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Opportunities for Innovation and Intervention in Uganda's Dairy Value Chain

A Scoping Report

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ABSTRACT

This report is generated as part of a scoping study to identify possible areas that should be prioritized for intervention to improve performance and sustainability of the dairy industry in Uganda. The evaluation relies on primary and secondary data collected by IFPRI and DDA in 2021. Ten primary datasets are used for the results informing the several interventions and secondary data relies on literature review and Uganda Revenue Authority (URA) dataset. The results underline five issues namely low productivity, low milk quality, and constrained markets.

Low productivity is associated with production systems that undermine pasture improvement, disease control and animal health, yet these are primary drivers of milk output notwithstanding breed and effects of climate shocks. Secondly, milk production practices are directly linked to milk quality and low milk quality has negative chain effect on productivity/performance of all actors in the dairy value chain with consequence of low competitiveness of Uganda's dairy products.

The evidence suggests that there is need to explore new approaches to improve productivity and innovations in design of interventions in a holistic value chain approach to improve market performance. To improve production, innovations in livestock management and animal health coupled with milk volume (MV) based rewards are proposed. To improve milk quality, the establishment of quality-based incentives are proposed.

1 INTRODUCTION

1.1 Background

Both the agricultural sector in general, as well as the livestock sub-sector in itself, remain important for Uganda's economy. The agricultural sector in Uganda contributes 24% to national Gross Domestic Product (GDP) and the livestock sector alone contributes 4.2% to national GDP and 17% to agricultural GDP (UBOS, 2020; WB, 2020; MAAIF, 2020). Furthermore, the agricultural sector provides 60% of the raw materials to manufacturing and 80% of Uganda's total exports (MAAIF, 2020). The sector also employs about 71% of the total workforce which makes it central to poverty reduction and development in Uganda (IFAD, 2021; NPA, 2020).

Under the livestock sub-sector, the dairy industry has become the most important industry in terms of its growth and contribution to Uganda's exports. Due to the potential positive effects on household poverty reduction and foreign currency reserves, the dairy sector has thus gained a solid place on the list of priority commodity value chains for government intervention in the medium to long term.

Despite its success, the dairy value chain faces several challenges. These include unstable supply due to seasonality in milk, poor quality of milk both in terms of milk sanitation and composition of milk, underdeveloped input sector, etc.

1.2 Objectives

The overall objective of this scoping study is to identify a limited number of interventions in dairy value chains in Uganda that will be subsequently tested through a field experiment. The ultimate aim is to come up with a design that as able to relax constraints at different levels, and then we can also estimate interaction between the different interventions at different levels to make statements about "innovation bundles". Such bundles may be particularly important in value chains, since previous research that suggest that both push- and pull factors are necessary for value chain upgrading. In order to achieve this overall objective, the scoping study has three intermediate goals:

a) To describe the structure and operation of the dairy value chain, particularly the middle of the chain consisting of producers, traders, milk collection centers, and to some extent dairy processors.
b) To diagnose problems in the supply chain, defined as obstacles or constraints that prevent the value chain from further upgrading, leading to lower earnings for participants along the chain, limited participation of smaller farmers or otherwise disadvantaged groups, and potential health risks to the wider population.
c) To explore alternative solutions that may address one or more of these problems, where the evaluation is based on an analysis of secondary data, the views of stakeholders, pilot projects, and experience in other countries.

1.3 Methods

This scoping report relies on a variety of data sources. **Secondary data** sources are generally obtained from government agencies like the Uganda Revenue Authority and the Dairy

Development Authority. Furthermore, **primary data** was collected by IFPRI in October 2021 as part of the PIM project on "Innovations for Inclusive and Efficient Value Chains. For that study, data collection proceeded in two stages to enable a comparison between export-led value chain development and local value chains development. A first stage focused on local value chains connecting milk production areas to Kampala, the main market for dairy products within Uganda. For this part, primary data was collected in the districts of Kiboga, Kyankwanzi, Masindi and Nakaseke. In a second stage, the focus was on export led value chains. In Southwestern Uganda, an influx of Foreign Direct Investment has resulted into an important expansion of processing capacity. These processors mainly produce for export. We thus collected data in the catchment area for these processors (the districts of Kirihura and Mbarara).

In both areas, data collection involved interviewing three dairy value chain actors (dairy farmers, milk collection centers, and traders) to get a good idea of the overall structure of the diary value chain and innovations developed over time. We also visited a few processors to collect qualitative information. In total, we collected data on 1,000 milk producers, 350 traders, and 140 milk collection centers.

We supplemented the quantitative data with **qualitative data** through key informant interviews and focus group discussions collected in August 2022. This included visits to two milk processing plants, but also smaller processors (eg cheese producer) in addition to milk collection centers, dairy farmers and traders/transporters.

Most of the report will use **exploratory data analysis**, relying on (subgroup) means and tabulations created from observational data. The usual disclaimer with respect to potential selection bias and reverse causality thus applies when interpreting the results.

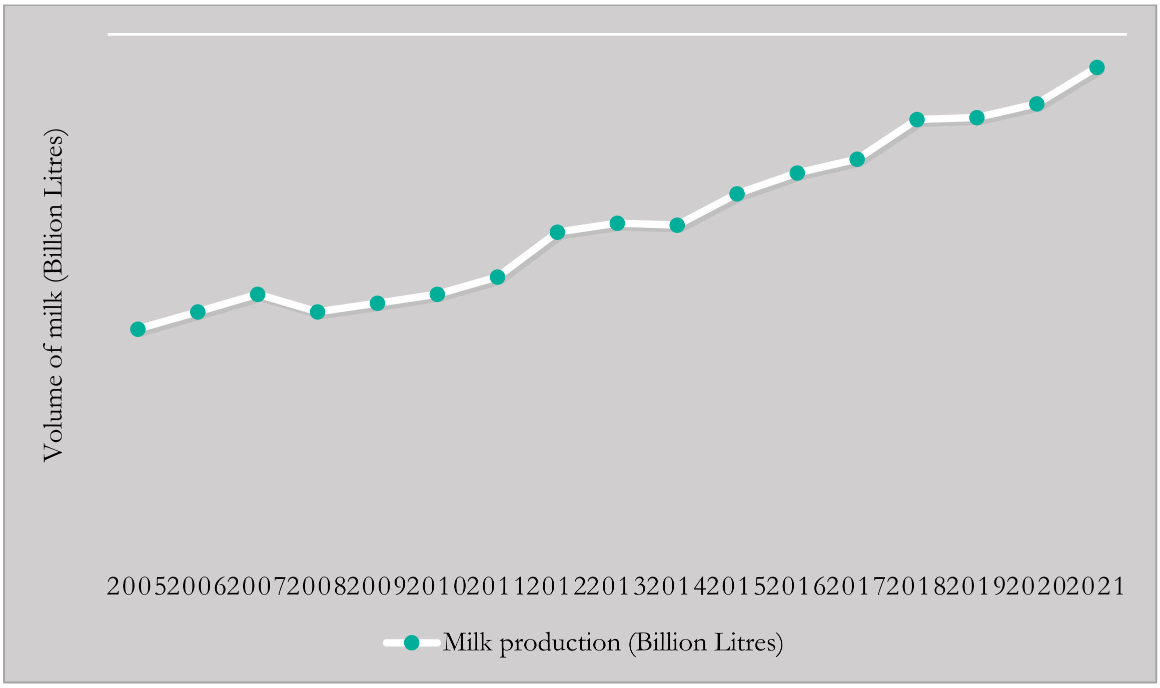
2 DAIRY INDUSTRY IN UGANDA

One of the drivers of livestock sub sector performance is the dairy industry which contributes 12% to national GDP, 16% to agricultural GDP, 8% of total value of exports, and 3.4% of value of agricultural exports (DDA, 2021; NPA, 2020; MAAIF, 2016). The growth is attributed to increasing national livestock herd size from 5.2 million in 2000 to 12.1 in 2010 and 15.7 million by 2018 valued at USD 1.523 billion (MAAIF, 2020; Mbowa, et al., 2012).

2.1 Milk production

As of 2019, MAAIF/DDA estimated that national milk production stood at 2.8 billion litres (DDA, 2020; DDA, 2021). The data shows that milk production has grown at an annual rate of 5% for the period 2005 through 2020. Most of the livestock herd is concentrated in the livestock corridor and similarly, it is where most milk production takes place. There are five milk production hubs also known as milk sheds namely the Central milk shed, Southwestern milk shed, Mid-west milk shed, Eastern milk shed, and Northern milk shed.

Figure 1: Milk production in Uganda

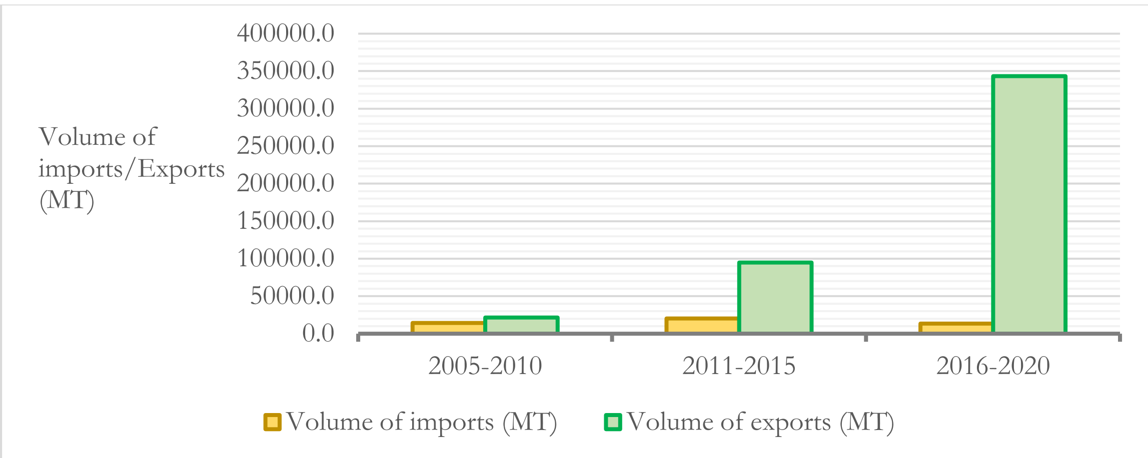


Source: DDA & MAAIF reports (2020)

2.2 Milk trade

The sector has the (regulated) formal market that is comprised of licensed value chain actors that dominate the opportunities in export markets while the informal market is comprised of unregistered operators that are entrenched in the domestic market and do informal exports of raw milk especially to DRC and Rwanda. According to SNV (2021), the flows of raw milk to DRC have grown but quantities are not well documented. For the period 2016 to 2020, the volume of exports (~350000 MT) was more than triple the volume of exports for the period 2010 to 2015. Generally, Uganda's dairy exports have immensely grown while imports have declined.

Figure 2: Volume of Uganda's exports and imports



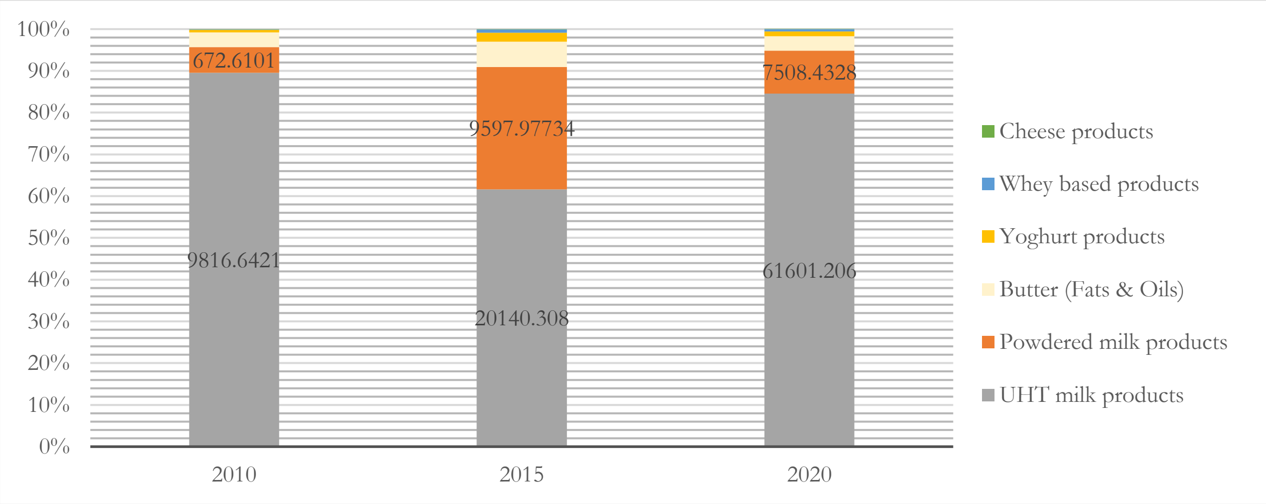
Source: URA data, 2021

Export volumes have consistently been higher compared to imports making Uganda a net exporter of dairy products, with imports ranging between USD 5.2 million and 5.4 million in 2015 to 2019 whereas export earnings were significantly higher (DDA, 2020). In the period 2010 to 2020, about 37000 tonnes of dairy products were imported which were about 13 times lower than volume of exports.

2.3 Milk products

Milk channelled through the formal marketing chain is what is processed into several dairy products namely pasteurised milk, powdered milk, UHT/Long life milk, ghee, butter, casein, whey protein concentrates, yoghurt, cream, ice cream, fermented milk, cheese, and others. The bulk of processed milk especially the UHT, powdered milk, butter, and casein are exported to various international markets in Africa, Asia, and North America. UHT milk is the main export product (>80%) followed by powdered milk products (Figure 3).

Figure 3: Uganda export dairy products



Source: URA data 2021

2.4 Export markets

Most of the milk produced in Uganda is traded within the domestic and regional EAC markets. Based on URA (2021) export data for the period 2010 to 2020, most of Uganda's dairy products to international markets were destined to 47 countries in various regional economic trade blocs. The common market for East and Southern Africa (COMESA) is the key trade bloc which also includes many countries of the east African economic community (EAC). However, not all the 47 countries have been consistent export destinations especially those outside the EAC and COMESA[1]. Countries where the biggest share of Uganda dairy products have been exported in Africa include Kenya, Rwanda, Tanzania, Sudan, South Sudan, Egypt, Somalia, Burundi, Democratic Republic of Congo, and Zambia while those outside Africa include India, UAE, and Japan.

[1] Some of countries where dairy products exported for only two or less years from 2010 through 2020 include Germany, Belgium, Canada, Australia, Angola, Cameroon, Eritrea, Kuwait, Korea Republic, Nigeria, Bangladesh, Pakistan, Qatar, Lebanon, and Yemen.

For the period (2016 to 2020), 94% of dairy exports went to EAC common market (Kenya, Tanzania, Rwanda, Burundi, and South Sudan) with Kenya alone taking a share of 87% (Table 1). Considering only 2020, Table 1 further shows that most of Uganda's dairy export destinations are in Africa (99%) and more so, within countries of the EAC trade bloc. The shares of exports show that Kenya is the major market (84%) for Uganda's dairy exports (Table 1). This points to limited market diversification and vulnerability to risk associated with product outsourcing to one main market. Government effort to diversify markets has targeted Algeria as a potential market: moreover, it is among the top importers of whole and skimmed milk powder in the world.

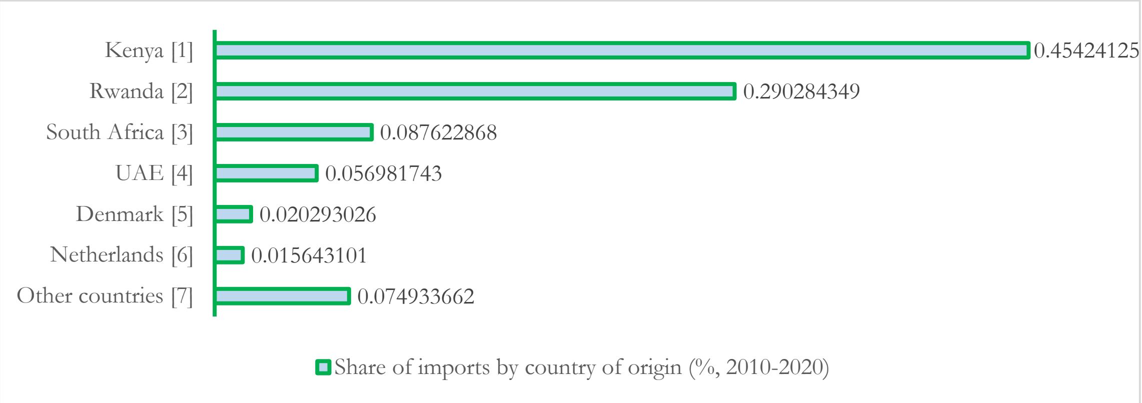
Table 1: Percentage share by destination of Uganda's dairy exports

Trade area	**Countries**	**Share of exports**	
		2020	**2016 -2020**
Outside Africa	Japan, Oman, Qatar, UAE, India, Great Britain	1.0	1.6
Middle East	Egypt, Oman, Qatar, UAE	3.2	1.5
SADC	Malawi, Tanzania, Zambia, DRC	1.8	2.2
COMESA	Malawi, Zambia, Kenya, Rwanda, Burundi, Egypt, DRC, Sudan, Ethiopia	88.8	91.3
Africa	All COMESA countries above + Tanzania, & South Sudan	99.0	98.4
EAC bloc	Burundi, Kenya, Rwanda, South Sudan, and Tanzania	95.0	94.2
	Kenya	84.3	87.2
	South Sudan	9.5	3.9
	Rwanda*	0.5	1.8
	Tanzania	0.7	1.1
	Burundi	0.1	0.1
	Other countries	5.0	5.8

Source: URA (2021) data. *Exports to Rwanda represent in 2020 are based on 2019 export volumes.

The dairy market in Uganda is fully liberalized with no government restrictions on imports of any dairy product and thus, imports of cheese, powdered milk, UHT milk, yoghurt, and butter enter the country from several countries in Africa and outside Africa. For the period 2010 to 2020, 91% of the imported dairy products originated from five countries namely Kenya (45%), Rwanda (29%), South Africa (9%), UAE (6%), Denmark (2%) and Netherlands (Fig. 5). Few other imports came from France, Malaysia, Great Britain, Belgium, and Italy.

Figure 4: Share of imports to Uganda by country of origin



Source: Based on URA IM data (2021)

Overall, Uganda's dairy industry has exhibited significant growth and buoyance despite several episodes turbulence in both the domestic and international market environments. The international outlook of the global dairy industry (2020-2030) is predicted to continue growing with developing countries being the drivers particularly India and Pakistan. Considering the growth and the present unexploited potential that still there is, it is fair to say that Uganda will be part of the African picture in a significant way if government takes lead in addressing the existing challenges in production and constraints to trade.

3 INSTITUTIONAL ENVIRONMENT

3.1 Organization

The government body mandated with coordination of development of the dairy industry in Uganda is the dairy development authority (DDA) which is directly under the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF). DDA has six branch offices in every milk shed responsible for training of farmers and monitoring milk quality.

3.2 Regulation

A range of policy reforms have driven transformation of the dairy sub-sector in Uganda (Campenhout, Minten, & Swinnen, 2021). Uganda's economic policy environment has fundamentally changed from that largely characterised by government control in the period 1960 - 1990 to a liberal market policy ushered in then with the coming to power of the National Resistance Movement (NRM) government in 1986. The fundamental switch in economic policy in part, involved privatization of several government parastatals to eliminate monopolies in among others: banking sector, insurance sector, foreign currency exchange, procurement, manufacturing, and trade in agricultural commodities such as coffee, cotton, tea, and dairy products. The liberalization phase involved institutional reforms that established legal frameworks for operationalization of market reforms. In the context of the dairy sector, the reforms followed the 1993 dairy sector master plan that set a foundation for strategic focus and establishment of DDA under an act of parliament, the Dairy Industry Act (1998). Besides allowing the creation of DDA, the Dairy Industry (DI) Act stipulated the core mandate for DDA existence being "to provide proper coordination and efficient implementation of all government policies designed to achieve and maintain self-sufficiency in production of milk in Uganda by promoting production and competition the dairy industry and monitoring the market for milk and dairy products." The Act also gives the Authority the powers to govern the industry and the duty to promote Uganda's dairy products, and train and coordinate other actors in the dairy value chain.

With the institutional framework in place especially that pertaining the laws to govern the dairy industry in Uganda, enforcement of DI regulations commenced in 2000. As one of DDA deliverables, the monopoly of Dairy Cooperation Limited (DCL) came to an end in 2006 and competition was ushered in. In the last two decades, several players have joined the dairy industry and impact has been significant in terms of benefits to farmers and market performance because of market competition. The rapid transformation of the dairy sector in response to agricultural sector liberalization policies since the 1990s has had positive effects on the sector's performance and economic relevance (Mbowa, Shinyekwa, & Lwanga, 2012). The major market issue to farmers is price volatility but government has maintained non-interference in the market and is stuck on provision of various incentives to both the producers, and the investors. In the case of the investors/processors, tax holidays have been granted and there are no export levies. These developments are, nevertheless, still overshadowed by a relatively underdeveloped value chain and the persistent sizeable 'informal' milk market that supplies lower-priced 'raw' or 'boiled' milk directly to domestic consumers (Abdulsamad & Gereffi, 2016).

Under the NDP II and NDP III the government medium term planning framework, the dairy sector is among the priority (18) commodities for intervention. The focus is to invest in agro industrialization to add value and increase the share of value-added products for domestic and export markets. The government of Uganda (GOU) has also been aggressive in promoting regional trade and is a member of the EAC, the COMESA, and recently ratified its membership in the AfCFTA. GOU aims to increase and sustain its share in the regional markets of EAC, COMESA, and eventually AfCFTA for export of dairy products among other processed commodities. Other markets the government is targeting for dairy products include the Middle East, and China. In line with government plans, DDA and the Exports Promotion Board (EPB) have implemented interventions with measures to increase production, quality, and exports. These government policy interventions have partly contributed to the good performance of the dairy sector in the past five years.

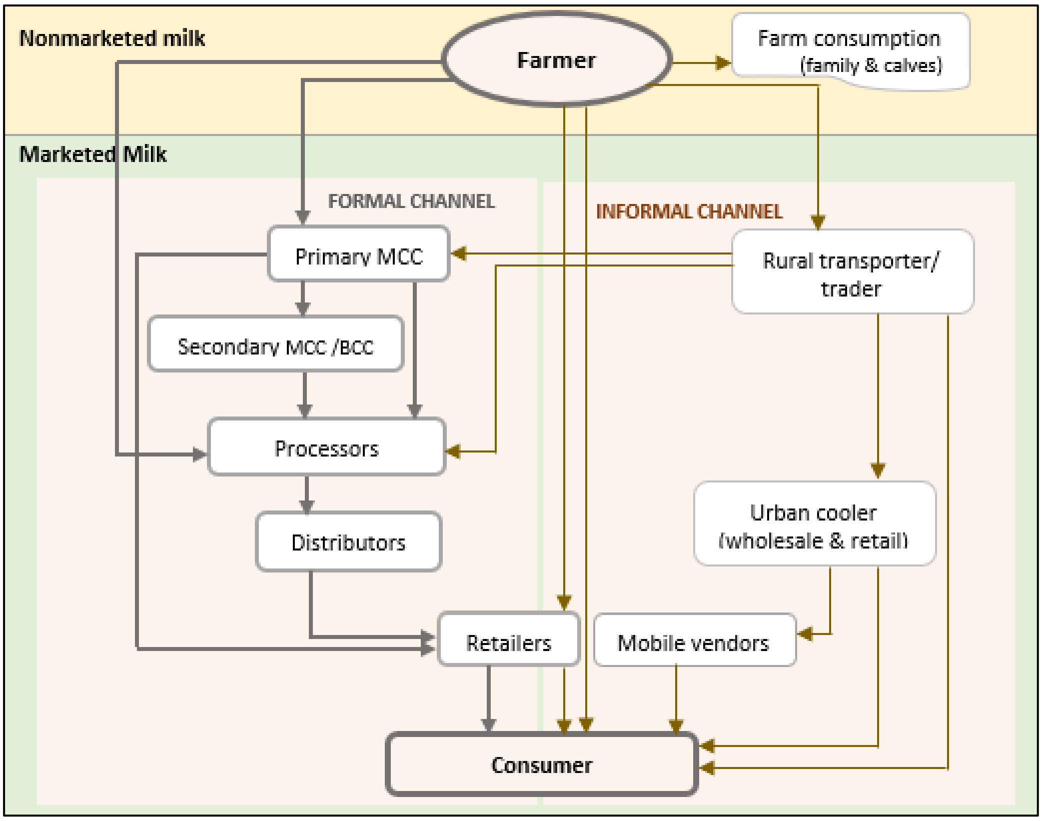
4 THE DAIRY VALUE CHAIN IN UGANDA

4.1 Milk marketing

The dairy value chain in Uganda is dual structured comprising of two competing channels, the formal and informal marketing channels (Ariong, Otikal, Pernechele, Nana, & Meilland, 2022). Both marketing channels are characterised by many players at each stage of the value chain save for the processors that have features of oligopoly in the formal channel. The informal marketing channel takes on two pathways that is: (i) Milk may flow directly to consumer from farmer which is common in the urban and peri urban settings where the consumers are in a close radius to the producer often an intensive farmer; (ii) Milk may flow to a consumer from the producer via a middleman (Fig. 5). The formal channel comprises registered and/or licensed value chain actors such as milk collectors, bulk transporters, processors, and distributors. Both the formal and informal supply channels alike are not well vertically integrated and horizontal linkages are still weak. Suppliers can easily switch alliance without notice due to weak trust-based relationships and limited formal contractual arrangements.

Out of the estimated daily production of about 8 million litres of raw milk, about 34% goes through the formal marketing channel while the rest goes through the informal marketing channel coupled with a small percentage retained by the producers for home consumption (DDA, 2020). Milk produced by farmers is delivered to the MCCs or processors by small-scale transporters and bulk-size transporters. The primary MCCs are the key first and main points of milk aggregation. Milk at MCCs is picked up by either milk transporter with small tankers that deliver the milk to bulk collection centres (BCC) with chilling facilities of bigger capacity and deliver to milk coolers in urban areas that sell unprocessed milk to fellow retailers and consumers; or the bulk milk tankers pick up and deliver milk directly to the processing plants. At the plants, milk is processed into various dairy products which are then delivered to various distributors who in turn, sell to the retailers/vendors for last mile access by the consumers in the cities or urban trading centres.

Figure 5: Milk marketing chain in Uganda



Source: DDA

Overall, milk that reaches the final consumer passes through 2 to 6 value chain actors with exception of few consumers that may access raw milk direct from a farmer. It is observed that milk that reaches the consumer via the informal channel has few actors and thus, is likely to be cheaper and present unfair competition since it can by-pass several delivery and regulatory costs.

4.2 Value chain actors, characteristics, and practices

The stakeholders in the dairy sector include Ministry of agriculture, (MAAIF), DDA, non-government development partners, producers/farmers, transporters, milk collectors/ MCCs, processors, exporters, retailers, and consumers. The following sub sections provide a description of key actors in the dairy value chain.

4.2.1 Producers

Milk production in Uganda is dominated by livestock farmers who own small to large size herds of local and crossbred cattle. An estimate of dairy cattle farmers/farms among the livestock farmers is not clear. Small scale farmers are common in the Eastern and Northern milk sheds and keep mostly local breeds whereas the Western (which includes southwestern and mid-west milk sheds), and Central milk sheds have farms that are medium to large scale with both local and improved breeds of cattle. However, the North-eastern area also known as Karamoja milk shed has pastoralists who own large herds of cattle but of purely local breeds. About 66% of national production and over 80% of milk marketed through formal value chain is from three milk sheds namely the central milk shed, mid-west, and southwestern milk sheds.Table 2 shows characteristics of farmers in the Central and Western milk sheds. The average area for livestock grazing area is about 60 acres and the stock size is about 36 of which 62% is of improved breeds. Most of the farmers (78%) have their grazing land either fully or partially fenced. Average daily milk production is 45 litres which drops by about 30% in the dry season and milk supply to buyers in the wet season is 32 litres and drops by 40% in the dry season. Average unit price of milk in the wet season is UGX 700 and the price increases by about 28% in the dry season on account of the drop in milk production and supply. The average distance from a farm to the MCC is 7.5 kilometres.

Table 2: Farmer and farm characteristics in central and western milk sheds

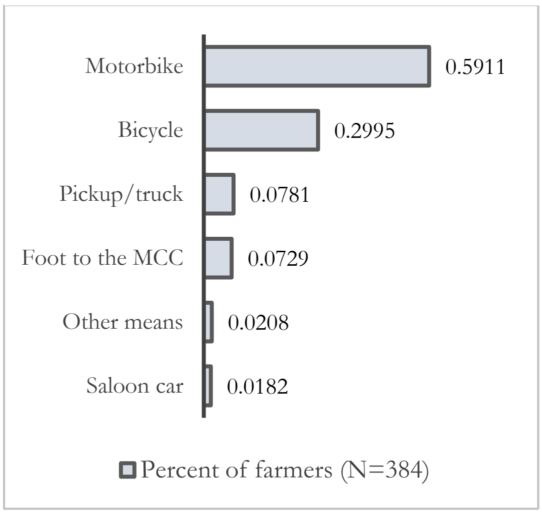
Variable	Obs.	Mean	SD	Min	Max
Key household income source					
Crop production		22.8		0	1
Dairy farming		68.6		0	1
Other employment/activity		8.6		0	1
Land available for livestock grazing (ac)	889	58.758	97.006	0	1115
Area used for crop production (ac)	911	4.739	8.213	0	100
Production system (%)					
Farmland fully fenced (Paddock)		53.1		0	1
Farmland partially fenced		24.5		0	1
Farmland not fenced (Free range)		22.4		0	1
Herd size 2020	865	36.9	47.668	1	730
Herd size 2019	760	35.8	42.443	1	500
Proportion of improved stock in 2020	859	0.621	0.412	0	1
Proportion of improved stock in 2019	753	0.577	0.433	0	1

Production (Litres/Day)					
Dry season (Dec- Mar)	849	31.786	86.233	0	1029
Wet season (Apr- Nov)	865	45.322	93.764	0	1119
Quantity sold in dry period	846	18.658	20.862	0	80
Quantity sold in wet period	864	31.581	42.327	0	320
Farmer unit price in dry season (UGX/L)	686	919.955	212.612	200	2000
Farmer unit price in wet season (UGX/L)	694	718.768	199.485	250	1500
Distance to MCC (km)	900	7.5	7.11	0.1	50
Proportion of raw milk marketed- dry period	845	0.637	0.261	0	1
Proportion of raw milk marketed- wet period	863	0.696	0.241	0	1

Source: IFPRI survey data 2021

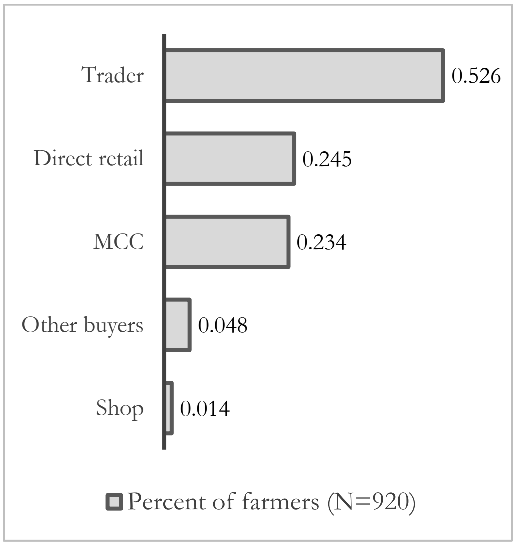
Given the remote location of some producers and the state of rural roads especially during the rainy season, quick transportation of raw milk is mostly done by motorbikes (Fig. 6). A motorbike is usually loaded with about 40 to 100 litres of raw milk (in 20L milk cans) which is delivered to collection points located 0.5 to 50 km away from the farms. Majority of milk deliveries are usually done between 6.00 hours and 12:30 hours. Farmers are commonly paid (by MCCs) after 14 days from day of milk delivery. Farmers registered in a cooperative that usually operate an MCC commonly receive a pay less by UGX 150 to UGX 300 on per litre due to deductions for operation costs and seldom MCC capital investments such as capacity expansion, tractor procurement among others. Figure 7 shows many farmers supply to traders (53%) and do direct retail while supply to MCCs was reported by 23% of the farmers.

Figure 6: Farmer milk transport means



Source: DDA survey data 2021

Figure 7: Farmer milk buyers



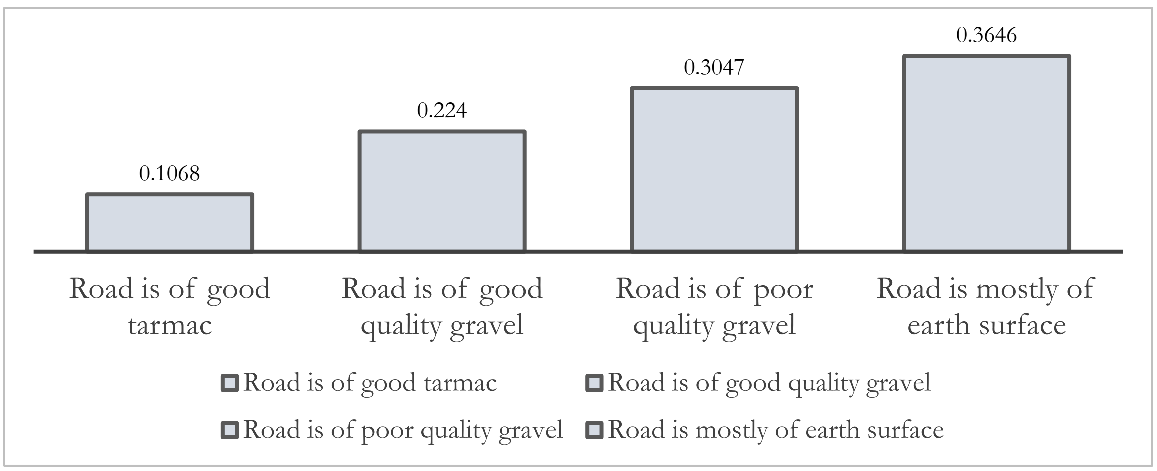
Source: IFPRI survey data 2021

The above graph indicates that farmer participation in the formal marketing channel (MCCs) is compromised by farmers indulging in supply to other buyers which can affect the processors. However, it is also possible that some independent collectors also deliver to the processors. One of the challenges facing the processing plants is insufficient amount of milk channelled through the formal marketing channel which gets available for processing. This affects plant operating capacity which goes along with ability to take advantage scale economies and produce at least cost for competitiveness. Figure 8 shows farmers sell to several buyers though sell to one type of buyer does not preclude sell to the others. However, what would matter most is the quantity sold to each buyer as it is possible to partition sales with a bigger share to the MCC or otherwise.

One of the incentives farmers sell to buyers other than those in the formal channel/MCC is quick payment. Providing incentives for farmers to sell most of the milk through the formal channel has the potential to improve operation capacity and Uganda's competitiveness. It is observed that reducing the practice of selling to informal actors is hard but one of the approaches to limit quantity of milk sold to informal actors would be to introduce milk quantity/volume (MV) based incentive structure whereby above a certain threshold, a farmer gets premium price. The quantity-based payment can then further be enhanced with the quality-based payment incentive arrangement.

Figure 8 indicates there are some infrastructure deficits that affect milk delivery and may have negative impact on milk quality. About 67% of the farmers access the MCC by roads that are of poor quality for most of the trip.

Figure 8: Quality of access roads



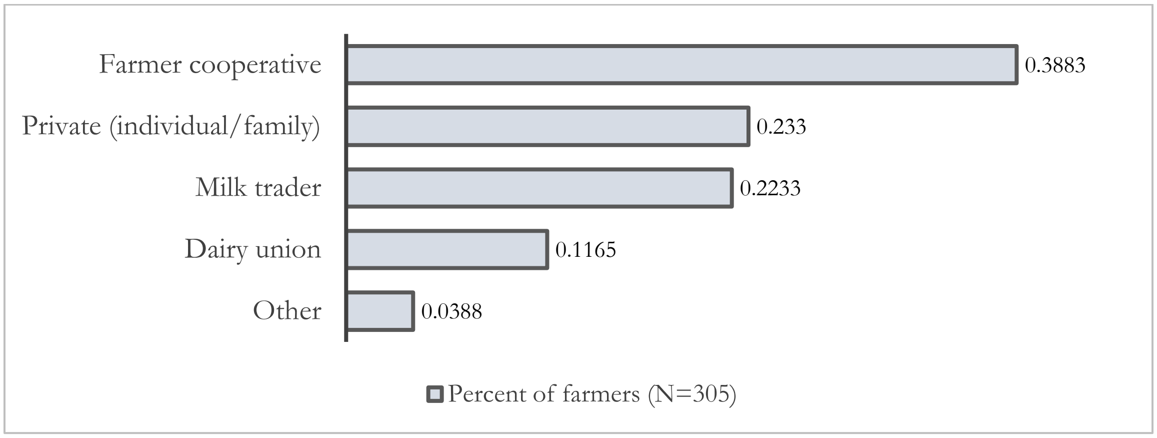
Source: DDA survey data, 2021

4.2.2 Primary milk collectors

The first act of milk aggregation is done by primary milk collection centres (MCCs) and private traders that must be registered/licensed to operate. However, there are isolated cases of unregistered MCCs and many unregistered traders. According to DDA (2020), there are 483 registered MCCs with a varying storage capacity and overall, the national total collection capacity per day is over 1.9 million litres. The MCCs are of three kinds: the farmer cooperative owned, processor owned, and the private owned milk collection centres. Figure 9 shows that many cooperatives are owned by farmer cooperatives (39%) followed by the private/trader owned. The cooperatives operate primary

MCCs while processing companies own most of the bulk milk collection facilities and some primary MCCs.

Figure 9: MCC ownership



Source: DDA survey data, 2021

On average an MCC receives milk from about 47 suppliers (Table 3). However, much as many farmers belong to a cooperative, they also supply milk to private traders who buy milk at the farm for cash or shorter payment period. To limit under capacity, farmer cooperative MCC receive milk from both member and non-members. The key thing though is the quantity of milk supplied by members vis-a-vi non-members. Table 3 shows that much as few members supply coop MCCs, the aggregate amount of milk from members is significantly higher than that for non-members.

Additionally, it is shown that only about 6% of the MCCs offer (always) a premium price for quality and 8% offer (always) a premium price dependent on quantity (for which 500 L was considered the minimum for eligibility). On average an MCC has a capacity to collect and hold about 6000 litres of liquid milk.

Table 3: MCC characteristics in central, southwestern, and mid-west milk sheds

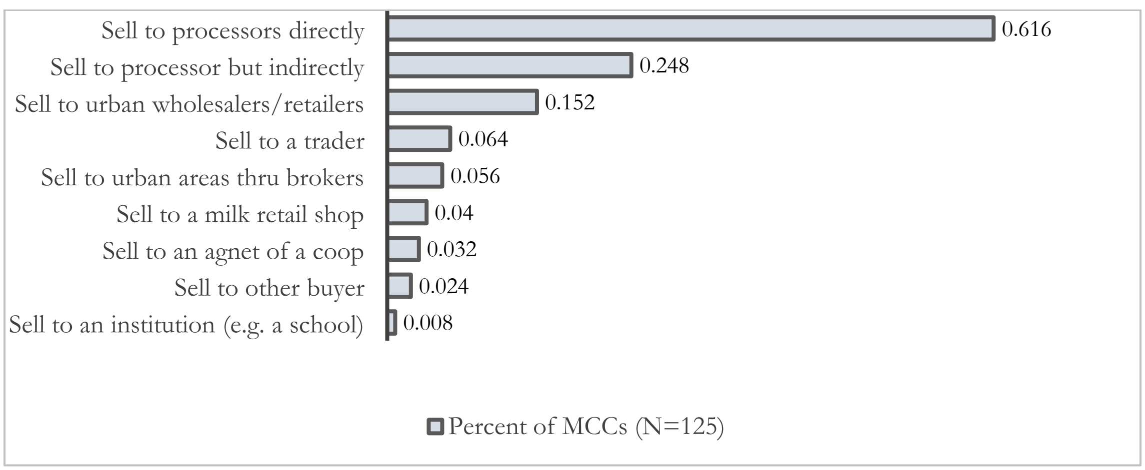
Variable	Obs.	Mean	SD	Min	Max
Had some training on MCC related activity	125	0.832	0.375	0	1
Buy milk from MCC members & non-members	125	0.840		0	1
Estimate of non-member suppliers	125	21.92	46.159	0	500
Estimate of member suppliers	125	25.02	61.143	0	500
Number of daily milk suppliers	125	46.94	97.402	0	1000
Estimate of milk from non-members (L)	103	1752.35	1331.190	14	7000
Estimate of milk from members (L)	65	3288.55	4826.075	70	30000
Amount of milk collected (L/Day)	123	3205.27	3704.304	88	30000
MCC milk installed holding capacity	125	5897.91	5969.410	1000	50000
Do premium payment for quality (%)					
Yes, always	125	5.60			
Yes, sometimes	125	11.20			

No	125	83.20			
Do premium payment for large quantity (%)					
Yes, always	125	8.00			
Yes, sometimes	125	17.60			
No	125	74.4			
Est. supply quantity for premium pay (L)	32	529.69	509.405	100	2000
Milk suppliers- dry/wet season (%)					
Milk trader	125	64.00			
Farmers directly	125	30.40			
Other MCC	125	3.20			
Other suppliers	125	2.40			
Payment of suppliers (%)					
Daily	125	20.00			
Weekly	125	50.40			
Fortnightly	125	39.20			
Test milk supplied for quality screening (%)	125	98.40			
Visual inspection/ organoleptic	125	36.80			
Alcohol test	125	94.40			
Lactometer	125	96.80			
Have had cases of rejection of farmer milk (%)	125	83.20			

Source: IFPRI survey data 2021

Most MCC milk is sold directly to the processors (Figure 10). It is observed that about 84% of the MCC milk was channelled to processors either directly by the MCC or indirectly through an agent.

Figure 10: MCC milk buyers



Source: IFPRI survey data 2021

According to DDA, average national farm gate milk prices in 2020/21 increased to 1070 UGX per litres compared to UGX 980 in the FY 2019/2020 (DDA, 2021). Meanwhile, higher farm gate prices were recorded at about UGX 1250 in Northeastern milk shed and retail raw milk prices of UGX 1870 in the

Northern milk shed. In Table 4, the results show that price offers differ per type of buyer and it is indicated MCC offer the lowest price which perhaps serves as a disincentive for farmers to sell to MCC than other buyers such as small-scale traders.

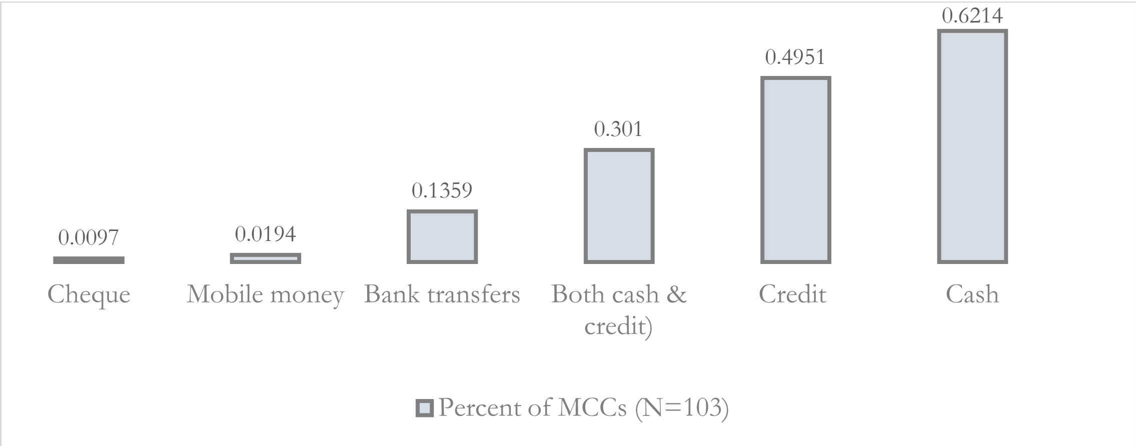
Table 4: Prices offered by different buyers to MCCs (October 2020)

Buyer	Obs.	Mean	SD	Min	Max
Local consumer	44	1234.091	336.150	800	3000
Traders	40	1168.250	367.827	150	3000
Bulking centre	36	1231.389	454.546	800	3000
Processors	48	1155.208	177.224	1000	1800
MCC	90	966.667	114.901	500	1500

Source: DDA survey data 2021

MCC payments to farmers for milk supplied are mainly done by cash at MCC offices and adoption of non-cash methods is still low (Fig. 11). The reasons for more reliance on cash payments is not very clear but this could be exposing MCCs to some risks.

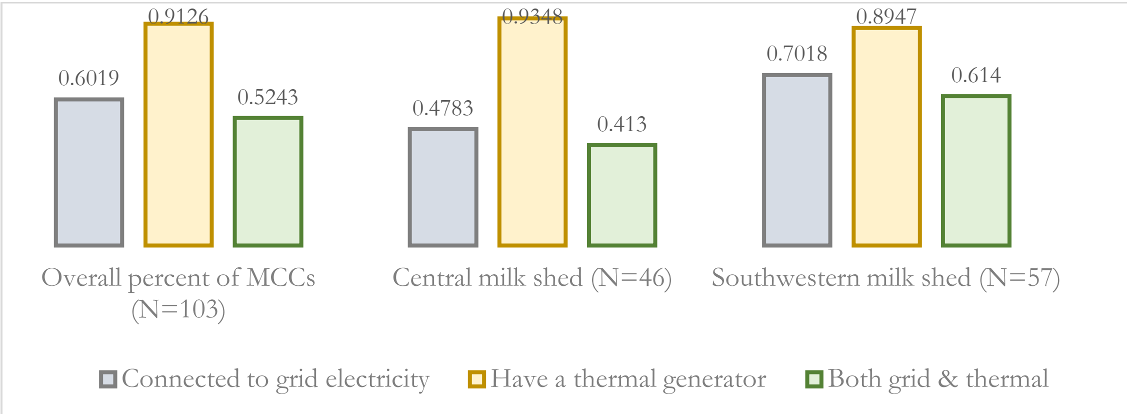
Figure 11: MCC-Farmer payment methods



Source: DDA survey data 2021

A good power source is central to MCC operations and depending on the source and reliability, there are consequences on milk quality and MCC profitability. Overall, 60% of MCCs reported that they are connected to the grid but also many rely on thermal generators solely or as backup in case of grid power outage (Fig. 12). Powers outages were reported to be an average of three times in a week.

Figure 12: Source of MCC energy



Source: DDA survey data 2021

Table 5 compares MCC performance during the dry and wet season and significant differences are seen for several parameters. On average, milk collection by an MCC during the dry season is about 2200 litres per day which increase by over 50% during the wet season. There is cyclical drop in milk production during the dry spells which significantly affects processors who are forced to operate at below 50% capacity, yet the plants are set up with a production throttle of wet season production. Overall, this can have negative effects on efficiency of the formal dairy value chain.

Table 5: Comparison of MCC performance during dry and wet season

Variable	Dry season (Dec-Feb)		Wet season (Mar-May)		Change
	Mean	SD	Mean	SD	
Milk collection per day (L)	2221.55	2866.343	3983.19	3720.365	0.793
Number of suppliers per day	30.48	36.650	41.68	53.068	0.367
Quantity sold/supplied (L/Day)	2146.19	2904.912	3846.28	4033.124	0.792
Supplied to milk shops	59.41	264.473	153.33	646.897	1.581
Supplied to individuals	38.97	372.259	118.08	894.702	2.030
Supplied to other MCCs	280.52	610.713	351.27	911.900	0.252
Processors	1965.98	2990.181	3074.37	4162.436	0.564
Hotels	8.47	64.816	6.66	53.031	-0.214
Other buyers	0.70	4.219	46.03	331.789	64.757
Usage of MCC capacity (%)	45.12	18.354	79.40	25.993	0.760
Purchase price (UGX/L)	1070.00	180.739	754.62	186.628	-0.260
Selling price (UGX/L)	1174.36	200.895	949.43	867.945	-0.192
Markup on purchase price (UGX)	134.75	93.878	205.62	841.584	0.526
Margin (proportion)	0.131	0.094	0.280	0.999	1.137
Number of buyers accessible	4.05	10.616	5.89	14.887	0.454

Source: IFPRI survey data 2021; N=116-120

Supply to processors during the dry season is low (~2000 L/Day) but increases by over 50% during the wet season (3000 L/Day). This is also reflected in the utilization of MCC installed milk collection capacity which stands at 45% during the dry season and over 80% during the wet season. Additionally, MCCs buy milk at prices that fluctuate based on the season with dry season prices ranging between UGX 600 to UGX 2000 whereas wet season prices are associated with a drop in milk supply and milk prices that range between UGX 500 to UGX 1200. The MCC markup on purchase price is 13% during the dry season which on average doubles in the wet season. Based on literature, MCC profit margin is about 5% or less with milk purchases taking up more than 70% of MCC operations costs (Nakiganda & Ahmed, 2014).

4.2.3 Bulk milk collection centres

Bulk milk collection centres (BCC) also considered secondary MCCs are mostly owned by the farmers/union and the processors. The installed capacity ranges between 8000-60000 and utilization is about 87% (Table 6). Daily milk collection is an average of 23000 litres. Four out of the six BCCs visited said they had experienced milk rejection (in the past 12 months) due to poor quality. All the BCCs do milk tests and the common ones include organoleptic tests, Lactometer test, and the alcohol test. Most of the milk is sourced from the primary MCCs.

Table 6: Characteristics of milk bulking centres

Variable	Number (N=6)	Mean	SD	Min	Max
BCC capacity (Litres/Day)					
Total installed capacity	6	25426.67	19578.08	8260	60000
Maximum utilization	6	24010.00	20874.23	2400	60000
Utilization (proportion)	6	0.869	0.308	0.24	1.0
Daily milk collection in wet season	6	32316.67	36855.96	1500.00	100000
Daily milk collection in dry season	6	13866.67	18493.42	700.00	50000
Estimated daily milk collection	6	23091.67	27589.53	1100.00	75000
Estimated monthly milk collection	6	702000.00	839000.00	33458.33	2280000
Wet/Dry season drop in collection	6	0.56	0.119	0.375	0.700
Experience (grid) power outages	5				
Power outages (Number/week)	6	1.5	1.049	0	3
Ownership of BCC					
Dairy union/farmers	3				
Processors	2				
Private proprietor	1				
Keep operation records	6				
Had milk rejection due to quality	4				
Milk testing methods					

Visual inspection	6				
Other organoleptic tests	6				
Clot-on-boiling	1				
Lactometer reading	6				
Alcohol test	6				
Resazurin test	4				
Milk analyser tests	4				
Lab culture methods	0				
Fat tests	2				
Type of milk cooling equipment					
Ice-bank type cooler	1				
Direct cooling milk coolers	6				
Chilling plant	0				
Silos	2				
Milk sources					
1^{0}Cooperative society MCC	4				
Union collection centres	1				
Individual farmers	2				
Traders	0				
Sources of energy/Power					
Grid electricity	5				
Thermal standby generator	6				
Solar	0				

Source: DDA survey data 2021; N=6

4.2.4 Transporters

There are two kinds of transporters namely the small-scale milk transporters who move milk in cans loaded on motorcycles and the bulk transporters who move milk loaded in milk tankers mounted on trucks. Some milk traders also double as traders but mostly the small-scale transporters. However, most of the large-scale transporters tend to be contracted by the big processors who transport milk for longer distances (from MCCs in western and central milk sheds to various destinations namely Kampala, Mbarara, Mukono, Jinja among others) traversing distances of 50 to 300 kilometres (KM). Majority (79%) of the bulk transporters have insulated milk tankers (Table 7). To clean the milk tanks, 86% use piped water to clean the milk trucks and only 43% use the ideal CIP method of cleaning.

Table 7: Characteristics of bulk milk transporters

Variable	**Obs.**	**Mean**	**SD**	**Min**	**Max**
Suffer milk losses	28			0	1
Reasons for milk losses					
Spillages (measurement, loading)	28	0.571	0.504	0	1
Rejected by processor due to low quality	28	0.357	0.488	0	1
Disposed by gov't body due to low quality	28	0.107	0.315	0	1
Wasted due to failure to secure	28	0.036	0.189	0	1
Wasted due to other reasons	28	0.143	0.356	0	1
Not had a any milk loss	28	0.250	0.441	0	1
Type of milk transportation vehicle (%)					
Insulated milk tanker	28	78.57			

Truck that is loaded with milk cans	28	17.89			
Refrigerated track	28	3.57			
Temperature at point of loading (ºC)	28	3.607	2.132	0	9
Temperature at off-loading (ºC)	28	8.357	7.145	2	28
Method of track cleaning					
CIP	23	0.435			
Machine cleaning	23	0.087			
Manual cleaning	23	0.478			
Main source of water for cleaning the vehicle					
Piped water	28	0.857			
Borehole	28	0.036			
Well	28	0.107			

Source: DDA survey data 2021

In line with other value chain actors, there is a significant drop in performance (in terms of milk deliveries) of the milk transporters during dry season as compared to the wet season. On average, quantity of milk transported is 70% of the tank capacity during the dry season and increases to 96% during the wet season (Table 8).

Table 8: Performance bulk transporters during dry and wet season

Variable	Dry season (Dec-Feb)		Wet season (Mar-May)		Change
	Mean	SD	Mean	SD	
Transport/Tanker capacity (L)	7008.929	3812.019	7008.929	3812.019	
Av. Quantity of milk transported	5308.929	4156.032	6813.929	3958.295	
Proportion of deliveries: capacity	0.703	0.283	0.961	0.119	
Distance between supplier-buyer	153.269	143.645	136.000	131.144	
Unit price of transport (UGX/L)			79.731	56.390	
Cost of milk per trip (UGX)	417000	547000	490000	589000	

Source: DDA survey data 2021

However, anecdotal information from MCCs indicates that there is a high likelihood milk adulteration with added water during transportation because most bulk transporters do not deliberately fill-up the tanks and it is suspected that the room left could be for opportunistic purpose.

4.2.5 Traders

Many traders operate on a small-scale basis and tend to own their own means of transport which is often motorbikes (84%). Only 52% reported to have had some training in milk handling (Table 9). Traders (94%) buy milk directly from the farmers and before loading the milk, 68% said they test milk for quality mostly using the Lactometer test. On average, 240 litres of milk are transported which is about five milk cans of 50L capacity.

Table 9: Characteristics and practices of traders

Variable	Obs.	Percent/Mean	SD	Min	Max
Av. Quantity traded per trip (L)	273	244.27	67.03	100	11300
Operate as independent trader	274	81.75			
Besides, also trade in other dairy products	274	4.74			
Besides, also trade in non-dairy products	274	14.23			
Part of a dairy association (coop/union)	274	28.10			
Had training on milk handling	274	52.55			
Sources of milk (Dry/Wet)					
Farmers/producers	274	94.16			
Milk shops	274	0.00			
Other traders	274	0.36			
Cooperatives	274	1.82			
Private collection centres	274	0.73			
Other source	274	2.92			
Test milk for quality	274	67.88			
Visual	186	33.87			
Alcohol test	186	27.42			
Lactometer test	186	90.86			
Milk is rejected by the buyer					
Yes, always	274	3.28			
Never	274	56.57			
Yes, sometimes	274	39.78			
Not sure	274	0.36			
Reasons for milk rejection					
Late delivery	118	11.02			
Low lactose content	118	63.56			
Blood clots in milk	118	3.39			
Poor milk hygiene	118	8.47			
Low fat content	118	4.24			
Other reasons	118	8.47			
Don’t know	118	0.85			
Means of transport					
Foot	274	0.73			
Bicycle	274	14.96			
Motorcycle	274	83.94			
Car/truck	274	0.36			
Milk buyers					
Private milk collector	274	48.54			
Agent of independent milk collector	274	4.01			
Farmer cooperative MCC	274	25.91			
Agent of a cooperative	274	0.73			
Milk processing company	274	10.58			
Agent of a processing company	274	9.49			
Milk shop	274	0.00			
Other buyers	274	0.73			

Source: IFPRI survey data 2021

Overall, significant differences exist between dry and wet season trader performance parameters. Raw milk is purchased at about UGX 950 per litres in the dry season, which drops by about 29% during the dry season (Table 10). Milk deliveries to MCCs increases by about 8 times during the wet season while that to processors doubles.

Table 10: Milk collection by traders in the dry and wet season

Variable	Dry season (Dec-Feb)		Wet season (Mar-May)		Change
	Mean	SD	Mean	SD	
Approx. purchase price (UGX/L)	956.955	174.070	680.444	176.628	-0.289
Number of suppliers per day - dry	6.80	6.463	7.498	7.142	0.103
Quantity usually collected in a day	204.493	193.804	349.827	630.385	0.711
Quantity sold/delivered to:					
Milk shop	10.163	66.915	8.110	53.411	
Individuals directly	0.743	8.74	0.688	4.658	
MCCs	13.682	45.506	107.694	177.442	
Private collection centers	118.241	183.138	6.723	34.947	
Processors	60.386	134.318	144.941	195.277	
Institutions (e.g., schools)	0.037	0.607	0.007	0.121	
Restaurants/hotels	2.018	17.090	1.706	14.327	
Others	3.221	7.470	3.827	7.896	
Approx. selling price (UGX/L)	4693.362	60685.11	762.834	226.579	-0.837
Approx. Number of buyers sold	3.225	27.005	2.143	5.002	-0.335

Source: IFPRI survey data 2021; N=258-272

4.2.6 Processors

There are several processors and vary by scale including large scale processors, medium, small scale, and micro cottages: producing various products that are sold both in the domestic and export markets. Uganda’s processing companies have increased from 79 with processing capacity of 1.9 million litres in 2015 to 116 with processing capacity of 3.1 million litres in 2021 (DDA, 2021; DDA, 2020; NPA, 2020). According to DDA, large scale companies have processing capacity ranging between 100000 and 800000 litres of milk per day per plant and a combined capacity of 2735000 litres (which is 94.5% share of the national capacity). Most processing is found in Southwestern milk shed (71.0%) and Central milk shed (28.4%). The processors are also directly involved in export business and sell to agents in various export markets.

Small-scale processors

The small-scale processors also called cottages process dairy products such as yoghurt, ice-cream, and ghee that use lower type of processing technologies and require small capital investment. They also face several challenges related to supply of required quantity and quality of milk. About 83% reported variation in milk supply between the wet and dry season. Milk supply in the dry season is less by 57% compared to what is supplied in the wet season and processing capacity vis-a-vi installed capacity is 22% and 32% in the dry and wet season, respectively. Like the MCCs, a small proportion of cottages offers incentives to improve volumes and quality of milk supplied.

Table 11: Characteristics of cottages

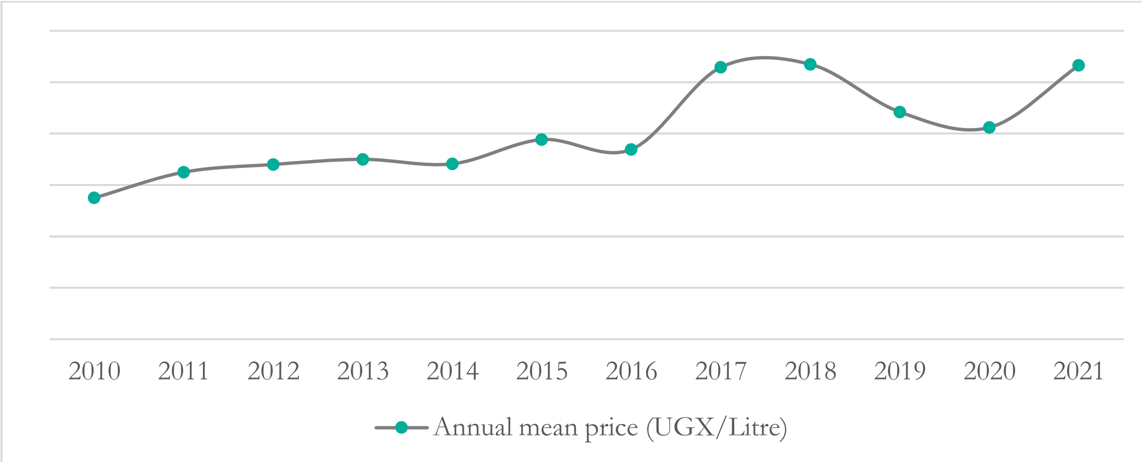
Variable	Obs.	Mean	Std. Dev.	Min	Max
Milk supply varies by dry/wet season	24	0.833	0.381	0	1
Av. quantity supplied –wet season (L/day)	20	5206.8	15884.55	21	70000
Av. quantity supplied –dry season (L/day)	20	3316.5	11201.56	25	50000
Est. amount produced in a year	24	8340000	3.87e+07	660	1.90e+08
Total installed capacity	24	16144.58	61414.93	0	300000
Average processing capacity (L/day)	24	10647.5	25762.6	0	100000
Av. volumes processed wet season (L/day)	24	5141.542	14885.99	0	70000
Av. volumes processed dry season (L/day)	24	3632.5	10812.1	0	50000
Basis for milk pricing					
Volume	24	0.542	0.509	0	1
Quality	24	0.042	0.204	0	1
Both volume and quality	24	0.333	0.482	0	1
None of the above	24	0.083	0.282	0	1
Challenges to milk quality					

Source: DDA survey data 2021

Large scale processors

According to DDA, there are 14 large scale processors, but milk processing is dominated by four players. In Figure 13, it is shown that the prices of milk offered to suppliers have gradually improved and for the period 2016-2021, prices have been relatively higher than for the period before. However, the same period (2016-2021) is associated with more price volatility which may be a bad reflection of market conditions and actor dynamics.

Figure 13: Processor reported price to raw milk suppliers



Source: DDA survey data 2021

The quantity of milk lost as a proportion of what is procured by the processor was found to range between 0 and 6% (Table 12). The loss is with the acceptable international standard which dictates a threshold of 5%. Milk loss at processor level is mainly attributed to the aspect of milk quality.

Table 12: Milk losses

Year	Proportion of milk lost to that procured				
	N	Mean	SD	Min	Max
2015	3	0.026	0.045	0	0.078
2016	4	0.019	0.028	0	0.060
2017	5	0.014	0.022	0	0.050
2018	5	0.016	0.022	0	0.045
2019	6	0.020	0.031	0	0.074
2020	6	0.007	0.014	0	0.035
2021	5	0.014	0.022	0	0.050
Average	5	0.017	0.026	0	0.056

Source: DDA survey data 2021

4.2.7 Retailers

Actors in the retail business are numerous and of two types namely the mobile and immobile. The mobile milk retailers commonly vend unprocessed milk door-door, a sales approach that strongly outmanoeuvres the processed milk retailers. The immobile milk vendors are often stationed in either shops and sell both processed and unprocessed milk or milk is picked off the shelves in supermarkets that sell only processed milk. Results in Table 13 characterise immobile retailers. It is observed that majority store milk in a fridge or freezer. About 32% reported milk returns from customers due to spoilage and the average price of milk per litre was UGX 1500.

Table 13: Retailer characteristics

Variable	Obs.	Mean (%)	SD	Min	Max
Years of experience in retail business	54	5.537	5.872	1	25

Type of milk storage facility					
Milk Cooler	54	0.333	0.476	0	1
Fridge/ Freezer	54	0.759	0.432	0	1
Other	54	0	0.000	0	0
Milk rejected (L) due to poor quality-wet	54	14.778	47.007	0	300
Milk rejected (L) due to poor quality-dry	54	13.926	46.451	0	250
Suffered milk returns from customers	54	0.352	0.482	0	1
Price of milk to induvial customers (UGX/L)	54	1500	289.377	1000	2000

Source: DDA survey data 2021

4.2.8 Consumers

WHO recommends a per capita milk consumption of at least 200 litres of milk to meet the body nutrient intake of some micro-nutrients (FAO, 2013). Per capita milk consumption in Uganda is estimated at about 64 litres which is just 32% of the recommended 200 litres (DDA, 2020). Low milk consumption is attributed to low income and social biases. For instance, many consider milk to be for children and the sick. Increasing domestic milk consumption has the potential of tripling annual domestic milk demand by 79% of current production (2.81 billion litres) leaving the country with very limited quantities for export (Ariong, Otikal, Pernechele, Nana, & Meilland, 2022). This means promotion of domestic milk consumption needs to be coupled with measures to improve productivity to meet the dual exports and consumption targets.

4.3 Value chain organization

Economic coordination in a firm can be achieved either by internal or external organization depending on the business model and environment but in all, choice is driven by transaction cost and risk minimization. In the case of the milk value chain in Uganda, it is observed that sourcing of milk supplies by MCCs is mostly internally done and to some extent, a third-party agent is involved for few MCCs. However, in the case of processors where the concept of approach to efficient organization is more crucial due to cost and risks involved in the daily procurement volumes, various coordination mechanism has been observed namely:

(i) Hybrid approach where a processor contracts out transportation but retains the ownership of milk. In this arrangement, the pay-out for the milk supplied is by the processor and the truck owner is paid for the transport service. The truck owner is thus, responsible for truck repairs. In the past, the defunct Dairy Corporation used to exercise full internal organization of procured milk by owning the MCCs, transport trucks, and milk tanker drivers. However, the hybrid approach tries to reduce risk and costs.

(ii) Some processors employ both internal and external procurement arrangements. In the case of external arrangement, a third party delivers milk to the plant and is paid for the milk delivered and thus, s/he is responsible for payments to the farmer. In the second scenario, the processor has its own trucks and directly collects the milk from the MCCs and farmers.

(iii) Spot market and ad hoc procurement also exists.

There is very limited vertical integration and trust-based relations are concentrated at upstream level namely the farmer-transporter-MCC level.

4.4 Milk quality

Current key government target is to grow milk exports to several markets and to achieve the set goal, it means that the aspect of quality control system needs to be improved and well streamlined to afford traceability and greater reach to markets with minimal impediments associated with phytosanitary controls and non-tariff barriers. regulations exist for quality control, but policing is a challenge to DDA due to limited capacity. Quality starts right at the farm and involves general hygiene of milkman, milking cow and the tools, screening for mastitis in lactating cows, observing withdraw period cows on treatment, non-adulteration of milk, and proper postharvest handling (storage and transportation). At mid- and downstream of the value chain, hygiene and cold chain maintenance is key.

4.4.1 Farmer level

Generally, at farmer level milk quality is affected by the practices adopted especially at milking, storage, and transportation but also feeds can have an impact. Milking is mostly done by hand and not many farmers have dedicated storage space (which could perhaps house cooling equipment) for milk. Thus, farmers are required to deliver milk to the MCC as soon as possible and within less than two hours. Survey results show that 92% of the farmers do not keep the milk at the farm at all after milking and 85% of the farmers deliver milk to a buyer/MCC in less than 30 minutes with the average delivery time of about 20 minutes which indicates many ship the milk to the MCC as soon as possible (Table 14).

Additionally, mastitis is one key concern for lactating cows, and it is regular teat stripping is recommended to identify infected teats before milking. The statistics show that majority of farmers do hand milking and only about 48% of the farmers regularly screen teats for mastitis. Only about 10% have a dedicated milk storage structure and thus, majority do not store milk on the farm. About 85% of the farmers deliver milk to the MCC in less than 30 minutes.

Table 14: Farmer practices with implication on milk quality

Variable	Obs.	Percent/Mean	SD	Min	Max
Milking method (%)					
Hand milking	384	99.22			
Machine milking	384	0.52			
Both hand & machine	384	0.29			
Use stainless steel buckets during milking	384	64.06			
Use stainless plastic buckets during milking	384	46.88			
Farm has a dedicated milk storage structure	384	10.16			
Keep milk on farm for some time before supply					
Do not store milk at all	384	91.93			
Yes (either morning or evening milk)	384	8.07			
Regularly check for mastitis before milking	384	48.18			
Check for mastitis using a strip cup	125	17.45			
Check for mastitis using other method	125	33.59			
Don’t check for mastitis	125	51.82			

Milk delivery					
Deliver in ≤30 minutes	384	84.64			
Deliver in 31-60 minutes	384	14.06			
Deliver in ≥60 minutes	384	1.30			
Time taken to deliver milk to a buyer (minutes)	384	19.73	18.956	1	120

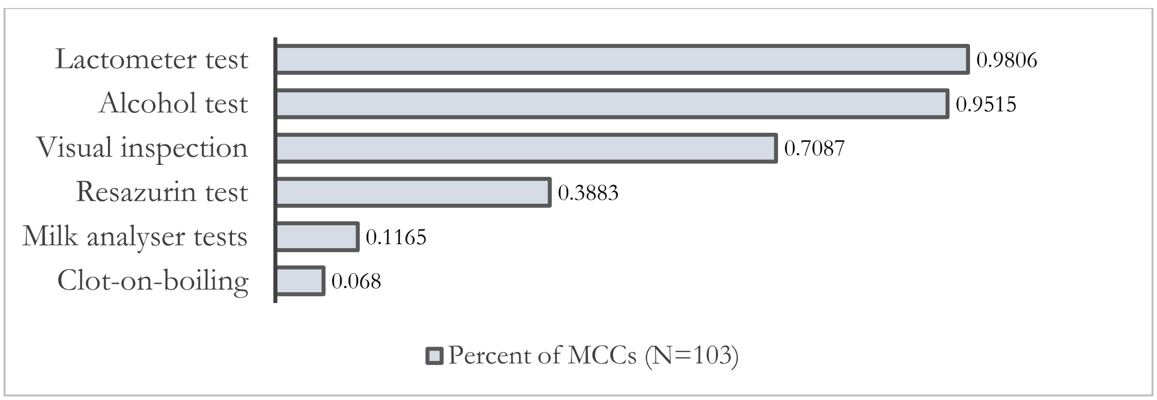
Source: DDA survey data 2021

On milking method, the results are consistent with a study done in Nakasongola, one of the districts in the cattle corridor that falls in the central milk shed, 93% of farmers practiced hand milking (Majalija, et al., 2020). Farmers/suppliers are required to deliver milk to the MCCs in less than two hours after milking since milk cooling is completely absent at farmer level.

4.4.2 MCC level

Quality control at MCC level is done by objective procedures that include lab platform tests and the subjective tests that include organoleptic tests. Figure 14 shows the common tests done by MCCs and among the organoleptic tests, visual inspection is associated with about 71% of the MCCs. The commonest platform tests include the lactometer test (98%) and alcohol test (95%). Use of the milk analyser also known as the Lactoscan/ Lactoscope is very limited, yet it is one of the best and fastest way of milk testing.

Figure 14: Milk tests done by MCCs on milk

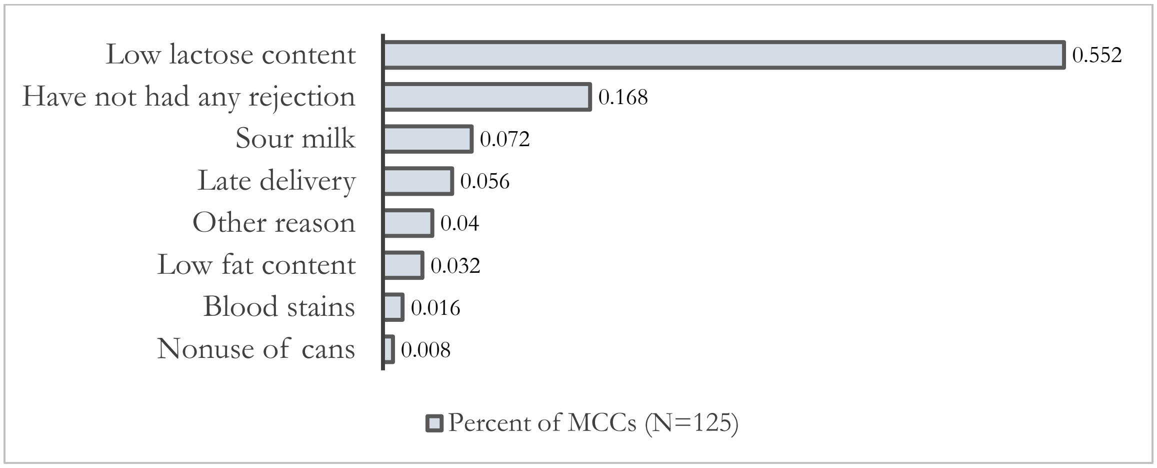


Source: DDA survey data 2021

Unlike other test procedures that are limited in range, the Lactoscan tool can be calibrated to test for BF, SNF, PH, Conductivity, protein content, lactose, added water, density, freezing point, temperature, total solids, and salts. Additional features may include presence of antibiotics in milk, bacterial load, hydrogen peroxide, and urea.

For milk that is rejected, many MCCs reported the reason being low lactose content in milk as the main reason for rejection which points to adulteration with added water (Fig. 15).

Figure 15: Reasons for milk rejections by MCCs



Source: IFPRI survey data 2021

4.4.3 *Transporters*

To observe quality, transporters said that they make sure milk is first tested before loading, move the milk fast to the delivery point, and proper maintenance of the vehicle. However, 68% of the transporters were found to have suffered some milk rejection due to quality concerns (Fig. 16).

Figure 16: Percent of transporters that had milk rejection in 12 months

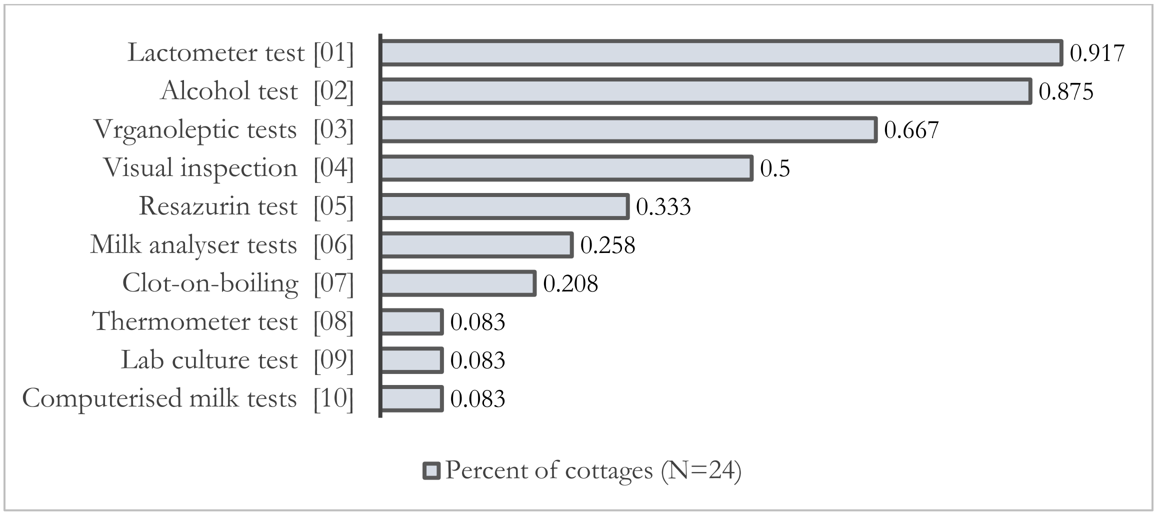
Source: DDA survey data 2021

In policy dialogue meeting convened by DDA in April 2022, processors reported high milk rejection rate and hinted that the biggest problem affecting milk quality could be at transportation. Some processors have own MCCs but also buy milk from Coop owned MCCs. The same applies to transportation facilities. It was reported that milk from the processor MCCs tends to be higher in quality and most milk quality is found with the contracted transporters. One of the reasons was that most contracted transporters have tankers not fitted with the cooling system.

4.4.4 *Milk quality processed by cottagers*

All surveyed cottages reported that they have challenges with milk quality and the quality of milk from suppliers is assessed using various test including organoleptic and platform tests. The lactometer test is commonest done (92%) by the cottages (Fig. 17).

Figure 17: Milk tests done raw milk by small-scale processors



Source: DDA survey data 2021

5 GENDER PERSPECTIVES IN DAIRY VALUE CHAIN

One of the fundamental aspects to inclusive development is gender inclusive growth. This means that value chain interventions need to be designed with a gender lens. In the case of the dairy value chain in Uganda, it is observed that gender participation by all gender appears to be skewed to the men. Livestock ownership in Uganda is a form of wealth and culturally confers social status for a household and more so, to men. Because of socio-economic and cultural connotations, dairy farms are dominantly controlled by men. However, women also play a key role in providing labour for production like cleaning of dairy tools/equipment and fetching water when scarce at home especially for intensive and semi-intensive dairy systems (Ransom, Bain, Bal, & Shannon, 2017). In-depth studies on labour participation at various levels of the dairy value chain are scarce.

6 INVESTMENT

Dairy sector development spending by government is still low and falls short of the NDP and DDA expectations. Table x shows that 36% of the 2020/21 fiscal expenditure was allotted to dairy sector development while the rest (64%) went to administration and operations. Staffing level stand at 68% of the expected human resource. This indicates more government investment and private sector support is needed in the sector. Government intends to add more investment under the DPA and the parish development model.

Table 15: Government expenditure in dairy sector

Category	FY 2020/2021 (USD Millions)		
	Budget	Actual release	Expenditure
Wage	0.437	0.437	0.437
Non-wage	1.340	1.340	1.116
Development	1.015	1.015	0.656

Source: DDA 2020/21 performance report

Several actors involved in research and development space namely GoU, development partners and NGOs with each playing several functions in the dairy sector. Key actors are listed below.

Key role	Actors
Policy	GoU/MAAIF, MFED, DDA, NPA with NGOs
Research	DDA, NARO, IFPRI, ILRI, SNV, Makerere University
Development	Government MDAs, Development partners (USAID, Netherlands Embassy), NGOs (SNV, Heifer International, Send a cow), aBi trust,
Private sector	PSFU
Credit	Uganda Development Bank
Advocacy	Uganda National Farmers Federation (UNFFE)

7 IMPLICATIONS AND INTERVENTIONS

The results presented in the preceding sections show that there are several challenges that mar the dairy industry in Uganda and therefore, several interventions and innovations are required to address the prevailing issues. In the following sections, intervention options that have been explored in Uganda and elsewhere are explored.

7.1 Milk production

At farm level, milk production is a function of animal breed, animal age, health, animal feeding, and the environment. Additionally, farmer knowledge is a key factor that must not be undermined because it underpins livestock input management that impacts actual milk output. Body condition score which may reflect animal management varies by season, herbage growth, and correlates with farm milk yield in Uganda (Okello, Sabiiti, & Schwartz, 2005). Moreover, production practices also influence milk quality (Sraïri, Benhouda, Kuper, & Gal, 2009).

A significant proportion Uganda's livestock herd is still of local breeds (~90%) which tend to be hardy but of low performance. However, many farmers who do dairy farming in the western region have increasingly adopted improved breeds particularly Frisian progenies 62% to 75% to boost milk production. Although exotic and cross breed cattle constitute less than 20% of the cattle population, they tend to produce over 60% of all the milk (Njarui, et al., 2012). Pure breeds are not popular as breeding practices try to take advantage of heterosis of local and exotic cattle trait mix (milk production and disease tolerance). Milk production of improved breeds is significantly higher (15-20 L/day) compared to local breeds (2-10 L/day). Higher milk production is hampered by management gaps (such as breeding & feeding system) and animal health (vectors & diseases). For instance, extensive grazing can yield as low as 1-2 litres of milk per day per cow, while semi-intensive grazing yields vary from an average of 5 to 20 litres per day per cow and zero-grazing yields can go up to 30 litres (MAAIF, 2010). From data, the statistics show significant drop (≥50%) in milk supply in the dry season relative to milk production/ supply in the wet season, a situation significantly attributed to access to water resources among other factors. Government has invested in construction of water communal water dams, but more are still needed. Moreover, communal water dams are also a point for disease spread. Some but few farmers have private water dams. Other interventions to reduce seasonality of milk production include pasture improvement with drought tolerant pastures and forage (grass-legume) mixes (Kabirizi, Ziiwa, Mugerwa, Ndikumana, & Nanyennya, 2013).

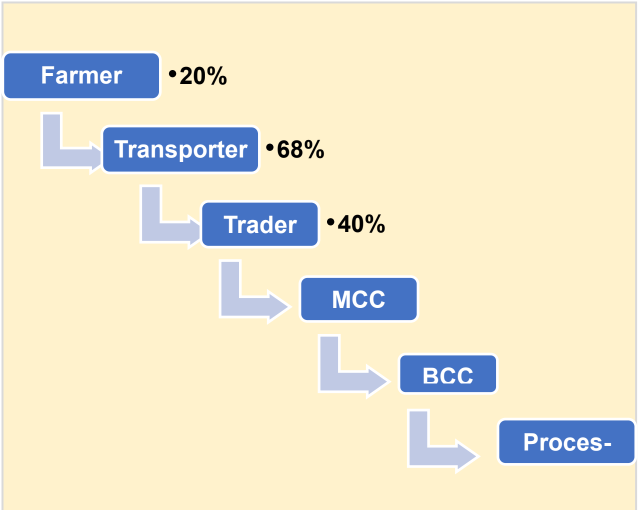
Besides breed and water, milk losses associated with parasites, vectors, and diseases affect animal health and can lead to 100% loss in milk production. Moreover, some parasites and diseases are zoonotic and thus a human health concern such as tape worms, brucellosis, and Anthrax among others. Some of diseases endemic to the cattle belt are controlled through routine vaccination by farmers and government while parasite control is strictly a function left to the farmer. Parasites and vectors of economic importance include worms, tsetse flies, and ticks. Ticks spread tickborne diseases (TBDs) and are the leading vectors of economic importance in Uganda estimated to cause an aggregate annual loss of over USD 1.1 billion of which loss in milk and beef being USD 187 million and USD 472 million (de la Fuente, et al., 2019). Both extensive and intensive use of acaricides coupled with inappropriate application to control for ticks and tickborne diseases (TTBDs) has led to acaricide resistance (Vudriko, et al., 2018a; Vudriko, et al., 2018b). About 77% of the farmers spray weekly but with sub-optimal results (Vudriko, et al., 2018a). Kasaija, et al., 2021 recommed vaccination against ECF, selective breeding for tick resistance and integrated tick control approaches that limit tick exposure, as possible micro-level options to interrupt spread of acaricide resistance. Additionally, increased monitoring and surveillance for TTBDs and for emerging acaricide resistance, improved extension services and sensitization of farmers on tick control measures, appropriate acaricide use and the development of vaccines for control of TTBDs are proposed as more sustainable and effective interventions suited at macro level (Kasaija et al., 2021).

Generally, poor farm practices lead to low milk production which has a negative impact on overall performance of the dairy industry in Uganda. According to DDA, the average annual operating capacity of processing plants is about 65% and during the dry season, operating capacity drops to 30%. Some interventions to improve productivity are being done by government and other NGOs such as AGRITERA and SNV (TIDES project/Rumen8).

7.2 Milk quality

Amid resource constraints, DDA is on ground monitoring milk quality. In the 2020/21 fiscal year, more than 2480 milk handling premises were inspected to ensure compliance to standards that ensure milk safety for consumers (DDA, 2021). Additionally, 3257 milk samples were collected countrywide and tested for adulteration and contaminants and at least 31 enforcement operations to curb unlicensed milk transporters were conducted.

Figure 18: Reports of milk rejection at delivery



Results presented in this report show that the challenge of milk rejections due to low milk quality is present at all nodes of the dairy value chain with highest milk rejection being reported by the milk transporters (68%). Some of the factors affecting the quality of raw milk include low hygiene at milking and poor milk handling practices right from the farmer through transportation, and storage (Majalija, et al., 2020). Milk rejections are observed to be highest at mid-stream segments of the value chain as compared to up and downstream (Fig. 17).

Quality of raw milk has impact on the quality of dairy products and their shelf life which lends merit to the need to invest in quality (Murphy, Martin, Barbano, & Wiedmann, 2016; Barbano, Ma, & Santos, 2006). Farmers continue to be paid for milk by volume rather than by quality, which undermines incentive for production of high-quality milk (Grimaud, et al., 2009). Some of the interventions that have been explored to address milk quality include training of farmers and all other value chain actors on proper dairy management and milk handling, and incentivising supply of quality milk. Farmer training has been a continuous endeavour in Uganda by several stakeholders including government and NGO but in limited scope while incentivisation of supply of quality milk has not been tested and milk grading is unheard of. Additionally, cooperative membership could have either effect on milk quality depending to sanctions mechanism in the collectivisation effort.

In a longitudinal study done (in Western Uganda) by Kaneene, et al., (2016), it was found that farmer education/training on milk quality and safety (emphasizing hygiene and sub–clinical mastitis (SCM)) had beneficial impact on quality and safety of milk of participating farms. Milk quality was determined by somatic cell count (SCC) scores, while milk safety was measured by the prevalence of mastitis and brucellosis. Other studies indicate low farmer awareness of SCM and therefore limited testing for mastitis by farmers. Also, studies elsewhere have shown that incentive-based programmes designed to enhance milk quality have had a positive impact on supply of quality milk. Some of the interventions include price segmentation based on milk grade and a bonus framework for set supply frequency. Ideally, two incentive instruments emerge, a price penalty for low quality and a bonus for consistent high-quality milk, on farmer investment in quality-improving inputs and practices. In a Brazilian panel study, an evaluation of the association between farmer participation in a milk quality payment (MQP) program and milk quality (on 4 indicative parameters namely fat, protein, SCC, and total bacterial count (TBC) percentages) showed a reduction in SCC and TBC and no contribution to milk fat and protein percentages (Botaro, Gameiro, & Santos, 2013). In Vietnam, statistical results suggested that price penalty drives farmers into higher input use, resulting in better output quality while bonus payment generates even higher quality milk (Saenger, Qaim, Torero, & Viceisza, 2013; Nightingale, Dhuyvetter, Mitchell, & Schukken, 2008). The studies suggest that strategies to enhance overall milk production and quality should encompass investment in knowledge and milk quality programmes in developing countries.

7.3 Milk processing

The key challenge of milk processors is uncertain supply of sufficient milk volumes to operate at optimum processing capacity. Processing capacity is reported to be 40% to 60% and can be as low as 30% in the dry season and up to 80% in the wet season (NPA, 2020; DDA, 2020). This is explained by seasonality of milk production and constraints to market access which forces some plants to forcefully limit operating capacity. This means there is redundant capacity which can lead to losses is ground for poor performance and could result in low competitiveness of Uganda’s dairy products if unchecked.

7.4 Inclusivity

For fairness, the share of benefits in the dairy value chain should be equitably distributed among the actors involved. However, the share of benefits ought to extend to the household members that participate in milk production. The extent to which dairy technologies such as crossbreed dairy cows benefit all smallholders, especially women, depends on the relationship between these technologies and the social, environmental, economic, and institutional factors such as production systems, the availability of markets for credit, and the governance and policy frameworks, in which they are embedded (Vercillo, et al., 2015; Ransom, et al., 2017). The dearth of information on labour disaggregation in the dairy value chain calls for more research.

8 CONCLUSIONS

Based on literature and evidence from data, five issues emerge: low farm productivity, animal health especially due to ticks and tick-borne diseases, seasonality of milk production and supply, under capacity, and milk quality.

Low productivity at the farm: this is a consequence of poor production systems and management practices including prevention and control of cattle parasites, vectors, and associated diseases, and inadequate feeding, as well as greater adoption of improved dairy cow breeds. Potential intervention options include: improved extension on animal health and nutrition best practices, as well as enhanced access to improved forage materials and improved breeds of dairy cattle.

Ticks and tick-borne diseases: among the several parasites/vectors implicated in low productivity, ticks are the key parasites/vectors of economic importance to dairy farmers in Uganda and evidence shows growing acaricide resistance. They also have a negative impact on farm productivity and profitability. To tackle the burden of TTBDs, innovations are needed in animal health extension and regulatory system, as well as in the markets which supply agro-chemical treatments to farmers.

Seasonality of milk supply: this further aggravates low productivity but affecting every actor in the dairy value chain which eventually reflects negatively on the performance of the dairy sector. The key cause is limited access to water during the dry season which leads to drop in milk supplies by over 50%. To improve on milk supply in the dry season, interventions are needed in facilities that can support farmer access to water for production. This can be in form of credit to facilitate construction private water dams or government should expand increase construction of more water dams.

Under capacity operations (of milk collection, transporters, and processors): this is a result of supply of inadequate milk volumes which also are further reduced by milk rejections. This negatively impacts profitability and ultimately affects competitiveness of Uganda's dairy products. Innovations are needed in procurement models and incentive mechanisms for high volume supplies.

Milk quality: all dairy chain actors indicated milk quality to be an issue. To enhance milk quality, innovations on incentive mechanisms for quality should be explored.

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