail of dairy products including pasteurized milk, UHT milk, evaporated milk, powdered milk, ice cream, yoghurts, curdled milk, cheese, butter, and Thiakry. Both imported and domestically processed dairy products are traded. However, retailers are much aware that in exception of "Dolima" and "Candia" brands produced with a combination of fresh milk and imported powder, all other domestic dairy products are processed exclusively from milk powder based on the information provided on the packages of the various products.

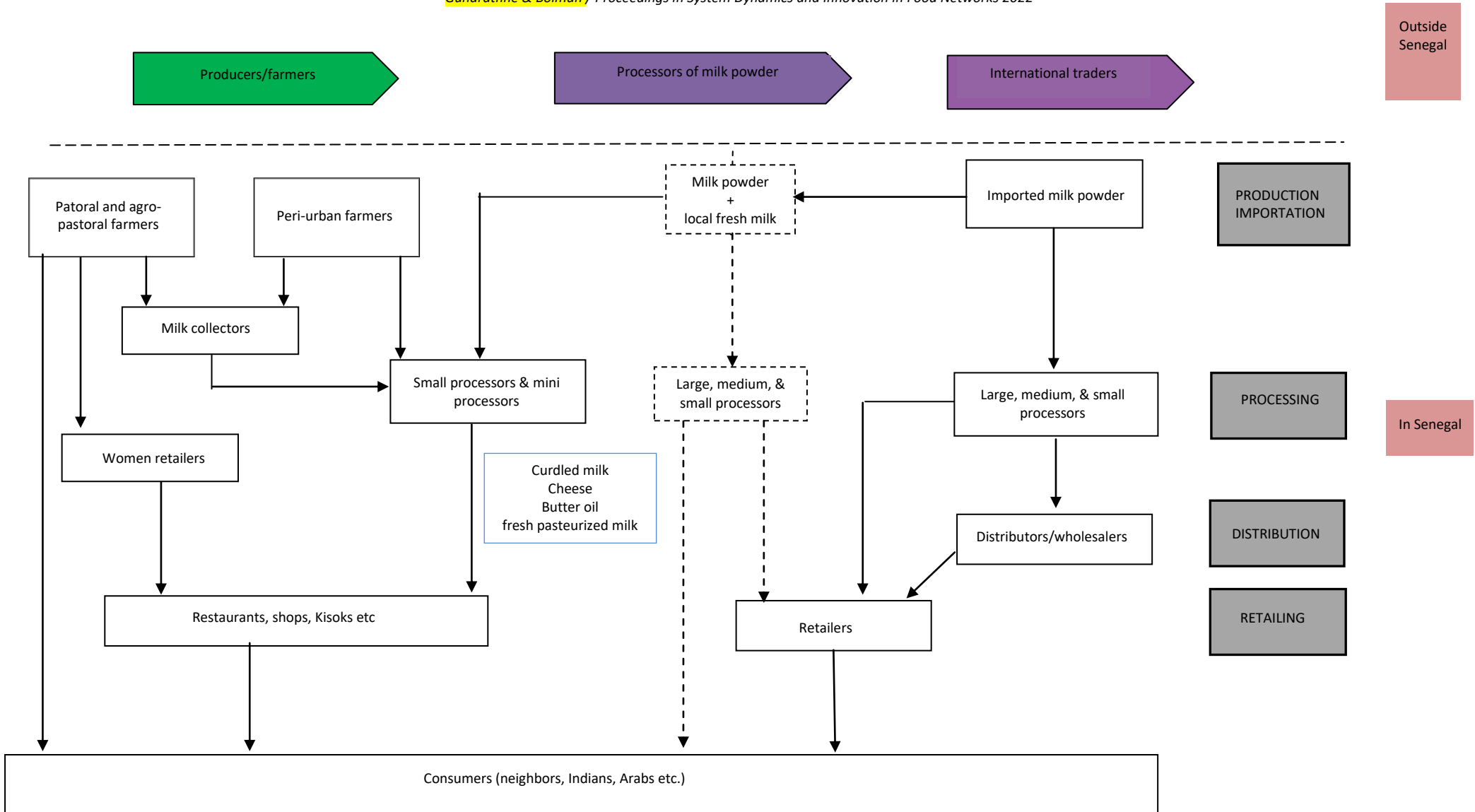


Figure 5. Milk value chain in Senegal

3 Discussion

Rapid population growth, rising per capita income, and fast-growing urbanization have led to large increases in demand for milk and dairy products in West Africa, and this trend will inevitably continue. However, our study reveals a number of constraints which hinder the development of the dairy sector. In both countries, local milk yields are very low and are unstable due constraints related to (i) low genetic potential of local breeds for milk production, (ii) the extensive system of feeding herds, especially during the dry season with incessant movements that do not facilitate the collection of milk, (iii) the low level of development of semi-intensive (agro-pastoral) and intensive dairy farming systems, (iv) and seasonal variations. During the dry season, milk yield per cow is very low and the small quantities of milk collected spoils easily due to a lack of refrigerators. Also, most farmers in rural pastoral and agro-pastoral areas do not have access to electricity supply and refrigeration equipment, and practically, it is a challenge to chill the milk on the farm. Milk yields are much higher in the rainy season compared to the dry seasons but due to a lack of storage facilities as mentioned early on farmers are forced to discard significant quantities when it becomes difficult to find buyers. Fresh milk, collected in plastic buckets, is transported under the sun without cooling equipment. The transportation of curdled milk and other dairy products, and their subsequent sale without adequate packaging and cooling systems pose a risk of deterioration of the sanitary qualities of the milk. Furthermore, the tropical temperatures of above 25°C hastens a reduction in the quality of milk before it gets to the market or to the processor. It is costly for middlemen and buyers to travel to milk producing areas which are located far from urban and city centers. Moreover, during the rainy season, roads are not traversable due to flooding as the roads linking milk producing areas are not tarred which makes milk collection difficult.

Due to the challenges encountered in securing buyers for their milk, resource-poor Fulani farmers process surplus milk into "wagashi" (cottage cheese) for both home consumption and sale to retailers and consumers. Furthermore, the farm gate milk price is determined by buyers based on the distance from the farm to the nearest market. The long-distance between farmers and the milk collector leads farmers to milk their cows once per day, primarily due to poor on-site milk storage and processing facilities. In the first place, local milk is a scarce input for processors who rely largely on imported milk powder. In the second, it is a costlier input for the processing industry in both countries compared to milk powder. However, because milk production is higher in Senegal, few processors who have access to it combine it with milk powder for some end products such as yoghurts and UHT milk.

As identified, the local fresh milk value chains are informal and short. Local milk handling and processing practices are purely traditional and are not hygienic. The processing methods used by mini and small-scale fresh milk processors are limited to few dairy products (wagashi and yoghurt). Furthermore, mini and small-scale processors lack adequate quality testing infrastructure. Almost all local value chain actors interviewed do not have any form of training on milk handling, processing and marketing. Also, local dairy products are characterized by poor packaging and labelling, making it difficult to compete against domestically processed and imported products.

The milk powder processing industry in both countries is witnessing continual growth as milk powder is readily available in desired quantities. The ability to store milk powder for longer periods also gives it an advantage over fresh local milk. Moreover, milk powder is cheaper compared to local milk.

Additionally, taxation still remains a major constraint on the development of the sector in both countries. In fact, currently, 18% VAT is levied on milk for collection on the same basis as products in category 3 of the ECOWAS CET (Common External Tariff 5%). Collected milk is a raw material for the manufacture of other dairy products such as yogurt, cheese and butter. To this problem is added the application of VAT on animal feed made available to producers by dairies, which does not contribute to increasing and securing the supply of milk in the dry season in Senegal.

4 Conclusions

Dairy processors in Ghana and Senegal depend on imported milk powder due to the scarcity of local fresh milk and local milk value chains are underdeveloped with numerous challenges. Among these include the seasonality in the supply of fresh milk with a high risk of perishability in the rainy season due to glut and the lack of storage facilities. Sanitation is a major problem in the fresh milk value chain, from milking to marketing. The study recommends that the competitiveness of Ghana's and Senegal's local dairy sectors require an upgrade in the standards of local milk production, processing, and packaging, in other words, all activities along the entire dairy value chain need to be modernized. It also recommends investment in bulk storage facilities for milk in the rainy season and supplied in the dry season to help stabilise the high pricing of dairy products. Specially, In the pastoral and agro-pastoral areas, local cattle breeds have low milk yield and low availability of natural forages during the dry season becomes a significant challenge. Therefore, national milk production fell

substantially because most of the milk coming from these production regions. Artificial insemination and higher-grade bulls may be utilized to produce cross breeds for improving milk production. Furthermore, the introduction of improved forage varieties such as Napier grass (*Pennisetum purpureum*), *Brachiaria* grasses etc., for better feeding of dairy cows during the period of feed scarcity, particularly in the dry season, appears to be a sustainable solution. There is abundant green grass and leaves available for cows during the wet season, making for high milk output compared to the dry season. Farmers often have to sell their surplus milk at throwaway prices due to the absence of cold storage facilities and infrastructure. In order to use the surplus milk produced during the rainy season, farmers would convert it into cheese that can be stored for months and months and consumed in the dry season when the cows are producing less fresh milk. Therefore, farmers should be encouraged to make artisan cheese by providing the necessary skills, knowledge, and technical assistance to sell at a premium price. Likewise, the milk collecting network of the area needed to be strengthened through the improvement of milk collection infrastructure facilities at the farmers' doorstep. Furthermore, training and extension programs are needed to improve farmers' knowledge about clean milking and milk handling, storage practices, value addition, and marketing.

Moreover, diversification of milk into other valuable products to attract and improve the low market in the rainy season is important. This could help increase consumption of dairy products in the rainy season and reduce spoilage of surplus milk. Additionally, investments should also target the purchase of feed as a buffer when there is a glut and sold to farmers at affordable prices when there is a shortage. Baling technology could also be employed to store forage during the dry season and supplied when there is a shortage in the dry season. Finally, in the long-term, the government could help stabilise the currency exchange rate and other factors that contribute to the high import and transportation cost of cattle and associated equipment.

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