

Dairy

Value Chain Analysis Report

Proposed Interventions for NAROSec to Catalyze Agro-Industrialisation









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Extended
Executive Summary

1.1 Background

Livestock is one of the important agricultural sub-sector contributing about 7.5% to total GDP or 17% to agricultural GDP in Uganda. Dairy products are the third-largest agricultural exports for Uganda after coffee and fish. Dairy contributes 50% of livestock sector GDP and 3.4% to country's export earnings. Dairy is among the 10 prioritized commodities (coffee, tea, fisheries, cocoa, cotton, vegetable oil, beef, maize, dairy and cassava) earmarked for sustainable agro-industrialisation under the third National Development Plan (NDP III) due to its potential contribution to food security, nutrition and export earnings. The growth potential for the dairy sector is still huge since current herd productivity stands at 3litres/cow/day for indigenous breeds and 5.7 litres/cow/day for cross breed against a potential of 22 -40litres/cow/day, and only 40 -60% installed processing capacity is utilized. Therefore, a deep understanding of the bottlenecks hampering sub-sector growth is necessary to guide implementation of interventions to unlock this enormous potential.

USAID FtF Uganda Agriculture Research Activity is a 5 year, US$10 million flagship research and development project, funded by USAID and implemented by CGIAR centers and NARO which seeks to promote use and commercialization of improved crop and livestock technologies with yield and nutrition enhancing characteristics. The activity focuses on: (i) continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand, and (ii) strengthening NARO's institutional sustainability in the marketplace. Specific activities that the project focuses on include: (i) facilitate the release and commercialization of varieties developed under previous and ongoing research efforts, (ii) develop improved crop and animal production and management technologies in response to emerging threats and market demands, and (iii) consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding. For USAID FtF Uganda Agriculture Research Activity to execute its mandate, (i) there is need for a clear understanding of the current and future trends in the target value chains (in this case dairy), (ii) identify the most profitable nodes of the dairy value chains and (iii) identify interventions for NAROsec and others to catalyze agro-industrialisation at profitable nodes of dairy value chain. Based on the above, Knowledge Wells Ltd was contacted by NAROsec to undertake a detailed desk research on the diary value chain in Uganda to guide activity priorities.

1.2 Key Findings

Global milk production was estimated to be 921 million tones in 2021, up from 906 million tones in the previous year. Global production increase was driven by increase in milk output in Asia, Europe and Americas (South and North). On the other hand Africa's production remained stagnant. For the past 5 years, global milk production has been increasing at a rate of 2.6% per annum and is projected to grow at 1.7% p.a. over the projection period (to 1 020 Mt by 2030, faster than most other main agricultural commodities.

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Over 7 billion people consume milk products worldwide, with the highest concentration in developing countries. Most of the consumption is in fresh form (i.e. unprocessed or slightly processed – pasteurized and fermented). Developing countries dominant consumption of fresh dairy products, accounting for 75%, while processed products such as butter and cheese are mainly consumed in developed economies. In Africa cheese and whole milk powder are the most consumed dairy products. Demand for dairy products is projected to grow in the coming decade, with fresh products growing stronger than any other product (i.e. at rate of 1.2% p.a), mainly influenced by the growing demand in India and Pakistan. Overall skimmed milk powder is projected to have the highest growth, although from a low consumption base.

Given the perishability nature of milk due to high water content (more than 85%) which limits its trade over long distances, global milk trade accounts for only 7% of the global production. Most of the milk traded between countries is in processed form as powder, cheese, and infant milk formulas. Trade in liquid milk is mainly in form of fermented products (yoghurt) between neighboring countries. Long distance trade in liquid milk is in form of ultra high temperature milk and cream products. Close to 28 million MT milk products, valued at US$ 94.2 billion were traded globally in 2020, with Cheese and curd being the most traded by value (US$32.9 billion) , although by volumes, milk powders followed by Cheese (7.8 million MT and 7.2 million MT respectively) were the most traded. In the last 5 years (2016 – 2020), global trade in dairy products remained almost the same by volume, however by value, it has increased by 22%, owing to increase in product prices. New Zealand, European Union and United States of America dominate global dairy products export markets. EU and USA continue to dominate cheese export, while New Zealand continue to dominate milk powders and butter. China is and in the short to medium term will remain the leading importer of dairy products, although imports are spread across countries.

World prices from dairy products have increased for the last 5 years (Jan 2016 to October 2021), with the major increase observed for whole milk powder revenues. Butter had the highest average price at US$4,648/MT, followed by cheddar cheese at US$3,492/MT, then whole milk powder at US$3,115/MT and lastly skim milk powder at US$2,313/MT. Whole milk powder prices increased by 82%, followed by skim milk powder at 79%, then butter at 70% and lastly cheddar cheese at 34%.

Dairy is one of the important and fastest growing sectors of agriculture in East Africa. The sector contribute between 2 and 8% of the different countries GDP in the region. Together with the horn of Africa, EAC region produces 68% of the continent's milk output, with Kenya, Uganda, Ethiopia and Tanzania among the biggest dairy producers. Demand for milk has been and further expected to increase in the region. The current per capita milk consumption in the region on average stands at 60litres/capita/year. However, consumption is still below WHO recommended levels of 200litres/capita/year, which provides an opportunity for increased investment in the sector. Kenya has the highest consumption at 115 litres/capita/year, followed by Rwanda at 69.4litres/capita/year, Uganda at 63.8 litres/capita/year, Tanzania at 47 litres/capita/year and Burundi at 4.6 litres/capita/year.

Just 1% of milk production is traded beyond the EAC region, meaning there is high and growing demand for dairy products locally. majority of the firms struggle with low capacity utilization attributed to low milk supply due to competition with informal market channels that control over 80% of the dairy market. The EAC region's demand gap is filled with imports from other regions. For instance, in 2020, , the region imported 19,863 MT of dairy products

(worth US$ 45 million), down from 20,169 MT (valued at US$ 46.3 million) that was imported in 2019. By value and volume, milk Powder (56.3%), infant milk formulas (27.5%) and liquid milk (5.9%) are the most imported into the region in 2020 . Kenya is the main destination for dairy products.

Of the total exported dairy products into different EAC countries, intra-regional trade from other EAC partner states accounts for over 75.9% all exports i.e. 62,871 MT of dairy products, valued at US$ 58.6 million was traded among EAC countries in 2020. Kenya still remains the main destination for dairy products for dairy exports even from EAC counter parts followed by Tanzania, Uganda, Rwanda and Burundi respectively. In 2020, the most traded dairy products across borders within are liquid milk (55,455 MT, valued at US$ 34.2 million – 88% of total trade), followed by are milk powder (6,621 MT, valued at US$ 21.8 million –10.5% of total trade), then butter (369 MT, valued at US$ 2 million – 0.6% of total trade), and lastly, infant milk formula (265 MT, valued at US$ 166,000 –0.4% of total trade). The main exporters of dairy products to EAC counterparts in 2020 were Uganda (accounting for 99.24% of total trade), followed by Kenya (0.7%), Burundi (0.05%) and Tanzania (0.01%).

In Uganda, most milk and its products are consumed locally, with small proportion exported to neighboring countries, even through local demand is higher than available supply. Most of the milk is consumed in unprocessed form (raw milk), given the dominance of informal channel which accounting for 66% of marketed milk. Apart from liquid milk, other dairy products are also consumed, although the consumption will vary depending whether it's a rural or urban setting. For instance, there is going demand for pasteurized milk, yoghurt, UHT milk, ice cream and milk powder, mainly sold through supermarkets, and retail/grocery shops in urban centers like Kampala. On the other hand, rural areas, unsold milk is processed by farmers is processed into bongo (a type of buttermilk that can be stored longer than liquid milk, is very popular) and consumed locally. Other products whose consumption is slowly increasing in rural areas include; butter (or ghee) and yoghurt.

Local supply of dairy products is complimented with imports from other countries, although volumes are low. For instance, Uganda imported dairy products worth UGX 12 billion in FY 2020/21. Milk products imported include milk cream, butter, cheese yoghurt, milk powder and infant milk formulas The top countries of origin of these milk products are United Arab Emirates, Oman, Ethiopia, Kenya, Netherlands, South Africa, United Kingdom, France and Germany.

In the recent past, dairy has become one of the most important export product in Uganda, which could explain its prioritization by government. As such, Uganda is now a major exporter of dairy products within and the EAC region and recently started exporting to COMESA such as Zambia. In FY2020/21, Uganda exported dairy products worth UGX 358.6 billion. Exports were mainly in form of liquid milk/UHT, milk powder butter and casein. Liquid milk exports were mainly destined to Kenya South Sudan, Malawi and Burundi. Milk powder was destined to Kenya, south Sudan, DRC and Malawi. Other countries include Oman and Qatar. Butter is mainly exported to Egypt, Kenya, Oman, Japan and Tanzania. While casein is mainly destined to USA and India.

Its estimated that Uganda's untapped dairy export potential stands at US$ 66.9 million (representing 44% of the total export potential). To tap into this potential, Uganda needs to capitalize on its low milk producer price (i.e. at US$0.22 per litre compared to its main trade partner, Kenya with a producer price of US$0.41 per litre), invest in processing of high

end dairy products such as casein, baby formulas, Whey, Cheese and curd, and ensure more substantial quality control and standards.

Dairy sub-sector chain in Uganda, provides an interesting case due to co-existence of both export-led and domestic market-led value chains for the same commodity. Export oriented dairy value chain is mainly concentrated in Southwestern Uganda where most processing and exporting companies (such as Pearl Dairies Ltd and Amos Dairies) have been established. The remaining 5 milk sheds (apart from South Western milk shed) are mainly serving the domestic markets attributed to lack of necessary infrastructure. Its estimated that out of the total produced milk volumes by different farmers, home consumption accounts for 19.8%, implying 80.2% is marketed. Milk and its products are marketed through two channels (informal and formal). Informal channel account for 66% of marketed milk. Under this channel, milk procured from farmers goes through range of value chain operators (such as transporters, rural traders, milk shops, milk collection centres, bulk transporters and bulk urban vendors) to consumers without processing and proper packaging. In most cases, the only value addition is chilling and transportation. On the other hand, formal marketing channel involves processing of milk to value added products. This channel accounts for 34% of total marketed milk. The major players in this channel include farmers, rural trader, milk collection centres, bulk transporters, processors, distributors, urban consumers or export markets). However, recent study by Campenhout et al. (2019) seems to suggest a paradigm shift towards formal channel in South Western and Central milk shed due to emergence or dominance of export oriented dairy value chain and growing domestic demand for dairy products.

Milk production in Uganda has steadily been increasing for the past 7 years from 2.08 billion litres in 2015 to 2.81 billion litres in 2021 . MAAIF and UBOS estimates that by 2019, Uganda had 14.8 million cattle with 22.3% in the Western Region, 21.8% in the Eastern Region, 21.7% in the Central Region, 19.8% in Karamoja sub-region and 14.4% in Northern Uganda. Indigenous breed dominate the national herd size, accounting for 92.7%, the remaining proportion is shared between exotic or cross breeds. Among the indigenous breed, Zebu/Nganda breed is the most predominant (70.4% of total national herd) and Ankole breed account for 29.6%. Of the reported 14.8 million cattle, only 4.7 million were milking cows. The highest concentration of milked cows was found in western Uganda which explains the region's contribution to total milk production while Northern Uganda had the least milked cows. Dairy farming is carried out through the following production systems: (i) extensive production (accounts for 90%) under pastoral or agro-pastoral production systems in range lands where cattle are fed on unimproved pasture without supplementary feeding, (ii) semi intensive production systems/ semi-zero grazing, where cattle graze in paddocks or/and are fed on improved pastures, and (iii) intensive production system/zero-grazing where animals are confined in an enclosure and feeds or fodder, concentrates and water brought to them. Herd productivity varies with breed and management. Generally herd productivity is way before potential (i.e. 3-6 litres/ cow/ day against a potential of 22 -40 litres/cow/ day) due to: (i) low genetic potential of breeds owned by farmers, (ii) poor animal nutrition, (iii) limited access to sufficient and clean water, (iv) disease outbreaks, and (v) limited knowledge & skills on dairy and farm management practices among farmers and farm workers. Apart from low cattle productivity, farmers are also grappling with low milk quality which result in 20 -40% post harvest losses.

From the farm, small scale rural traders play a critical role in aggregation and off-take of raw milk from dairy farmers and its transportation to central bulking/collection centres,

processors or direct sale to rural consumers. Farmers mainly sell milk at farm gate to rural traders, although some milk is delivered either by known transporters attached to milk collection centres or farmers deliver by themselves. Milk collection centers play a critical quality assurance function especially for formal channel as milk awaits further transportation (by bulk transporters) to processors. Approximately 475 licensed milk collection centres with total national milk collection centre capacity of 2.21 million litres per day exist in the country.

Approximately only 34% of marketed milk is processed in Uganda. The national installed processing capacity has increased from 2.7 million litres per day in 2017/18 (from 100 companies) to 3.1 million litres per day (from 116 companies) in 2021. South western and central milk sheds account for 99.44% of total installed processing capacity. South western accounts for 71.03%, Major products processed include pasteurized milk, powdered milk , casein, cream; ice cream; yogurt, Cheese, UHT milk , ghee, and butter.

Processors are mainly supplied (with raw milk) by milk collection centres through large scale transporters (accounting for 69 – 80%%). However with stiff competition (from other processors and informal channel), processors also procure milk in small volumes (as low as 8 litres) from rural traders. This is very common in South Western milk shed. The low supply of raw milk contribute to the under utilization capacity (at 40 - 60%) of most established processing facilities . This implies that there is still room to absorb more milk from farmers to process high value products which can increase country's forex. With expansion of export markets, there is a huge potential for tapping into high-end and high value dairy products such as Whey, Casein, Butter and Oils, cheese and curd.

The main players at the distribution node are retailers (supermarkets and grocery shops located in major towns), hotels and restaurants, wholesale distributors and exporters for formal channel. However, informal channel which handles 66% of the marketed milk products (mainly raw milk) is dominated by bicycle or motorcycle traders/hawkers/vendors, urban cooling centers/milk coolers, shops and farmers (selling to neighbors).

Compared to other value chains, dairy support system over the years has tremendous grown thanks to sub-sector prioritization and liberalisation by government, support from development support from organizations such as aBi Development Ltd, Heifer International, SNV, Heifer International, Send a Cow and many others. In addition to private sector investment especially at the processing node and refrigerated milk tankers. There several private support players ranging from suppliers of veterinary drugs and vaccines, veterinary and extension service providers, Fodder and feed concentrates and financial institutions.

There several existing supportive policy frameworks to guide development of the dairy sector, with an entity (Dairy Development Authority established by act of parliament (Dairy Industry Act, 1998) to promote and control production, processing and marketing of milk and dairy products. There several policies, acts and regulations such as The Dairy (Marketing and Processing of Milk and Milk Products) Regulations of 2003 in place to ensure effective regulation of the sub-sector. Other supportive agencies to dairy sub-sector include: UNBS, UIRI, Uganda Veterinary Board, National Drug Authority (NDA), National Animal Genetic Resources Centre and Data Bank (NAGRC&DB), National Livestock Resources Research Institute – NaLIRRI, and District Veterinary Office. The country has sufficient laws, policies and strategies to transform the sector, what is need is to update some laws that might be outdated (e.g. cattle trading act, 1943), increase funding to the sector, ensure effective

implementation of existing laws (for example prevalence of adulterated inputs/vet drugs and poor quality animal feeds due to weak regulation of agro-inputs market). Adulterated vet drugs could explain mixing of acaricides by farmers and excess use of antibiotics

There is no specific study on labour markets in dairy value chain, especially given its informality. However, the dairy sub-sector is among the strategic sub-sector with immense job creation potential directly or indirect through support subsectors. Several people are employed at (i) production (with estimated 1.663 million households owning cattle) as family workers or hired labour (given that its labour intensive), (ii) trading where majority are involved in rural milk aggregation and transportation, (iii) processing where several people especially women and youth are employed in processing facilities, and (iv) at distribution and retailing of value added products. For instance dairy cooperatives with coolers employ between 3 -4 full time employees (30) and dairy processing plants employ between 10 and 50 full-time workers. Apart from direct job creation potential within the value chain, dairy has a strong multiplier effect to other support sub-sectors. There are several people employed in (i) manufacture and distribution of veterinary drugs, (ii) provision of veterinary services, (iii) manufacture and distribution of milk processing additives and packaging materials, (iv) manufacture of production and processing equipment, (v) in regulation and quality assurance and many others. More untapped potential exist in virgin areas such as pasture production, animal feeds and concentrates, ICT for dairy farm management and many others.

Value share analysis for milk value chain during dry season, shows that under formal channel (considering pasteurized value chain), the dairy processor received the highest share (35%) of the final price offered the consumer (UGX 2,900 per litre), they are followed by bulk transporter (21%) and rural trader/collectors gets the least share of the final. On the other hand under informal channel (where the final product is fresh or chilled milk costing UGX 1,900 per litre), the largest value share (32%) goes to bulk transporter, followed by farmer (26%) and rural trader gets the least share (5%).

Profitability analysis along dairy value chain as conducted by World Bank in Kyegwegwa district (2020) shows that:

- A dairy farmer level a gross profit of UGX 279,625 from each Ankole cow per year kept under free range system. This increases to UGX 369,750 from each Ankole cow per year if the production system is changed to a paddocking system on a 0.25 acre land. While adoption of improved breeds (cross breeds) under paddocking system with moderate animal husbandry practices increases the profit to UGX 959,000 per cow per year. If cross breeds under paddocking system are supplemented with pastures, profitability increases to UGX 4,117,600 per cow per year. However, changing production system for improved breeds (cross breeds) from paddocking to zero grazing reduces profitability to UGX 4,006,400 per cow per year
- Milk coolers and retailers of fresh milk each make a gross margin of UGX 300 per litre.
- At processing level, large processors producing UHT milk and milk powder make a gross profit of UGX361 per litre and UGX 325 per litre respectively. Ghee processors earn the most profit of UGX 1,300 per litre.

SWOT analysis that summaries the strengths, weaknesses, opportunities and threats within the dairy sub-sector is presented in figure below. Proposed strategies to take advantage of such opportunities are also included

Dairy Value chain SWOT Analysis

	Internal factors / External Factors	Strengths (S)	Weakness (S)
		▪ Existence of large, medium and scall scale processors to add value to raw milk ▪ Low milk producer prices and low production cost compared to other countries ▪ Supportive policies and agencies in place for development of the subsector – dairy is also among the prioritized commodities by GoU ▪ Diversification into high end dairy products such as casein	▪ Dairy value chain is still largely informal which complicates its regulation ▪ Inferior milk products quality and high post harvest losses affecting market access ▪ Weak rural infrastructure especially milk cooling centres are mainly concentrated in South Western milkshed, leaving out the others ▪ Most processing plants are operating below capacity due low supply of raw milk, partly attributed to low productivity ▪ Limited support services outreach especially veterinary services and AI ▪ Weak value chain institutions & enforcement of regulations ▪ Expensive labour in rural areas ▪ Weak input system
Opportunities (O)	▪ Productivity is still below potential which present opportunities in breed improvement, animal nutrition and many others ▪ Milk per capita consumption still below WHO recommendation ▪ Growing domestic (due to growing middle class) and export markets ▪ Increase in proportion of raw milk going through formal channel ▪ Growing infant milk formula market domestically ▪ Existence of harmonized standards within EAC to ease trade ▪ Regional and international markets with existing trade agreements ▪ Population boom	**SO Strategies** ▪ Strengthen DDA and collaborating agencies capacity to regulate the sector ▪ Implement a robust export strategy, focusing on high end products for export markets such as casein, whey, cheese, butter	**WO strategies** ▪ Focus on improving product quality and certification from production to end consumer ▪ Pilot quality based milk payment models ▪ Invest in more rural infrastructure especially cold chain system and water supply ▪ Invest in human capital development e.g. training of AI technicians ▪ Invest in mechanization and value chain financing ▪ Strengthening value chain coordination
Threats (T)	▪ Unpredictable weather patterns which leads to limited access to water and pastures ▪ Parasites and diseases such as Foot and Mouth, East Coast Fever, ticks and many others ▪ Import bans on Uganda's dairy products by the major market (Kenya) which deter market access and leads to uncertainty. ▪ Raw milk price volatility especially depression during wet seasons ▪ Competition from imports especially for milk powder and infant milk formulas	**ST Strategies** ▪ Bilateral negotiations with key markets to ease market access ▪ Invest in research and commercialization of products – priority should be on breed improvement and animal nutrition	**WT strategies** ▪ Establish infant milk formula processing plant to reduce importation

1.2 Key Findings Continued

The challenges affecting performance of the dairy sub-sector are either technological or knowledge related. Technology and knowledge are critical in fostering value chain efficiency and competitiveness. Commercialization and the distribution of the technology, ensures that innovations are scaled-up and sustainable. Livestock research is coordinated by National Livestock Resources Research Institute – NaLIRRI, Tororo (one of the NARS), whose mandate is to carry out research on livestock diseases and technologies. Once technologies are developed by NALIRRI, they are passed on to MAAIF for implementation. However, NALIRRI's performance has remained sub-optimal because of lack of expertise especially to develop vaccines, and lacks equipment and facilities. Generally, dairy research has been limited more to development of anti-tick vaccines and evaluation of improved pastures. Efforts on breed genetic improvement have been limited.

Although some technologies have been developed, value chain actors, especially farmers are not putting them in practice. This results is a large difference between the average productivity of value chain actors and herd potential due to: (i) weak linkages between research and private sector players who play a critical role in commercialization of such technologies. Furthermore this is worsened by the limited distribution networks by research institutions and capability to market such technologies; (ii) sometimes the developed technologies are not necessarily superior (in terms of user preferences) or responding to evolving market needs than what is already existing. Real needs of users are not met due to limited involvement of relevant stakeholders during technology development process which is critical for buy-in (iii); developed are costly in terms of acquisition, operation and maintenance. Often times technologies are not accompanied by adequate information yet the two are interconnected (iv); information asymmetry, partly attribution to weak research – extension – end user linkages to facilitate timely and effective dissemination of research products for enhanced awareness and adoption (v); focus has been more on knowledge transfer or dissemination of research results (through publications, trainings, workshops, seminars, grants, and fellowships) rather than technology commercialization; (vi) mass production (producing the product at a commercial scale) is often the most expensive aspect of the development process as it usually requires investment in a facility, equipment, and workers; (vii) breeding focus has been more inclined towards improved resistance and production characteristics, with less emphasis on consumer tastes and preferences; (vii) limited funding directed to research. Breeding cycle is very long and costly; (ix) limited quality assurance and control during mass production which may result into inferior products and can pose a reputational and financial risk to the research institution; (x) limited access to demonstration trails by end users i.e. often times, trails are done at research stations which are distant from end users. It is important to note that adoption occurs in a social context that has local characteristics, an aspect that should be taken into consideration from the development until the transfer of technology.

For research commercialization to be effective, the following needs to be considered: (i) clearly defining the role of the research institution as a resulting product is handed off to a company, including how its role is funded; (ii) addressing intellectual property ownership of the research, protection of the organization's own proprietary information and implications for further research; (iii) recognizing that research is just one part of R&D, and commercialization which is the second part, takes considerable time and resources; (iv) there should be a shift in thinking from viewing the farmer as a participant/beneficiary to viewing the farmer as a customer; (v) Understand the motivation, and the responsibilities, of the Researcher; (vi) establishing

a platform for networking and relationships between researchers and commercial entities is very important; (vii) early engagement of private sector in development process is very critical as it brings different perspective and idea.

For greater impact, dairy research should be driven by the current and future dairy market dynamics. Such dynamics include the following: (i) incomes and population growth expected to positively influence consumption of fresh dairy products; (ii) urbanization and changing lifestyles towards consumption of animal-based food products; (iii) growing regional trade which might have a big influence on milk powder export growth; (iv) food safety concerns especially use of antibiotics; (v) increasing trend towards sustainable practices (to reduce GHG emissions) such as water access and manure management are additional areas where policy changes could have an impact; (vi) climate change which will affect traded volumes and ultimately price volatility; (vii) COVID 19 impacts affecting consumption of certain products such as cheeses (in form of pizzas and burgers) which are consumed away from home; (viii) changes in trade policies and environment in different countries; (ix) reducing landholding as a result of population pressure which will call for adoption of intensification production systems.

Key recommendation to increasing commercialization of dairy research are presented in matrix below



Table 6: Specific recommendations for the activity

Theme	Activity	Recommendations
Continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand	Facilitate the release and commercialization of varieties developed under previous and ongoing research efforts	• Organize periodic networking events to bring together researchers with value chain players and enablers • Strengthen linkages with extension agencies and development partners to leverage networks for catalysing technology commercialization • Advocate for conducive investment climate to incentivize private sector to commercialize innovations such as taxation policy, and subsidy scheme for new products to lower product price for market demand generation while covering development costs • Facilitate access to capital for product development • Establish trails on farmer plots for easy buy in.
	Develop improved crop and animal production and management technologies in response to emerging threats and market demands	• Undertake market research for identifying market demand in advance of research project and attempts to scale up and commercialize specific technologies with proven market demand • Adopt interactive development of knowledge and technologies with intended end users rather than development of technologies for potential users • Develop dairy breeds or intensify evaluation of breeds that are adopted to local conditions • Intensify research on high end milk products such as casein, cheese
Strengthening NARO's institutional sustainability in the marketplace	Consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding	• Develop and implement policies, legal frameworks and guidelines for management of IP, technology transfer/ commercialization and partnership with industry • Establish Technology Transfer Offices to support researchers through the formal and administrative aspects of technology commercialization • Build capacity of staff/researchers in modern technology transfer and commercialization process, • Strengthen linkages with business incubators and science parks to sharpen entrepreneurship • Equip NARS with adequate equipment and funding of research daily operation expenses (consumables) • Establish innovation fund/vouchers to support spin-offs/start-ups or SMEs commercialize developed products

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Acryomns

aBi	Agricultural Business Initiative
CGIAR	Consultative Group on International Agricultural Research
COMESA	Common Market for Eastern and Southern Africa
COVAB	College of Veterinary Medicine, Animal Resources and Bio-security
DDA	Diary Development Authority
DRC	Democratic Republic of Congo
EAC	East African Community
EADD I&II	East African Dairy Development phase I & II
EU	European Union
FtF	Feed the Future
FY	Financial Year
GDP	Gross Domestic Product
GHG	Green House Gasses
GoU	Government of Uganda
ICT	Information and Communications Technology
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MT	Metric Tonnes
NAADS	National Agricultural Advisory Services
NAGRC&DB	National Animal Genetic Resources Centre & Data Bank
NaLIRRI	National Livestock Resources Research Institute
NARO	National Agricultural Research Organisation
NAROsec	National Agricultural Research Orgnisation Secretariat
NDP III	Third National Development Plan
NGOs	Non-Governmental Organizations
p.a	per annum
R&D	Research and Development
ROI	Return on Investment
TIDE II	The Inclusive Dairy Enterprise project phase II
TVC	Total Variable Costs
UBOS	Uganda Bureau of Statistics
UCCCU	Uganda Crane Creameries Co-operative Union
UDPA	Uganda Dairy Processors Association
UGX	Uganda Shillings
UHT	Ultra-High Temperature
UK	United Kingdom
UNDTA	Uganda National Dairy Traders Association
US$	United States Dollars
USA	United States of America
USAID	United States Agency for International Development
UVA	Uganda Veterinary Association
WHO	World Health Organization
ZoI	Zone of Influence



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1. Introduction

1.1 Background

Agricultural sector remains the backbone of Uganda's economy and livelihoods with over 63.4% of the labour force is employed in the sector (1), contributes to more than 50% of country's export earnings (2), and approximately 60% of manufacturing output (2).

However sector's gross domestic product (GDP) stands at only 24% (3), and for the past 5 years the sector has only grown at an average of 3.9% per annum against set target of 6% per annum from 2015/16 to 2019/20 (3, 4).

Slow sector growth is attributed to: (i) low agricultural production and productivity; (ii) poor storage infrastructure and post harvest management; (iii) low value addition; (iv) poor market access and low competitiveness of agro based products in domestic, regional, continental and international markets; (v) limited access to agricultural financial services and critical inputs; and (vi) poor coordination and inefficient institutions for planning and implementation of agro industrialization (5).

Amidst the above challenges, the sector has a huge untapped potential to contribute to country's GDP and reduce poverty through employment creation, a reason for sector prioritization under agro-industrialisation, export promotion and private sector development strategies of the National Development Plan 2020/21 – 2024/25 (NDP III).

Livestock is one of the important agricultural sub-sector contributing about 7.5% to total GDP or 17% to agricultural GDP (6). In the recent past, dairy has become an important sub-sector i.e. dairy products are the third-largest agricultural exports for Uganda after coffee and fish (7). This explains why dairy is among the 10 prioritized commodities (coffee, tea, fisheries, cocoa, cotton, vegetable oil, beef, maize, dairy and cassava) earmarked for sustainable agro-industrialisation under NDP III due to its potential contribution to food security, nutrition and export earnings. Dairy contributes 50% of livestock sector GDP (7) and 3.4% to country's export earnings (8). However, the growth potential for the dairy sector is still huge. For instance herd productivity is estimated at 3litres/cow/day for indigenous breeds and 5.7 litres/cow/day for

cross breed (9) against a potential of 22 -40litres/cow/day, and only 40 -60% installed processing capacity is utilized (8). This calls for deep understanding of the bottlenecks hampering sub-sector growth to guide implementation of interventions to unlock this enormous potential.

1.2: About USAID FtF Uganda Agriculture Research Activity

USAID FtF Uganda Agriculture Research Activity is a 5 year, US$10 million flagship research and development project, funded by USAID and implemented by CGIAR centers and NARO which seeks to promote use and commercialization of improved crop and livestock technologies with yield and nutrition enhancing characteristics. Since 2004, USAID has invested over US$17.8 million to support research efforts (for both crops and livestock) in Uganda, in addition establishing NARO as a premiere research organization on the continent through infrastructure and human capacity development. Although NARO continues to develop new technologies to respond to development challenges, commercialization of such technologies remains the biggest impediment for the institution. Although this activity will continue to support development of new technologies, more focus will be put on positioning NARO as a leader in commercializing transgenic and conventional crop and animal technologies through (i) establishing partnerships/market linkages with private sector to take up developed technologies, (ii) partnering with other USAID Uganda activities to leverage public and private sector resources and sell its products

The activity focuses on: (i) continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand, and (ii) strengthening NARO's institutional sustainability in the marketplace. Specific activities that the project focuses on include: (i) facilitate the release and commercialization of varieties developed under previous and ongoing research efforts, (ii) develop improved crop and animal production and management technologies in response to emerging threats and market demands, and (iii) consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding.

The activity is implemented through different Consultative Group on International Agricultural Research (CGIAR) centers, collaborating with specific NARO research institutions based on the targeted value chains. CGIAR centers and NARO also leverage expertise from USAID/ Washington staff, Feed the Future Innovation Labs and other centrally-funded research programs. Lastly, the activity leverages on-going USAID projects in Uganda (such as Inclusive Agricultural Markets activity, USAID Uganda's Biosafety activity, and Institutional and Systems Strengthening activity) to facilitate private sector engagement and assess demand for new products that need to be developed and commercialized.

Product commercialization and integrated crop and pest management research will be implemented in USAID's Zone of Influence (ZOI) depending on the target value chains (coffee, tea, fisheries, cocoa, cotton, vegetable oil, beef, maize, dairy, cassava, rice, beans, fresh fruits and vegetables, bananas, potatoes).

For USAID FtF Uganda Agriculture Research Activity to execute its mandate, there is need for a clear understanding of the current and future trends in the target value chains. Based on the above, Knowledge Wells Ltd was contacted by NAROsec to undertake a detailed study on dairy value chain Uganda to guide activity priorities.

1.3: Specific objectives and outputs of the study

Table 1: Specific objectives and outputs of the study

Specific objective	Deliverable
Conduct livestock (dairy) value chain analysis	Value chain assessment report highlighting current and future trends in Uganda's dairy value chain
Identify the most profitable nodes for each of the focus value chains based on return on investment (ROI)	Most profitable nodes identified based on return on investment analysis
Suggest best interventions to catalyze agro-industrialization at profitable nodes	Compendium of proposed interventions for NAROsec and others to catalyze agro-industrialisation at profitable nodes of dairy value chain



2. Methodology

Data and information contained in this report was obtained principally from existing literature through desk research. The data was analyzed and triangulated to come up with different analytical products and also to inform recommendations. The approach used is presented on schematic diagram in Figure 1.

Approach

Description of Phase	Phase I	Output
Comprehensive review of literature, data mining and analysis was undertaken to produce secondary based report	Phase I: Secondary data review	Secondary data based report

Sources: *Publications by DDA, Researchers, Dairy value chain enablers and online resources e.g. ITC website, and FAO*

Figure 1: *Schematic for the Methodology and Approach*

Limitations to the study

- The study mainly relied on secondary data sources some of which were not upto date especially information on gross margins and national herd statistics.
- Information on ongoing development initiatives, value chain support function and dairy research process was scanty



3. Key Findings

3.1: Dairy Market Review

3.1.1: Global dairy Industry

By 2021, global milk production was estimated to be 921 million tones, up from 906 million tones the previous year (10). This was driven by increase in milk output in Asia, Europe and Americas (South and North). On the other hand Africa's production remained stagnant. For the past 5 years production has been increasing at a rate of 2.6% per annum and is projected to grow at 1.7% p.a. over the projection period (to 1 020 Mt by 2030, faster than most other main agricultural commodities [11].

Production increase will mainly be driven by yield growth (as compared to herd growth) as a result of optimization of milk production systems, improved animal health, improved efficiencies in feeding, as well as better genetics. India and Pakistan are expected to contribute to more than half of the growth in world milk production over the next 10 years. By 2029, both countries are expected to account for more than 30% of world production, and then production will mostly occur in small herds of a few cows or buffaloes

Currently, 62% of the world's milk output is produced by the top 10 producers (figure 2), and 81% of global milk production is from cattle – figure 3 [12].

More than 7 billion people consume milk products worldwide, with the highest concentration in developing countries (figure 4). Most of the consumption is in fresh form (i.e. unprocessed or slightly processed – pasteurized and fermented). Developing countries dominant consumption of fresh dairy products, accounting for 75%, while processed products such as butter and cheese are mainly consumed in developed economies [11]. For instance, cheese consumption primarily occurs in Europe and North America; and butter is the most consumed processed in Asia (accounting for 50% of consumed processed products). On the other hand in Africa, in terms of processed dairy products, cheese and whole milk powder are the most consumed dairy products. Dairy products demand is projected to grow in the coming decade, with the share of fresh products expected to grow stronger than any other product (i.e. at rate of 1.2% p.a), mainly influenced by the growing demand in India and Pakistan. Overall skimmed milk powder is projected to have the highest growth, although from a low consumption base [11].

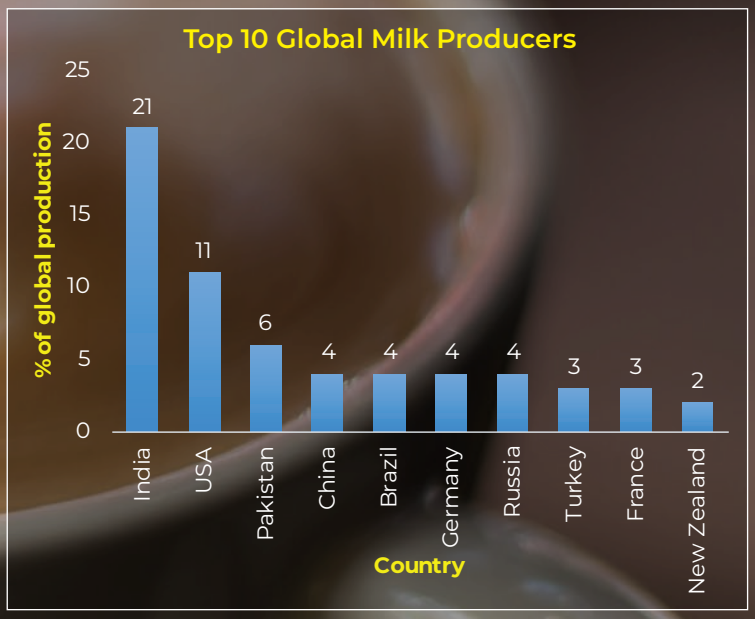


Figure 2: Top 10 global milk producers

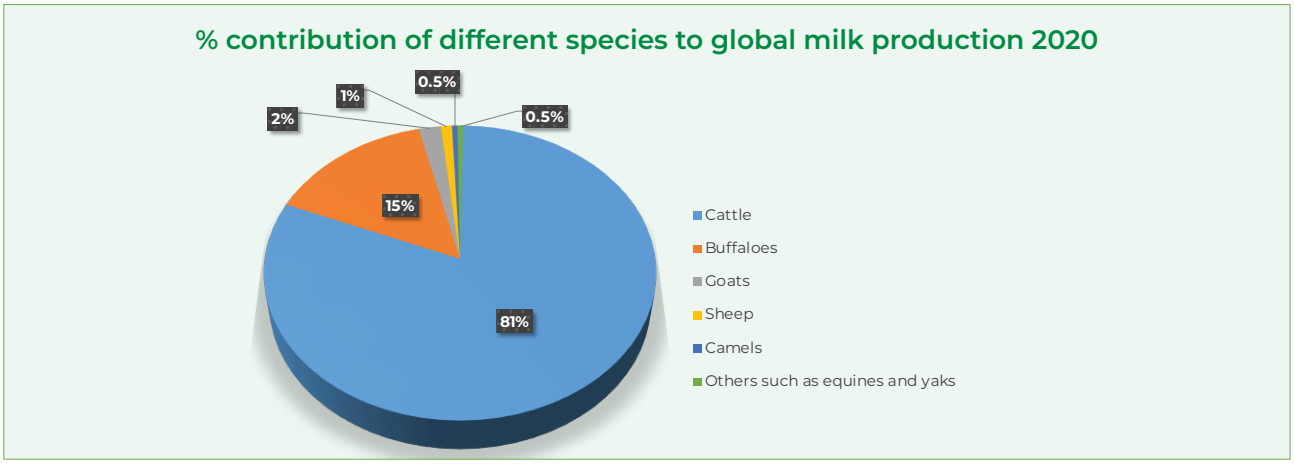


Figure 3: Milk contribution by different species

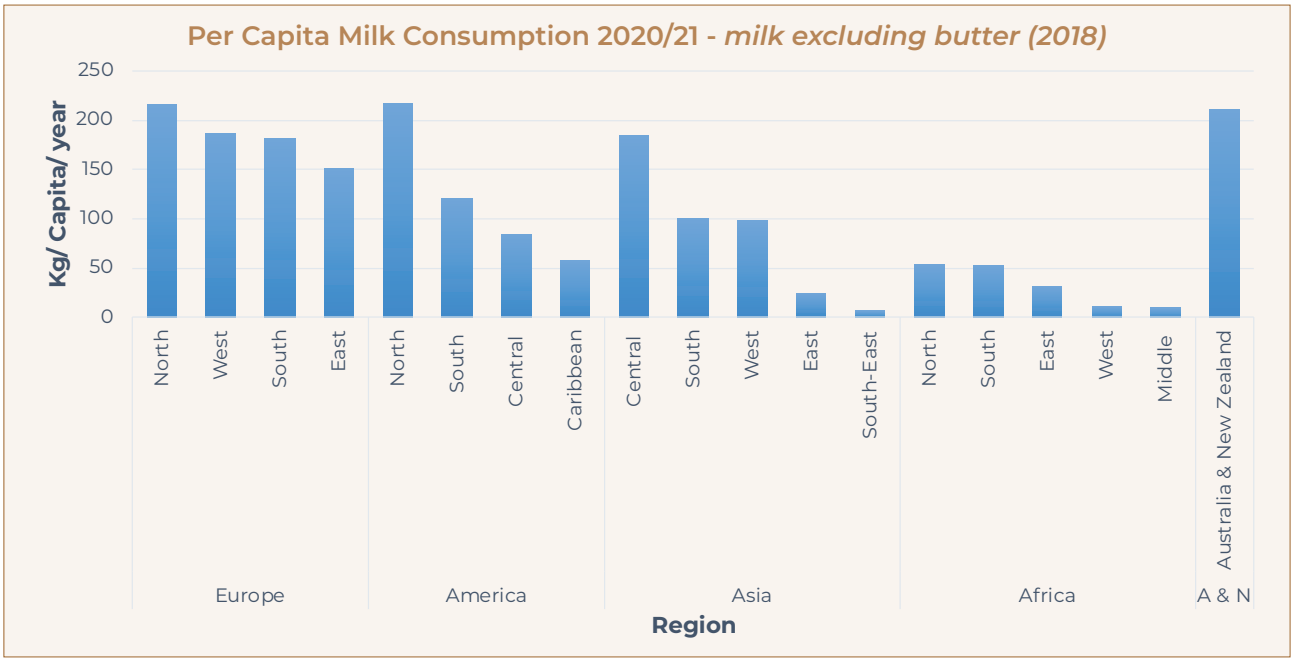


Figure 4: Per Capita milk consumption for different regions

3.1.2: Global Trade in Dairy Products

Given the perishability nature of milk due to high water content (more than 85%) which limits its trade over long distances, global milk trade accounts for only 7% of the global production (11). Most of the milk traded between countries is in processed form as powder, cheese, and infant milk formulas. Trade in liquid milk is mainly in form of fermented products (yoghurt) between neighboring countries. Long distance trade in liquid milk is in form of ultra high temperature milk and cream products. Close to 28 million MT milk products, valued at US$ 94.2 billion were traded globally in 2020, with Cheese and curd being the most traded by value (US$32.9 billion) , although by volumes, milk powders followed by Cheese (7.8 million MT and 7.2 million MT respectively) were the most traded (figure 5 & 6). By volume for the last 5 years (2016 – 2020), global trade in dairy products has remained almost the same, however by value, it has increased by 22%, owing to increase in product prices (13).

New Zealand, European Union and United States of America dominate global dairy products export markets. EU and USA continue to dominate cheese export, while New Zealand continue to dominate milk powders and butter export (figure 7). Competitiveness of New Zealand is partly attributed to its efficiency of grass management.

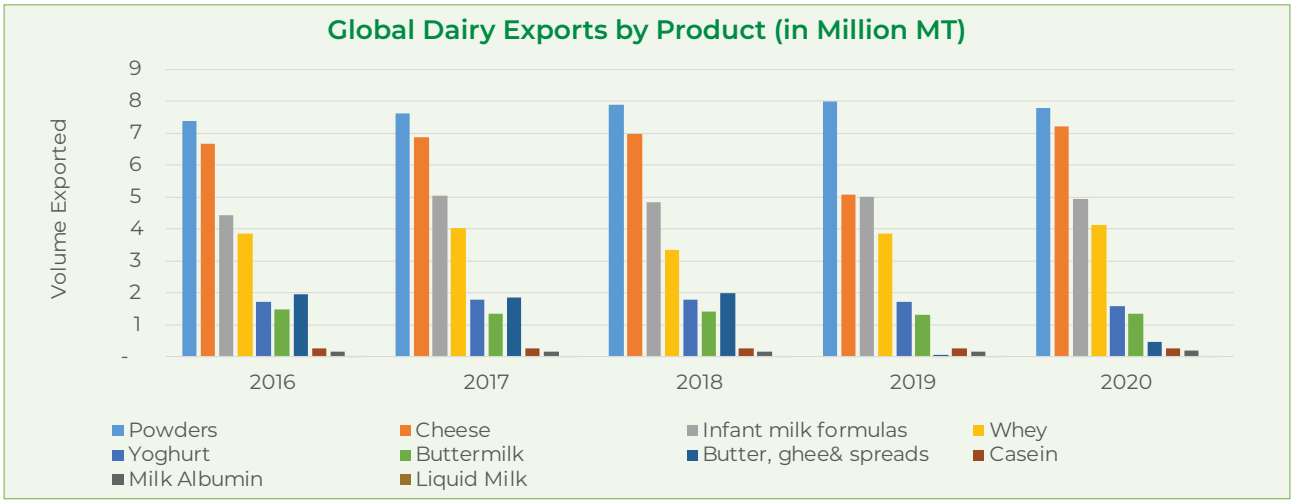


Figure 5: Global dairy exports by volumes

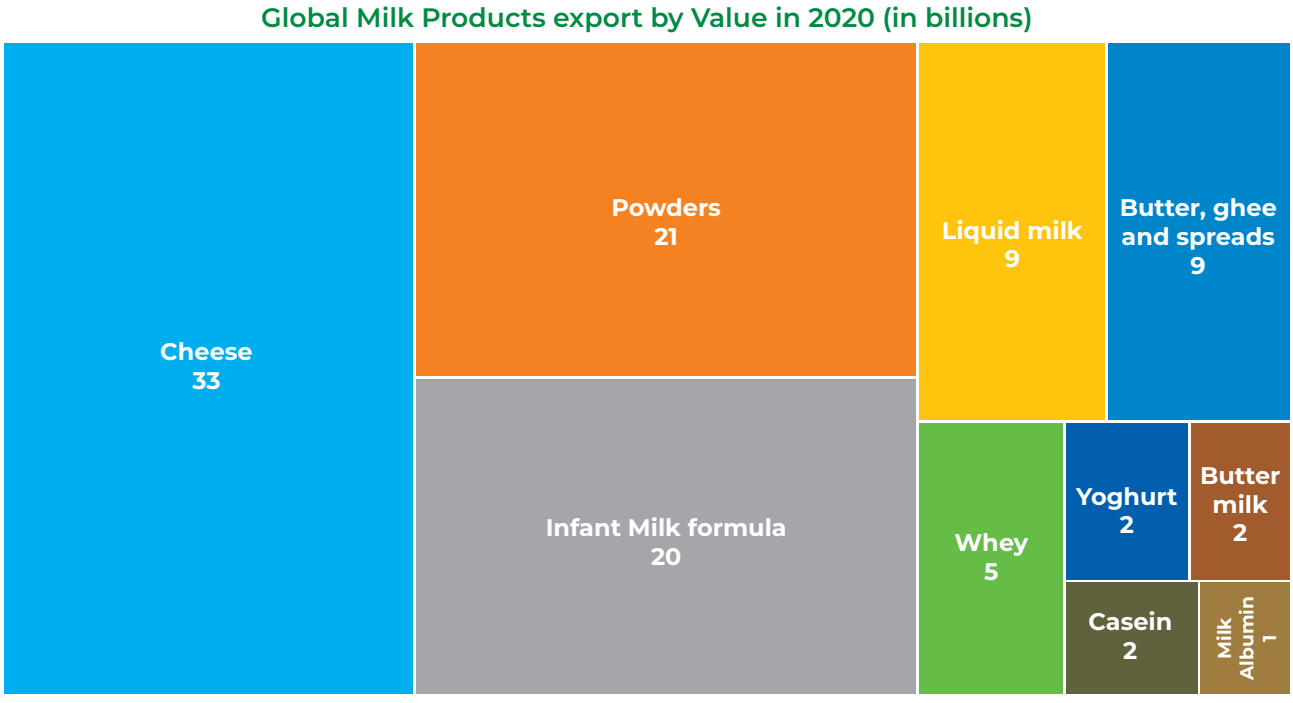


Figure 6: Global dairy exports by value

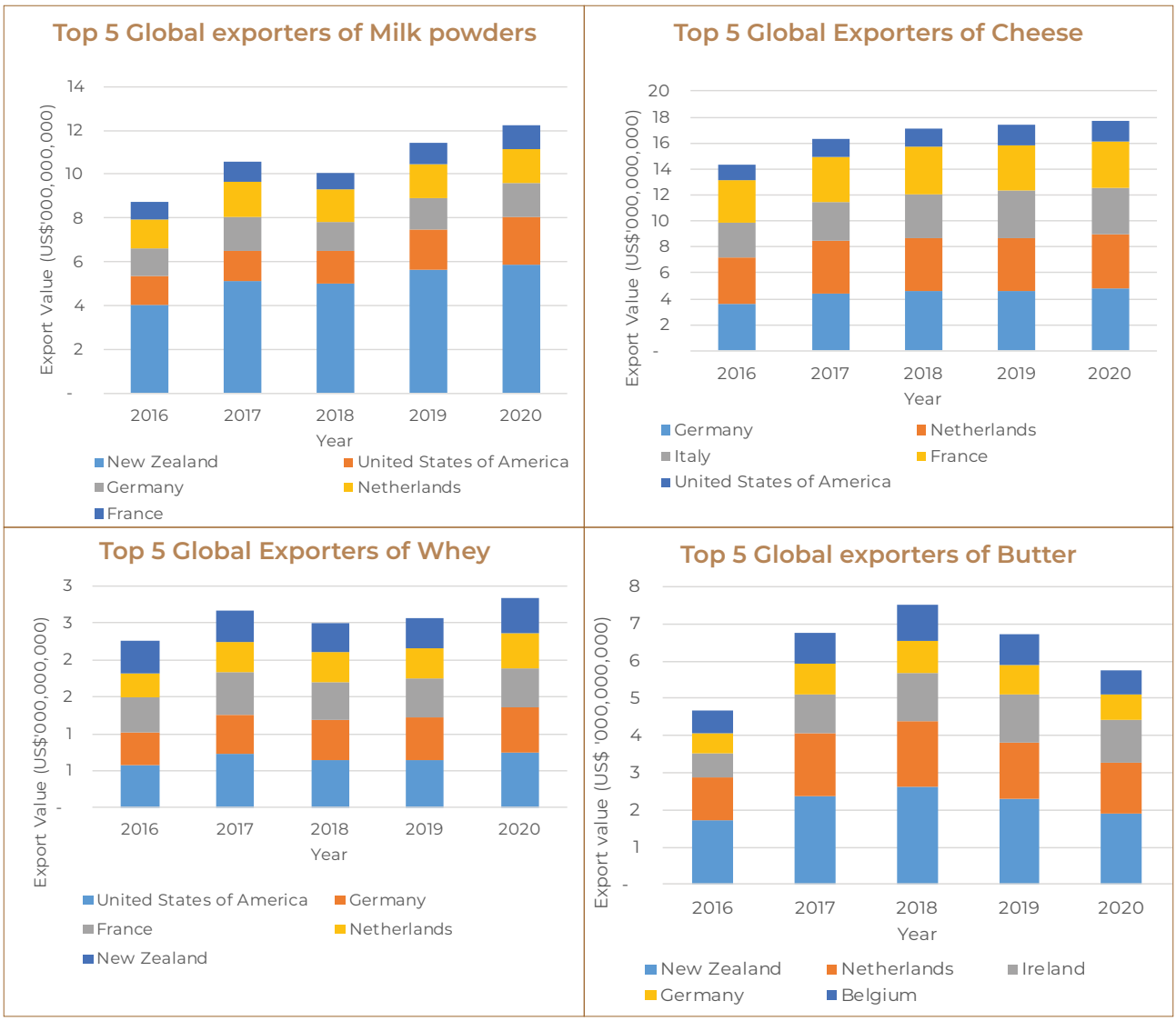


Figure 7: Top exporters of different dairy products

China is and in the short to medium term will remain the leading importer of dairy products, although imports are spread across countries. China tops importation of whey and milk powder. In Africa, Algeria and Nigeria import consideration volumes of milk powder, thus among the top 10 importers.

EU countries top importation of cheese and butter. EU is followed by United States of America, Japan and Saudi Arabia with respect to cheese importation

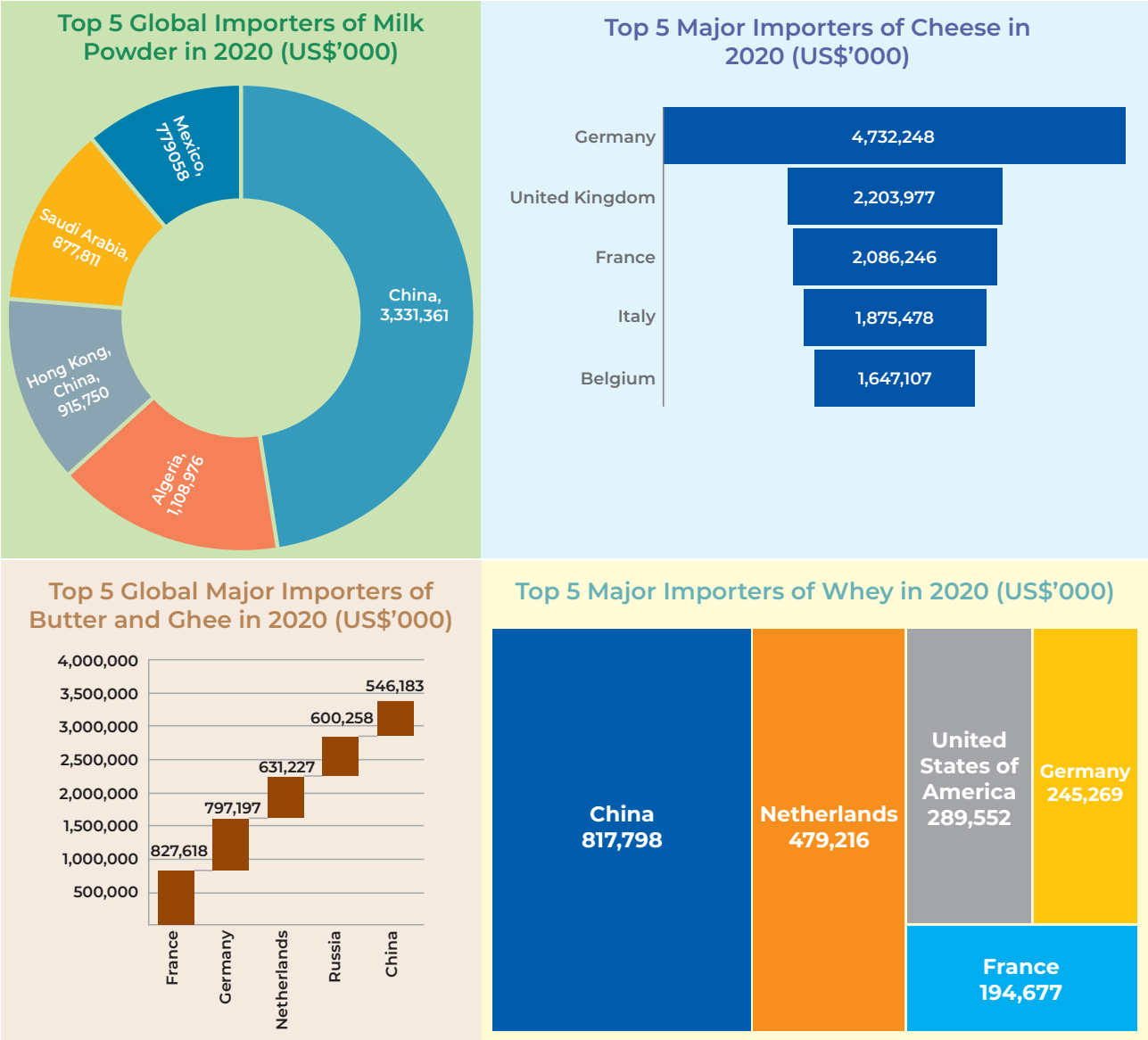


Figure 8: Top importers of different dairy products

3.1.3: Global Dairy Price Review

Generally, world prices from dairy products have increased for the last 5 years (Jan 2016 to October 2021), with the major increased observed for whole milk powder (figure 9). Butter had the highest average price at US$4,648/MT, followed by cheddar cheese at US$3,492/MT, then whole milk powder at US$3,115/MT and lastly skim milk powder at US$2,313/MT. Whole milk powder prices increased by 82%, followed by skim milk powder at 79%, then butter at 70% and lastly cheddar cheese at 34% (14). However, there was contraction in dairy prices from late 2019 to late 2020. This could be attributed to reduced demand as a result of economic hardships due to COVID-19 impacts in major dairy markets which led to the accumulation of unsold supplies in major exporting countries (15). Prices are slowly peaking up in 2021.

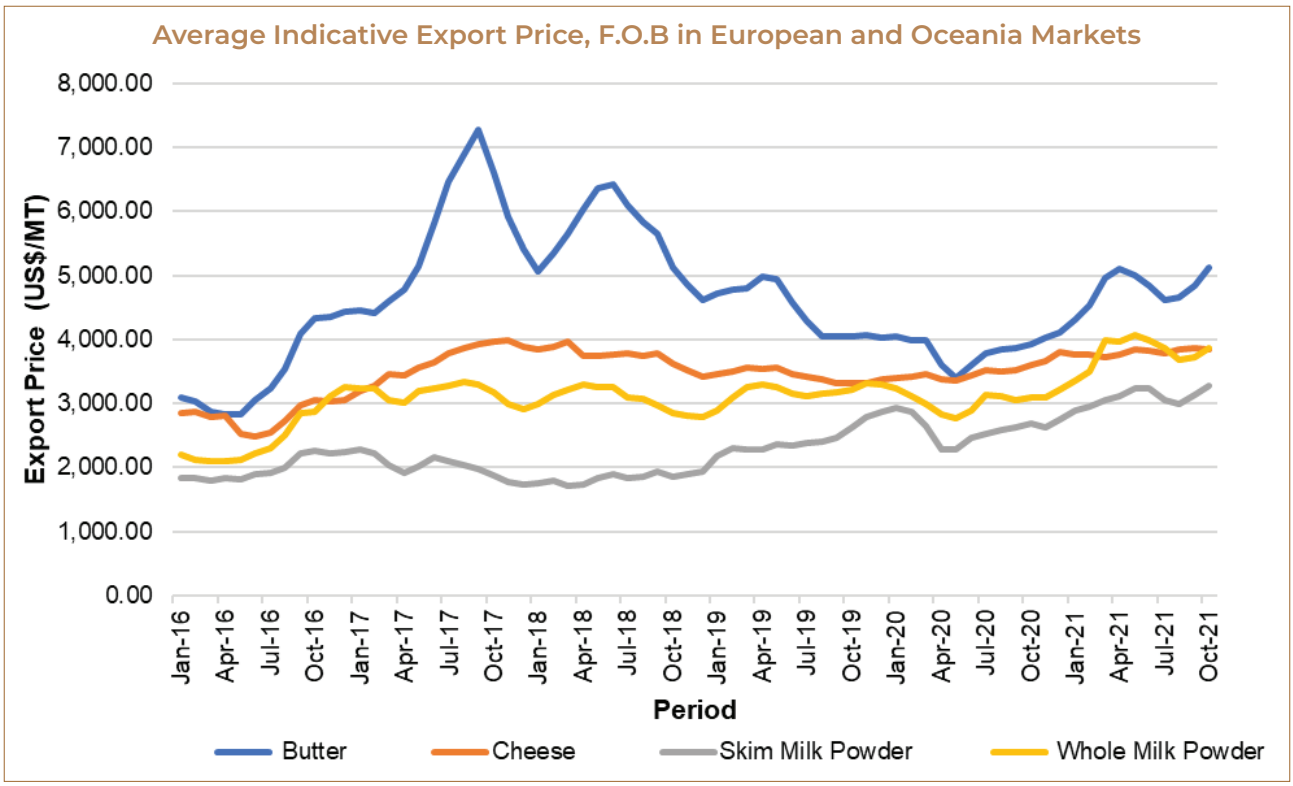


Figure 9: Global Prices of different dairy products

3.1.4: Global trends shaping current and future dairy markets

Trends expected to shape current and future dairy markets include (11):

- Incomes and population growth expected to positively influence consumption of fresh dairy products, especially in China and Pakistan
- Regional preferences will be important factors driving this consumption variation. e.g. largest percentage of total cheese consumption occurs in Europe and North America, where per capita consumption is expected to continue to increase.
- Increasing urbanization and incomes i.e. cheese consumption will increase in South East Asian countries as more people eat away from home, including fast food such as burgers and pizzas
- Growing manufacturing sector such as confectionary, infant formula, and bakery products.
- Given that liquid milk is expensive to trade, its projected the demand for milk powder will increase, where water will be added for final consumption or further processing
- Growing animal industry i.e. for instance skimmed milk powder and whey powder imported by China for feeding pigs
- COVID 19 impacts affecting consumption of certain products such as cheeses (in form of pizzas and burgers) which are consumed away from home
- Climate change increases the chances of drought, floods, and disease threats all of which can affect the dairy sector in several ways (e.g. price volatility, milk yields, cow inventory adjustments).
- The increasing trend towards sustainable practices (to reduce GHG emissions) such

as water access and manure management are additional areas where policy changes could have an impact

- Food safety concerns e.g. use on antibiotics to control diseases like mastitis whose residues are traced in milk. In addition to growing antimicrobial resistance which reduce treatment effectiveness
- Growth of plant-based dairy substitutes (e.g. soya, almond, rice and oat drinks), albeit from a low base, but conflicting views exist regarding their environmental impact and relative health benefits (lactose intolerance). As a result, there is uncertainty on the long-term impact these will have on dairy demand.
- Changes in trade policies and environment in different countries

3.2: EAC market for dairy products

3.2.1: Inter-regional trade in dairy products

Dairy is one of the important and fastest growing sectors of agriculture in East Africa. The sector contribute between 2 and 8% of the different countries GDP in the region (16). Combined with the horn of Africa, the region produces 68% of the continent's milk output, with Kenya, Uganda, Ethiopia and Tanzania among the biggest dairy producers (17). 80% of milk production is done by smallholder farmers, who mainly market their milk through informal channels (control 80% of dairy market), mainly in raw form (18).

Owing to increasing urbanization, population growth and increased household incomes/ middle class, demand for milk has been and further expected to increase in the region. The current per capita milk consumption in the region on average stands at 60litres/capita/year. However, consumption varies among countries, with Kenya having the highest consumption at 115litres/capita/year (19), followed by Uganda at 63.8litres/capita/year (20), Tanzania at 47litres/ capita/year (21), Rwanda at 69.4litres/capita/year (22) and Burundi at 4.6 litres/capita/year (23). However, consumption is still below WHO recommended levels of 200litres/capita/year, which provides an opportunity for increased investment in the sector. Meaning annual demand gap stand at 140 litres within EAC region.

In East Africa, just 1% of milk production is traded beyond the region (18), implying high and growing demand for dairy products locally. Although huge investments have been made at processing level, majority of the firms struggle with low capacity utilization attributed to low milk supply due to competition with informal market channels that control over 80% of the dairy market i.e transporters often buy milk from farmers and sell directly to customers with little or no preservation or quality control measures (18).

The region's demand gap for the different dairy products is also depicted by level of importation from outside EAC. In 2020, the region imported 19,863 MT of dairy products (worth US$ 45 million), down from 20,169 MT (valued at US$ 46.3 million) that was imported in 2019 (13) as shown in figure 10. The decrease could be due to COVID impacts on trade

By value and volume, milk Powder (56.3%), infant milk formulas (27.5%) and liquid milk (5.9%) are the most imported into the region in 2020 (13) as shown in figure 10 & 11.

Kenya is the main destination for dairy products. For instance, out of US$ 949,000 of liquid milk imported into the region in 2020, Kenya accounted for 98%, followed by Tanzania, Uganda,

Burundi and Rwanda. South Africa, Germany, UAE in that order are the main suppliers of liquid milk imports on EAC market (13).

For milk powder, Kenya is still largest importer (representing 61%), followed by Rwanda, Tanzania, Uganda and Burundi. Out of the US$ 26.5 million of milk powder imported into EAC region, Kenya alone imported US$ 16.2 million, The main suppliers of milk powder imports on EAC market included Netherlands, Belgium, South Africa and Germany in that order (13).

And Lastly for infant formula, Tanzania is the largest importer in the region accounting for US$ 4.4 million out of US$ 11.5 million imported by all EAC countries in 2020. Kenya comes in second (with US$ 4.03 million), followed by Uganda at US$ 1.96 million, Rwanda at US$1.6 million and Burundi at US$ 420,000. The major suppliers of infant milk formula into EAC market include France, South Africa, Mexico, Poland and Ireland in that order (13).

On the other hand, as a block EAC region exported are generally still low at only 19,941 MT, valued at approximately US$ 35.6 million in 2020. Exports were mainly in form of liquid milk (35.4%), infant milk formula (35%), butter (10.7%) and milk powder (7%). Exports were mainly destined to Somalia, DRC, Malawi, South Sudan, Ethiopia, Botswana. The largest exporter was Uganda, exporting more of liquid milk (to DRC, Malawi, South Sudan) , powdered milk (to Oman, Ethiopia, Malawi, Qatar, Zambia), and butter (to Oman, Egypt, Japan, Sri Lanka). Second leading exporter from the region was Rwanda, followed by Kenya, Tanzania and Burundi respectively (13).

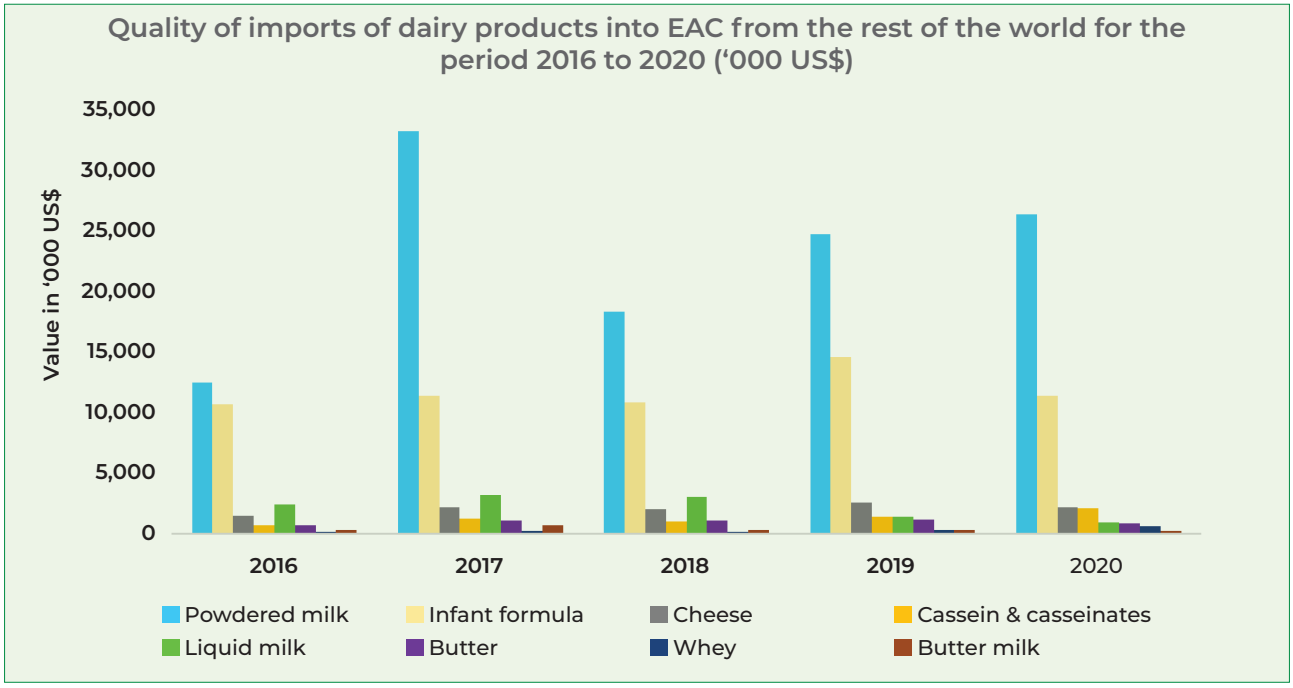


Figure 10: Value of imports of dairy products into EAC

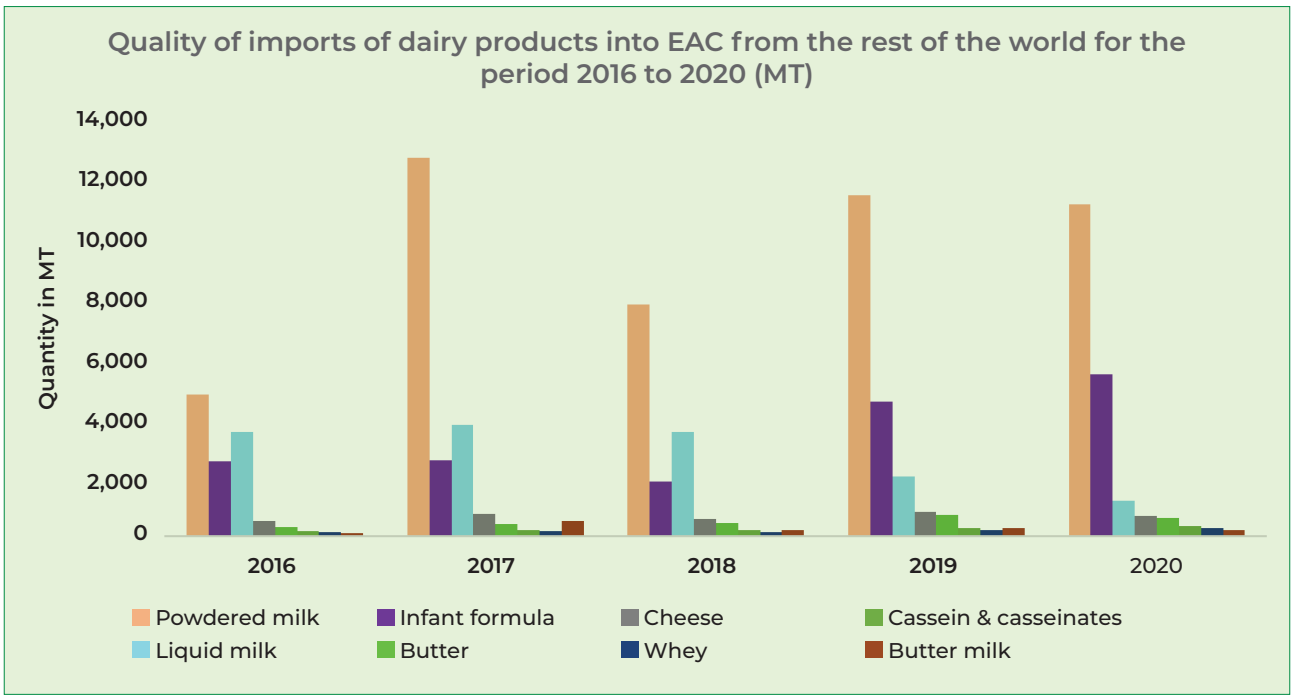


Figure 11: Quantity of imports of dairy products into EAC

3.2.2: Intra Regional Trade in dairy products

Of the total exported dairy products into different EAC countries, intra-regional trade from other EAC partner states accounts for over 75.9% all exports i.e. 62,871 MT of dairy products (Figure 12), valued at US$ 58.6 million (figure 13) was traded among EAC countries in 2020. This trade has been increasing for the last 5 years at a rate of 45.9% from 43,079MT in 2016 (13). The high intra-regional trade in dairy products could be attributed to their perishability nature which makes it expensive to transport or trade over long distances.

Kenya still remains the main destination for dairy products for dairy exports even from EAC counter parts. Kenya is followed by Tanzania, Uganda, Rwanda and Burundi in that order. And regionally in 2020, the most traded dairy products across borders are liquid milk (55,455 MT, valued at US$ 34.2 million – representing 88% of total trade), followed by are milk powder (6,621 MT, valued at US$ 21.8 million – representing 10.5% of total trade), then butter (369 MT, valued at US$ 2 million – representing 0.6% of total trade), and lastly, infant milk formula (265 MT, valued at US$ 166,000 – representing 0.4% of total trade). Other products are cheese, milk albumin, casein &caseinates, and whey which are traded in negligible quantities in that order (13).

The main exporters of dairy products to EAC counterparts in 2020 were Uganda (accounting for 99.24% of total trade), followed by Kenya (0.7%), Burundi (0.05%) and Tanzania (0.01%). For liquid milk, Uganda accounts for 99.96%, mainly to Kenya, followed by Kenya (accounting for 0.04%). The same is true for milk powder where Uganda is still the largest exporter to EAC counter parts (mainly Kenya), accounting for 98.2% of trade valued at US$ 21.7 million (6,506 MT). The rest of the milk powder comes from Kenya (1.1%), Burundi (0.5%) and Tanzania (0.2%) (13).

Kenya was the largest exporter of infant milk formula to EAC counter parts, accounting for 99.2% (valued at US$ 144,000), mainly destined to Tanzania and Uganda. The other supplier was Uganda (13).

Level of intra-regional trade in dairy products compared to total trade, shows a big potential that can possibly be tapped into if more investments are made to strengthen the dairy value chain

Regional demand for dairy products is mainly driven by growing middle class with more disposable income, and population growth.

However, imports into East Africa's largest milk market could be affected by 10% levy imposed in 2020 to curb cheaper dairy imports into the country (24).

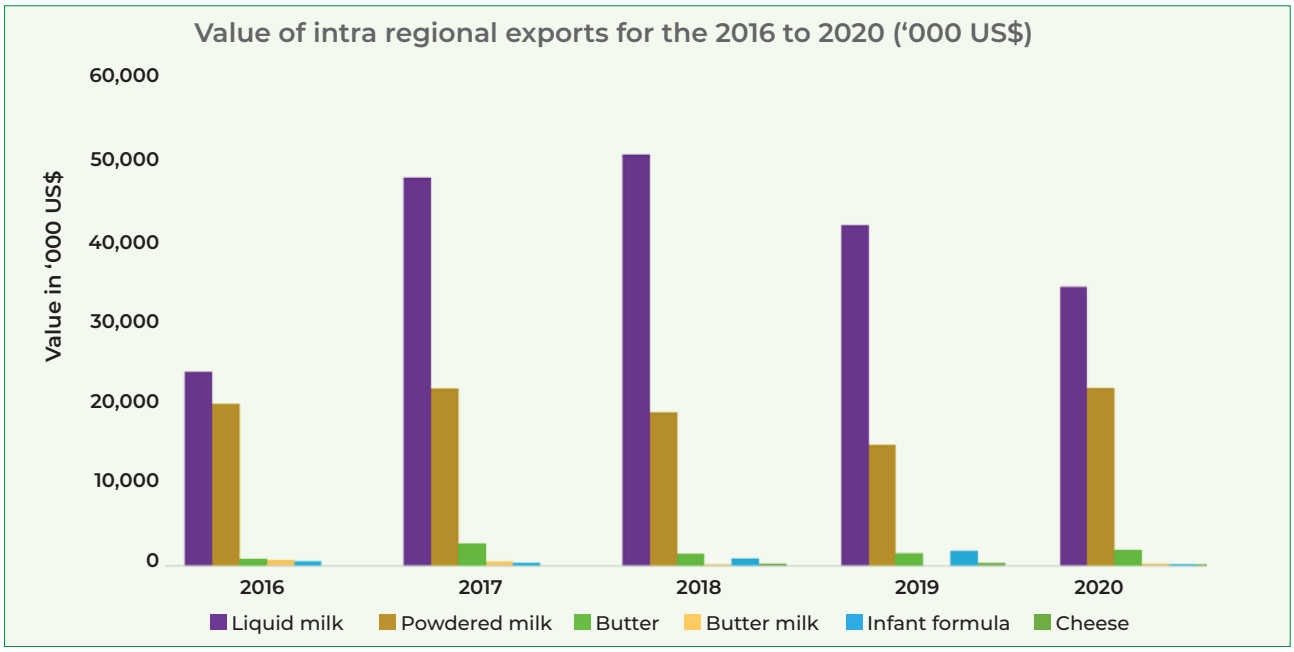


Figure 12: Value of intra-regional exports

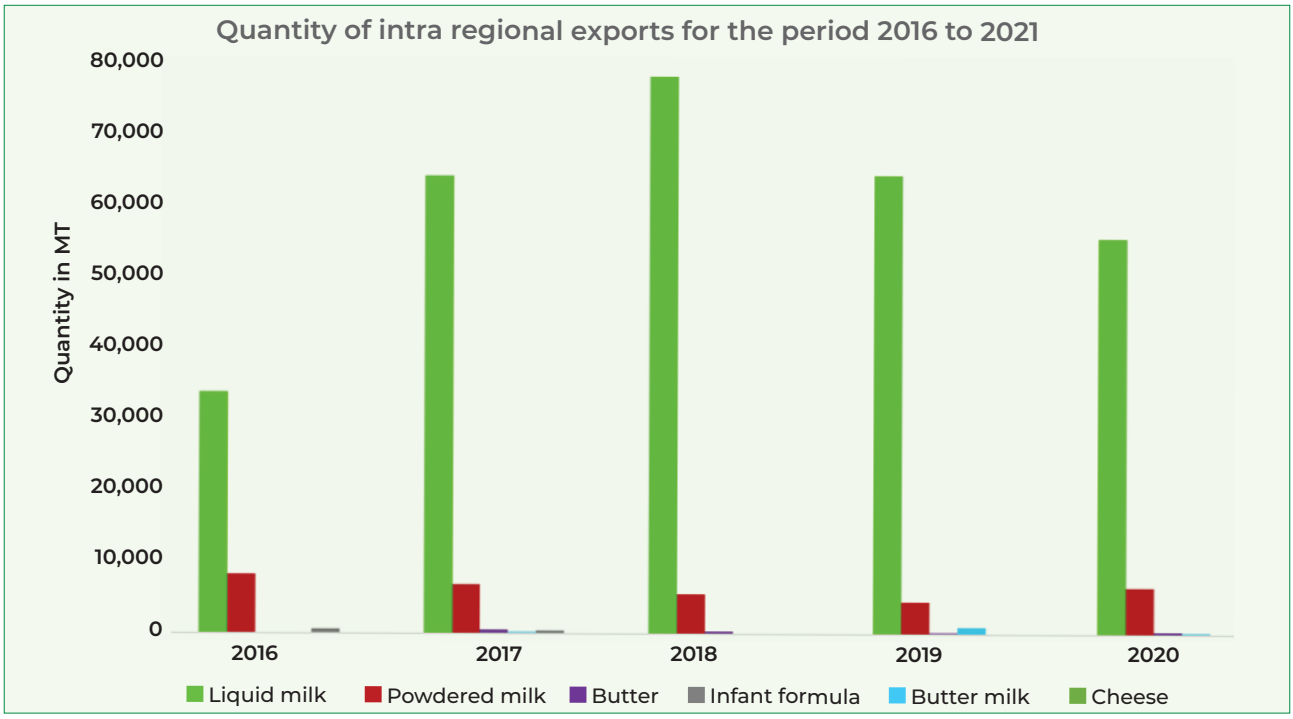


Figure 13: Quantity of intra-regional exports

3.3: Market for dairy products in Uganda

3.3.1: Domestic market for dairy products

Uganda's national milk per capita milk consumption has improved from 60 litres/capita/year in 2015 to 63.8 litres/capita/year in 2019 (20). However, consumption is still below WHO recommendation of 200 litres/capita/year, implying apparent unmet demand stands at 5.7 billion litres per year. This shows that there is potential for market expansion within the domestic market. Milk consumption has been increasing over time in both rural and urban areas. In terms of frequency, average weekly consumption of milk in rural areas is 1.6 days per household, while in urban areas its 2.2 days (25). Ankole region has the highest milk consumption (with average weekly consumption of 2.9 days), followed by central region at 2.2 days and least consumption occurs in Acholi, Bukedi and Kigezi regions (with average weekly consumption between 0.7 and 0.9 days).

Most milk and its products are consumed locally, with small proportion exported to neighboring countries, even through local demand is higher than available supply. Most of the milk is consumed in unprocessed form (raw milk), given the dominance of informal channel which accounting for 66% of marketed milk (20). Apart from liquid milk, other dairy products are also consumed, although the consumption will vary depending whether it's a rural or urban setting. For instance, there is going demand for pasteurized milk, yoghurt, UHT milk, ice cream and milk powder, mainly sold through supermarkets, and retail/grocery shops in urban centers like Kampala. On the other hand, rural areas, unsold milk is processed by farmers is processed into bongo (a type of buttermilk that can be stored longer than liquid milk, is very popular) and consumed locally (26). Other products whose consumption is slowly increasing in rural areas include; butter (or ghee) and yoghurt.

Among processed products, pasteurized milk has the biggest market share as depicted in figure 14 (27). However, the most preferred milk products are yoghurt, ice cream, butter and ghee. Yoghurt demand is steadily increasing across different classes which has attracted small and cottage processors to venture into the same (27). Product choice is mainly influenced by price, age, and education level.

Hotel, restaurants, hospitals and schools are also important outlets for milk products (especially pasteurized milk and yoghurt) and these mainly target middle class segment, expatriates and tourists.

School milk programs such as one run under TIDE II project implemented by SNV and funded by the Embassy of the Netherlands in Western Uganda, has increased awareness of the role milk plays in children's diet and piloted parent led school feeding, which ultimately increases milk consumption.

Generally, key factors influencing increased milk products consumption in Uganda include income levels, population growth, urbanization, social norms, values and beliefs and changing lifestyles towards consumption of animal-based food products. These are expected to also influence future demand for milk products

Unlike other subsectors, dairy industry has low or no significant competition from would be plant based substitutes like soy milk especially in terms of availability of the products on the market and affordability.

Higher or more frequent consumption of milk and its products consumption is mainly constrained by affordability, low disposable income, availability and seasonality of supply or quality?. For instance, although major market for milk products is the urban population, and even among urban dwellers a small fraction of households can afford milk regularly. In most households, milk is preserved for children below 5 years, mainly due to low household incomes.

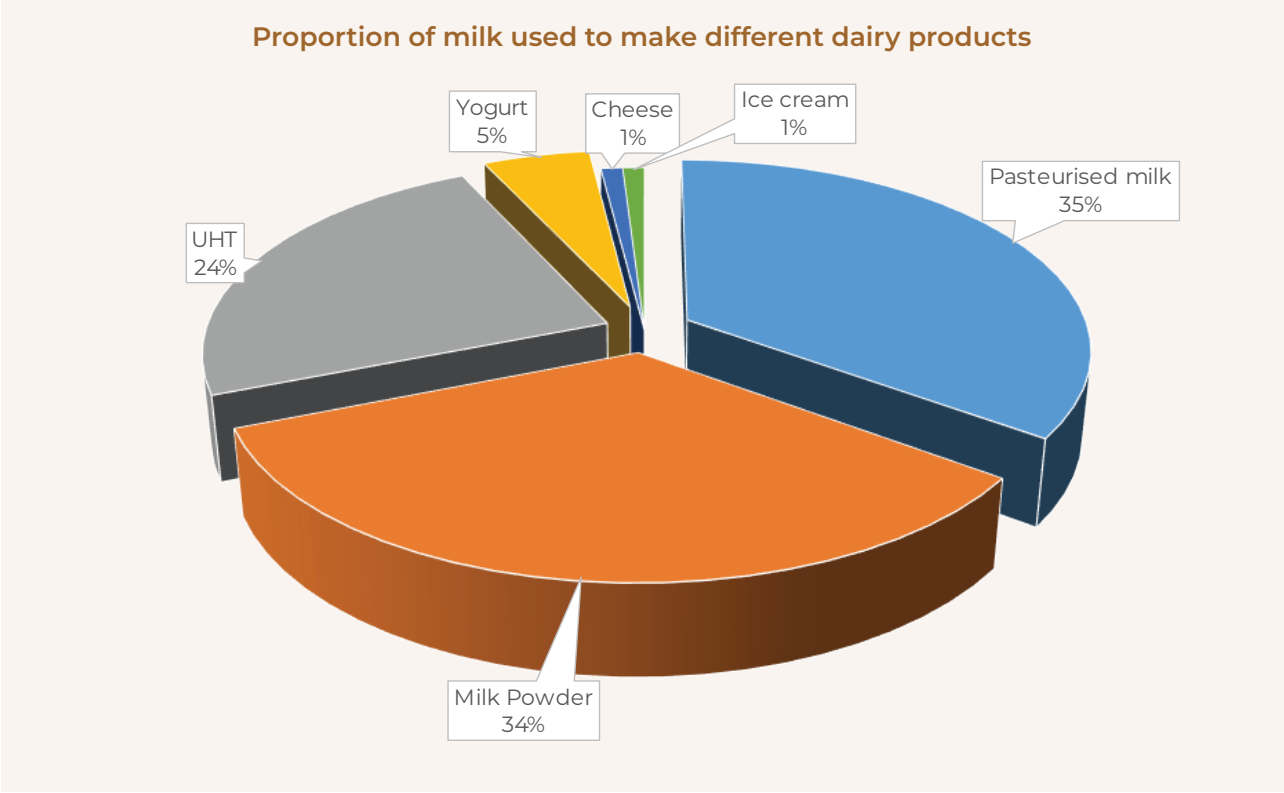


Figure 14: Proportion of milk used to make different products

3.3.2: Uganda's dairy Products Imports and Exports

Local supply of dairy products is complimented with imports from other countries, although volumes are low. For instance, Uganda imported dairy products worth US$5.9 million (1,416MT) in 2020 (13) compared to US$7.6 million imported in 2018, mainly in form of milk powder and infant milk formulas (representing 77% of total import volumes). Infant milk formulas is a growing market segment, mainly targeting children under 3 years to supplement breast feeding. This is another niche market that can be tapped into by local processors, however, it requires huge investment in quality assurance.

Uganda's milk powder imports mainly come from Netherlands, France, UAE and Malaysia. Most common imported milk powder brand is Nestle Nido and safa. While infant milk formula imports mainly came from Rwanda, Poland, UK, Switzerland, Mexico and France. Common infant milk formulas on the market include: SMA, Nan, Cow&Gate, Similac, Isomil, Lactogen, and Enfamil (28). Other products imported include Cheese and curd (8%), buttermilk and yoghurt (5.5%). The main target market segment for imports are the middle class and expatriates who shop from super markets.

However, official statistics from DDA (20), showed that Uganda imported dairy products worth UGX 12.075 billion (approximately US$3.43 million) in FY 2020/21. Milk products imported include milk cream, butter, cheese and yoghurt. The top countries of origin of these milk products are United Arab Emirates, Oman, Ethiopia, Kenya, Netherlands, South Africa, United Kingdom, France and Germany.

In the recent past, dairy has become one of the most important export product in Uganda, which could explain its prioritization by government. As such, Uganda is now a major exporter of dairy products within and the EAC region and recently started exporting to COMESA such as Zambia.

According to ITC (2021), In 2020, Uganda exported 73,719MT, valued at approximately US$83.5 million down from 76,619MT (valued at US$72 million). However, DDA reported that Uganda exported UGX 358.6 billion (approximately US$102 million) worth of diary products in 2021 (20). This was attributed to increased compliance of Uganda's milk and milk products on both regional and international market standards .

Exports were mainly in form of liquid milk/UHT, milk powder butter and casein. Liquid milk exports were mainly destined to Kenya South Sudan, Malawi and Burundi. Milk powder was destined to Kenya, south Sudan, DRC and Malawi. Other countries include Oman and Qatar. Butter is mainly exported to Egypt, Kenya, Oman, Japan and Tanzania. While casein is mainly destined to USA and India. New markets added in FY 2020/21 include Algeria and Malawi.

However, the unrelenting blockage of Uganda's milk exports by Kenya (on account of quality) will affect milk export statistics to Kenya in 2021. The unpredictable regional markets has forced Uganda to explore other markets. For instance , in 2021, through Pearl Dairies Limited, Uganda secured a 700MT agreement to export milk powder to Zambia

Major exporting companies are Amos Dairies, Pearl Dairies Ltd (controlling 42% of export value and mainly exporting milk powder to COMESA, West Africa, Gulf States, Japan, India, UAE and Nepal), Brookside ltd (account for 20% of exports, mainly exporting UHT to EAC), Birunga Dairies Industries (account for 14% of total exports, mainly UHT to DRC, Rwanda and Burundi), Jesa farm dairy Ltd (account for 11%, mainly for extended shelf life milk to Kenya) and Amos Dairies (account for 14% of total export value, mainly exporting casein to USA). Other small processors/exporters include Lakeside Diaries Ltd (specialize in other locations such as South Sudan), Sameer Agriculture and Livestock Ltd, UNGA Group Ltd, GBK Dairy Products Uganda Ltd, Ahmed Raza Foods Industries Ltd (9).

According to ITC (2021), Uganda's untapped dairy export potential stands at US$ 66.9 million (representing 44% of the total export potential). In the terms of products, the highest potential is in liquid milk at US$40.7 million (representing 49% of total liquid milk potential), followed by low fat milk powder at US$22.3 million (representing 57% of total low fat milk powder export potential), and lastly sweetened milk powder at US$3.9 million (representing 37.5% of total sweetened milk powder export potential). Others include casein and butter (29).

To tap into this potential, Uganda needs to capitalize on its low milk producer price (i.e. at US$0.22 per litre compared to its main trade partner, Kenya with a producer price of US$0.41 per litre), invest in processing of high end dairy products such as casein, baby formulas, Whey, Cheese and curd, and ensure more substantial quality control and standards.

3.3.3: Milk and milk products prices in Uganda

Unlike 2020, in 2021 price volatility slightly decreased. National average farm gate increased from UGX 984 (in FY 2019/20) to UGX 1,072 (in FY 2020/21) per litre, while retail prices increased from UGX 1,440 (in FY 2019/20) to UGX 1,603 (in FY 2020/21) per litre (20).

During FY2020/21, both retail and farm gate raw milk prices remained lowest in South Western milk shed at UGX 1,390 and UGX 935 per litre respectively. Higher farm gate were recorded at UGX1,250 per litre in North Eastern milk shed and retail raw milk prices of UGX 1,878 per litre in the Northern milk sheds. Higher prices could be attributed to the effect of COVID-19 and drought that hit dairy farmers in the North and North Eastern milk sheds constraining milk production and productivity causing milk deficits in the region (20).

Annual variations of prices in FY 2020/21 are presented in Figure 15

National milk prices are therefore predicted to continue an upward trend (as shown in Figure 16). This will benefit local farmers who contribute to the global supply chain.

In comparison with other countries, Uganda is very competitive in the region with the lowest producer prices as shown in Figure 17 (30), which should be capitalized on to increase exports.

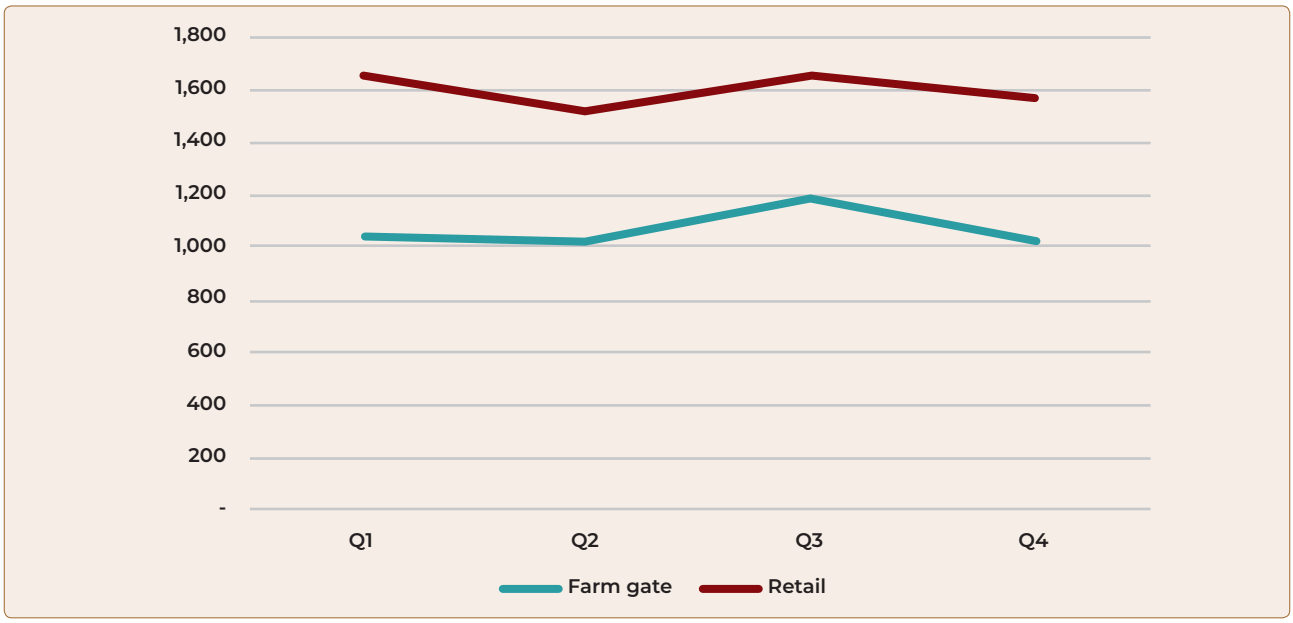


Figure 15: Annual national milk prices at farm gate and retail in FY 2020/21 (adopted from DDA annual report FY2020/21

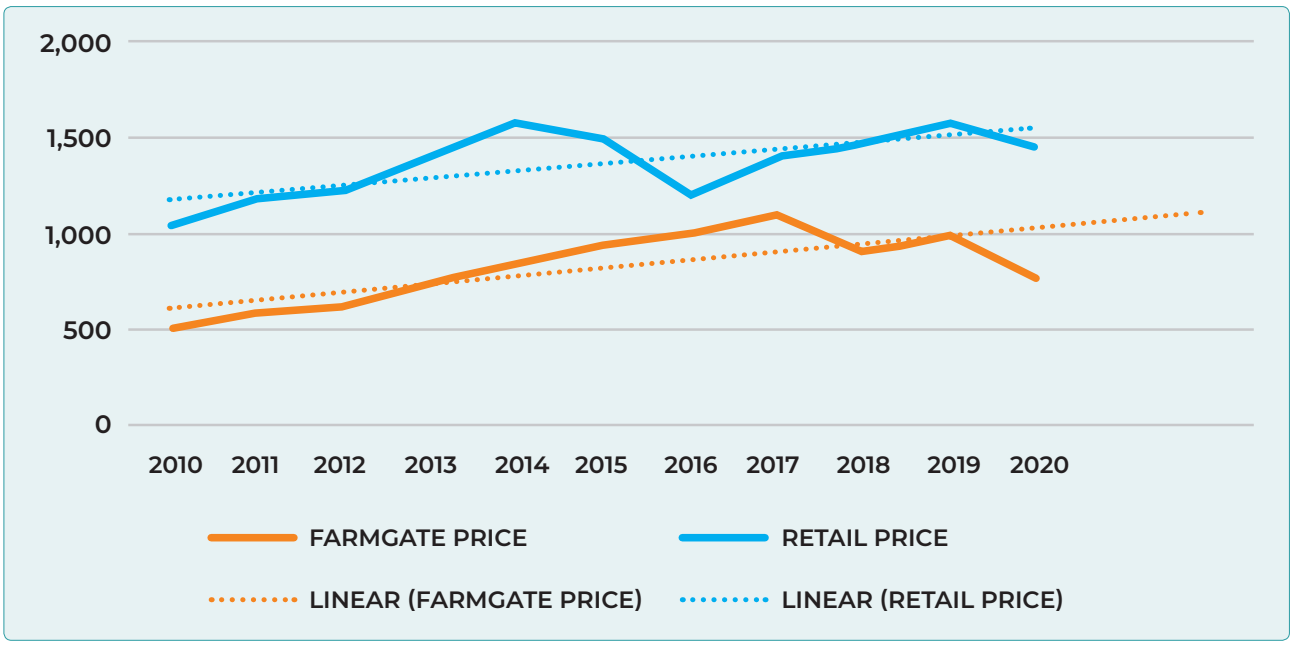


Figure 16: Local milk prices forecast (adopted from DDA annual report FY2020/21

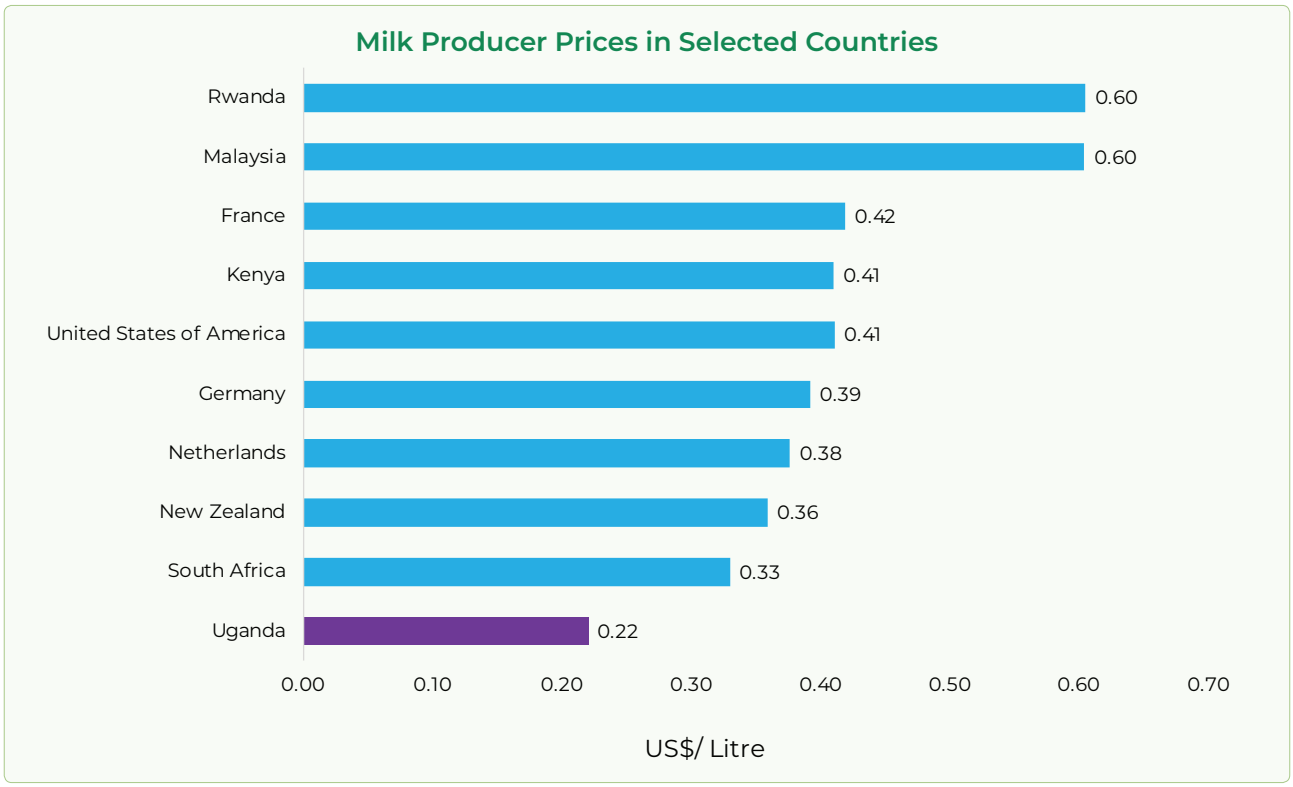


Figure 17: Milk Producer Prices in Selected Countries



4: Dairy Market System Development mapping

4.1 Dairy Market System

Dairy sub-sector chain in Uganda, provides an interesting case due to co-existence of both export-led and domestic market-led value chains for the same commodity (9).

The dairy market system has a range of players, including: farmers, traders, transporters, milk collection centers, processors (some doubling as exporters), retailers (informal grocery shops and supermarkets) and end consumers (both local and international). Others include support institutions and regulatory bodies. The dairy market system map is shown in figure 18.

Note that dotted lines represent the informal channel, which is the most dominate

Dairy sector is one of the most regulated sub-sector in Uganda with a Directorate of Animal Resources at Ministry of Agriculture established for policy formulation and Dairy Development Authority, established by Act of Parliament to coordinate the sub-sector and ensure effective policy implementation.

Compared to other value chains, dairy support system over the years has tremendous grown thanks to sub-sector prioritization and liberalisation by government, support from development support from organizations such as aBi Development Ltd, Heifer International, SNV, Send a Cow and many others. In addition to private sector investment especially at the processing node and refrigerated milk tankers.

The dairy map is unpacked in the section 4.4

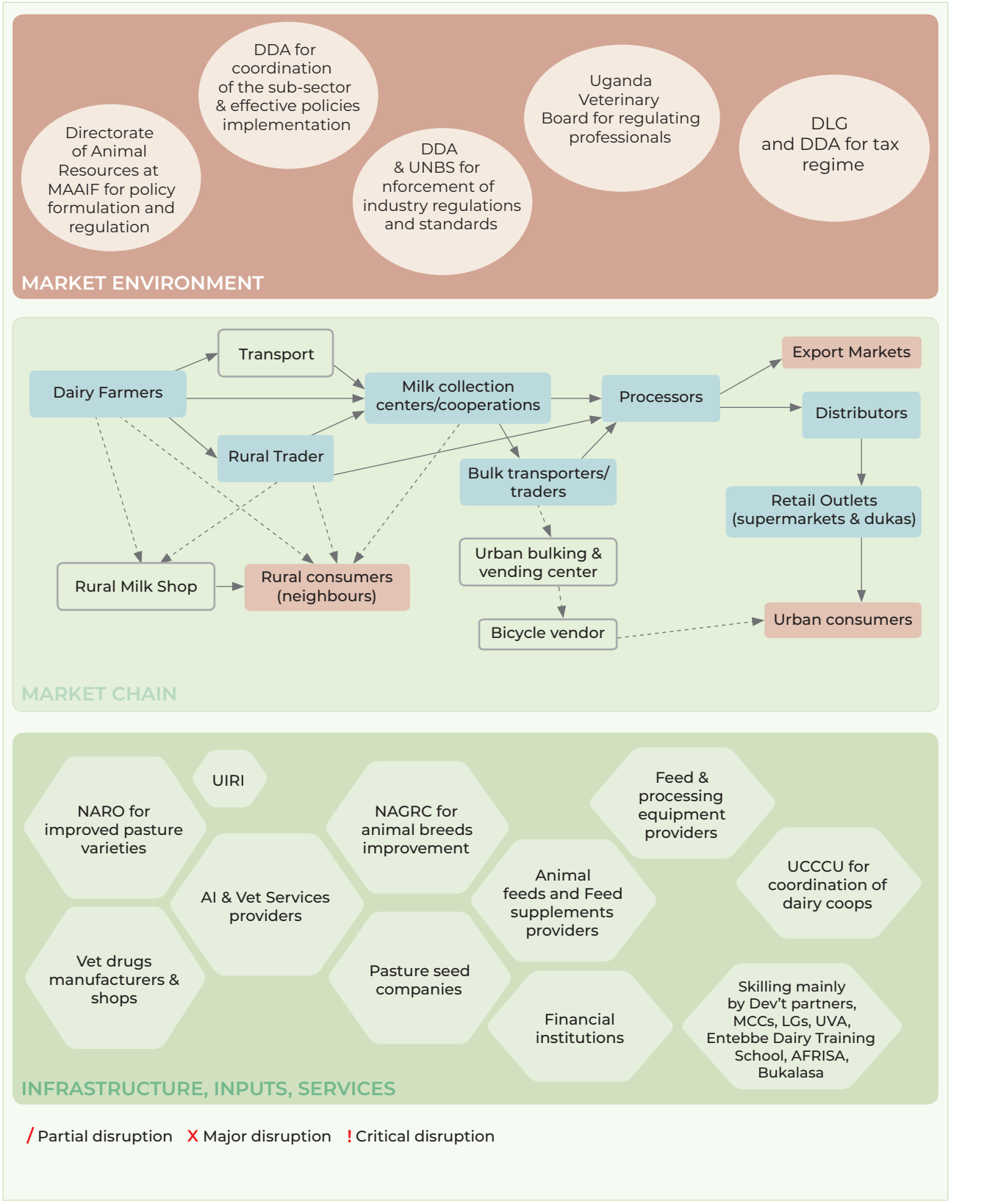


Figure 18: Dairy Market System Development Map in Uganda

4.2 Dairy Products Channels and Trade Flow

Generally, in Uganda, the milk and its products is marketed through two channels (informal and formal). Its estimated that out of the total produced milk volumes by different farmers, home consumption accounts for 19.8%, implying 80.2% is marketed (20). Most milk (66%) is marketed through informal channels (20). Under this channel, milk procured from farmers and goes through range of value chain operators (such as transporters, rural traders, milk shops, milk collection centres, bulk transporters and bulk urban vendors) to consumers without processing and proper packaging (21). In most cases, the only value addition is chilling and transportation. On the other hand, formal marketing channel involves processing of milk to value added products. This channel accounts for 34% of total marketed milk (20). The major players in this channel include farmers, rural trader, milk collection centres, bulk transporters, processors, distributors, urban consumers or export markets). However, recent study by Campenhout et al. (2019) seems to just a paradigm shift towards formal channel in South Western and Central milk shed due to emergence or dominance of export oriented dairy value chain and growing domestic demand for dairy products (9).

4.2.1: South Western Milkshed Product flow (Export oriented dairy value chain)

According to Campenhout et al. (2019), export oriented dairy value chain is mainly concentrated in Southwestern Uganda where most processing and exporting companies (such as Pearl Dairies Ltd and Amos Dairies) have been established. Milk flows through different actors to the final markets (Figure 19). The most predominant channel is represented by thick arrows. Compared to previous years, Campenhout report shows that more marketed milk from dairy farmers in Southwestern milk shed is channeled to processors, probably due to export oriented nature of the value chain, physical presence of processing facilities within production areas and the fact that there is high competition for raw milk supply. Fierce competition for raw milk in the southwestern milk shed, has made processors to be flexible to also procure from small rural traders, supplying as low as 8 litres. It is also worthy noting that there is significant raw/chilled milk consumption within production areas, where raw milk is marketed to neighbours. Milk collection centers are central in bulking and provision of cold chain services prior to transportation of milk to established processors (mainly within the same watershed). Only 17% of the aggregated milk at milk collection centres is sold to large traders who also supply processors, mainly Brookside Ltd in Kampala. This implies that there is limited trading of raw milk outside the milkshed. Majorly finished dairy products will be traded to export markets and major towns across the country. A few processors (Such as Jesa Dairy Farm Ltd and Brookside Ltd) are located outside the South Western milkshed.

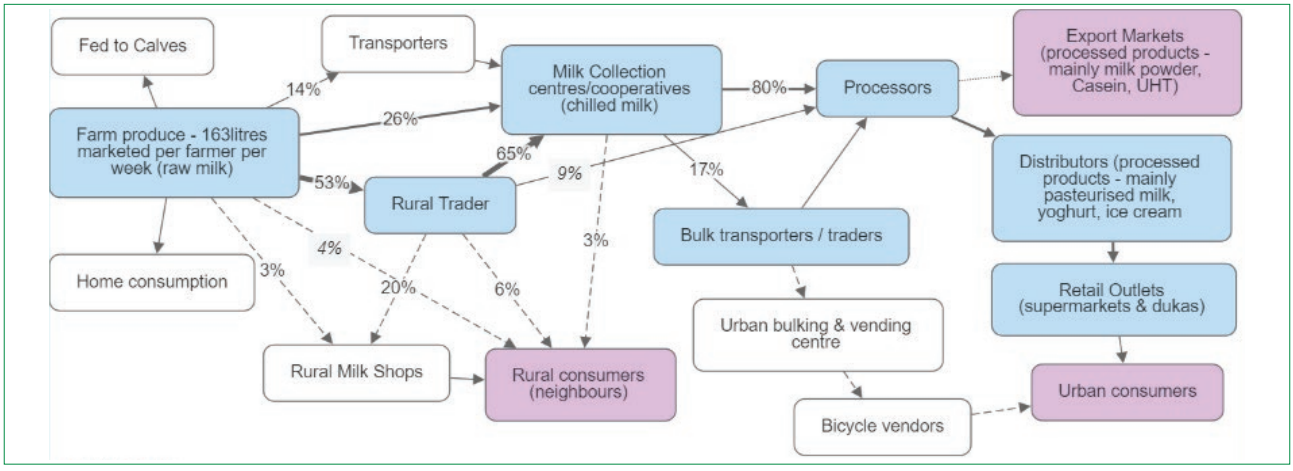
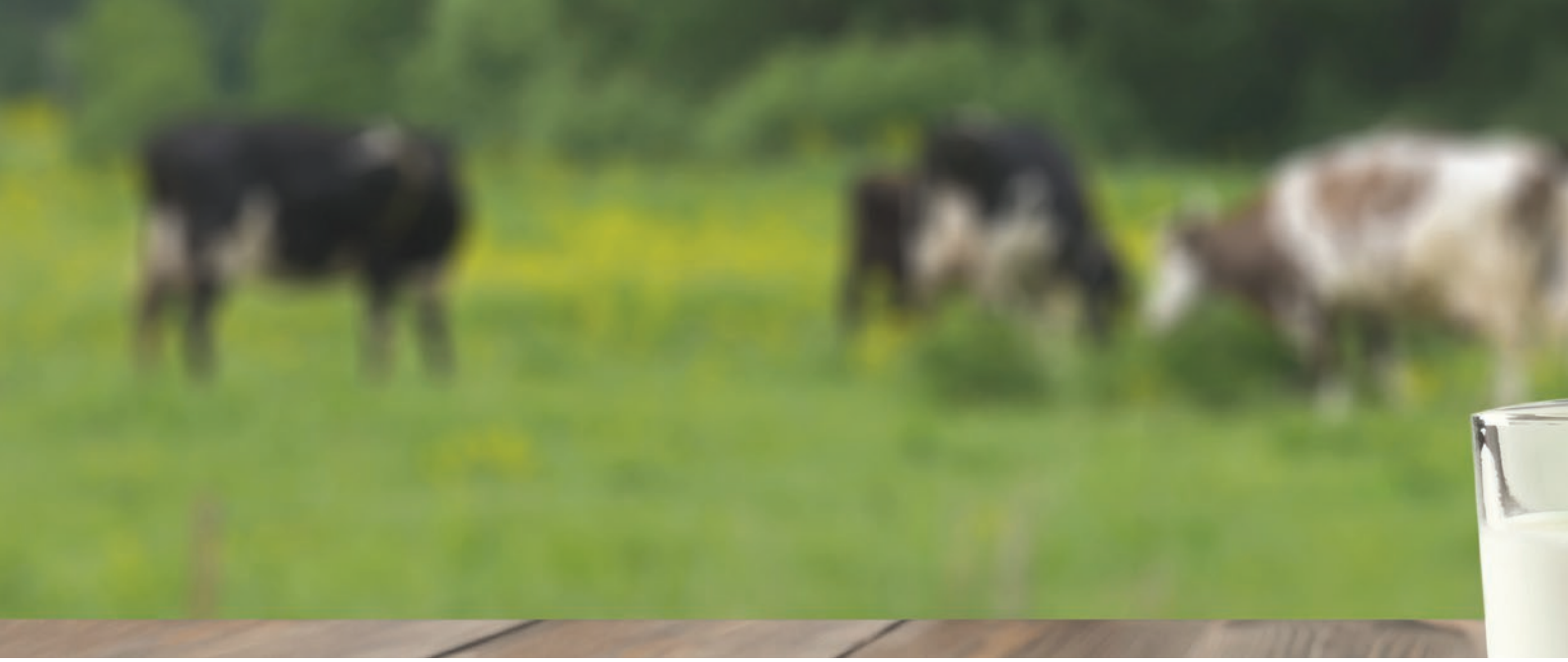


Figure 19: Export oriented dairy value chain map for South Western milkshed



4.2.2: Central Milkshed Product flow (Domestic oriented dairy value chain)

The remaining 5 milk sheds (apart from South Western milk shed) are mainly serving the domestic markets attributed to lack of necessary infrastructure (e.g. there are few or non-existent large and medium processing facilities which are export oriented). Just like South Western milk shed value chain, milk goes through several actors from the dairy farmer to end consumers. The actors remain the same though. What potentially changes are the proportions of milk that go through formal and informal channels. The largest proportion of milk in domestic oriented value chain is marketed as unprocessed milk. It is sold from dairy farmers, bicycle/motorbike seller, coolers and milk shops, mainly in cups, polythene bags and bottles in rural areas and local towns. Processed products are sold through local shops and supermarkets in major towns and greater Kampala. Recent study by Campenhout et al. (2019), also revealed a paradigm shift in marketing of milk in Central milk sheds towards formal channels as shown by percentages in figure 20 (9). Figure 18, shows the value chain map for central milkshed, which also reflect significant proportion of marketed volumes of milk passing through formal channel. This could still be attributed to the fact that Central region has the second largest processing capacity. The picture is different in other milk sheds with no large to medium processing facilities or cooling facilities, where up to 80% of milk goes through informal channels and traded as unprocessed and within the same milkshed. Only processed products are traded outside the milksheds.

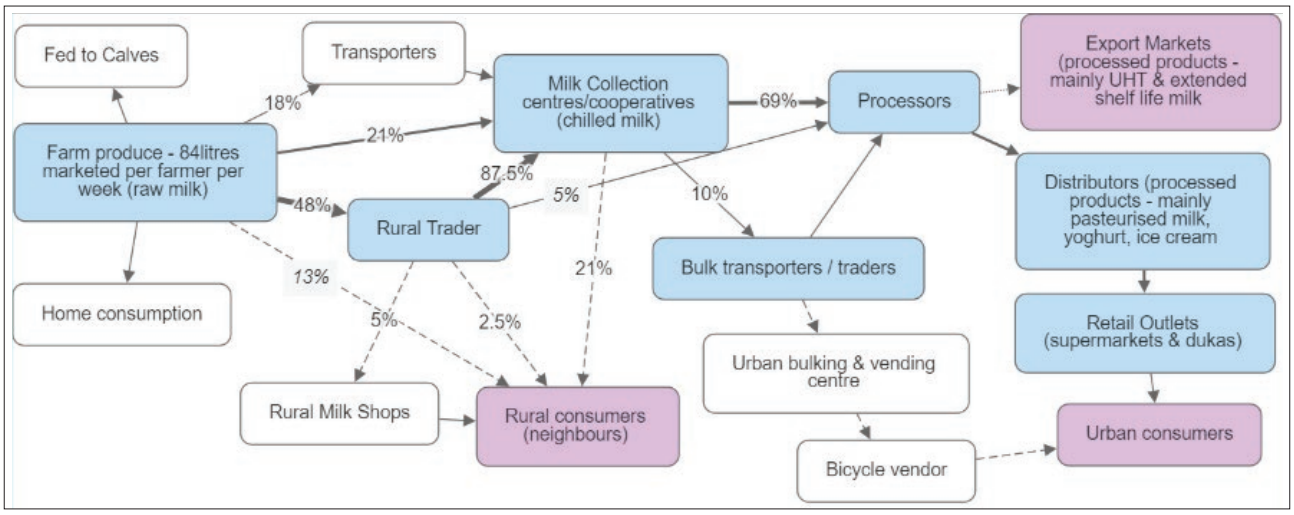


Figure 20: Domestic oriented dairy value chain map for South Western milkshed



4.3 Value Share Across Dairy Value Chain – not worked on – primary data

Value share analysis for milk value chain during dry season, shows that under formal channel (considering pasteurized value chain), the dairy processor received the highest share (35%) of the final price offered the consumer, they are followed by bulk transporter (21%) and rural trader/collectors gets the least share of the final. On the other hand under informal channel (where the final product is fresh or chilled milk), the largest value share (32%) goes to bulk transporter, followed by farmer (26%) and rural trader gets the least share (5%).

	Dairy farmer	**Rural Trader**	**MCC**	**Bulk Transporters**	**Processor –** *Pasteurised milk*	**Retailer**
Price received (UGX/ litre)	500	600	1,000	1,600	2,600	2,900
Market share (%)	17%	3%	14%	21%	35%	10%

	Dairy farmer	**Rural Trader**	**MCC**	**Bulk transporters**	**Bulk urban vendors** *of fresh milk*
Price received (UGX/ litre)	500	600	1,000	1,600	1,900
Market share (%)	26%	5%	21%	32%	16%

Figure 21: value share along dairy value chain – informal channel

4.4 Function mapping

Input provision	Production	Aggregation	Processing	Trading
AI service providers; pasture seed companies; Vet drug shops; Vet service providers; animal feeds & feed supplement providers; technology providers; ICT providers, cold chain equipment & packaging materials	Dairy farmers (individual and cooperatives)	Small traders, & transporters & milk collection centres (mainly run by cooperatives)	Small and large dairy processors	Distributors, wholesalers, & retailers (supermarkets, dukas & urban bulking centres)
▪ Supply inputs required by farmers for improved milk production ▪ Provide platform for dairy farm management ▪ Provide advisory services to dairy farmers	▪ Pasture production and conservation ▪ Milk production	▪ Bulk and chill milk for further transportation to the processors & consumer markets ▪ MCCs carryout milk quality assurance (often provide milk cans to farmers) ▪ Sell inputs such as feeding supplements & Vet drugs ▪ Provide vet services such as AI services ▪ Prefinance their suppliers and provide training on milk hygiene	▪ Secondary processing of chilled milk into value added products ▪ Distribution of value-added products to retail outlets ▪ Export dairy products	▪ Retailing of chilled (un-processed) and processed dairy products

Figure 22: Functions performed on each node

Key functions performed at different nodes of the value chain (that enable milk to move from producers to end consumer) are presented in Figure 22.

From the figure, its clear that bulking node (especially milk collection centres) have a big influence on performance of the value chain given other complimentary functions/services that come with bulking.

4.4.1: Production

Milk production has steadily been increasing for the past 5 years from 2.08 billion litres in 2015 to 2.81 billion litres in 2021 (20). Of the milk total production, its estimated that 80.2 - 82% is marketed by households, mostly from farmgate (20). Although in 2018, MAAIF and UBOS reported 50.9% of the 1,004 liters produced annually per household is milk marketed (21). Production occurs in six dairy regions (milksheds). These include south western, mid-western, central, eastern, Karamoja and northern milk shed (Figure 23). Close to 50% of annual production is contributed by South Western and Central milkshed (Figure 24). This could be attributed to differences in milk production potential, cattle numbers, market dynamics and dairy infrastructure among others (27). Most of the milk is produced by small-scale dairy farmers who own 90% of the national herd (31).

MAAIF and UBOS estimates that by 2019, Uganda had 14.8 million cattle compared (32) to 11.4 million cattle reported in 2008 livestock census. In terms of regional distribution, by 2008, 22.3% (2.5 million) was in the Western Region, 21.8% (2.5 million) was in the Eastern Region, 21.7% (2.5 million) was in the Central Region, 19.8% (2.3 million) was in Karamoja sub-region and the rest of Northern Uganda accounted for 14.4% (1.6 million cattle).

By 2018, 2.4 million households owned cattle. Highest concentration of cattle rearing households is in Eastern region (0.63 million households), while Karamoja region had the least number of households owning cattle (0.11 million) (33). Average herd size per cattle

raising household is 5 cattle, with variations among regions. According to livestock census report of 2008, Karamoja had the highest herd size per household (average of 21 cattle) and Eastern Uganda had the least (average of 4 cattle per household), mainly attributed to small landholding (33). However Campenhout et al (2019) study reported that herd size in South Western and Central milk shed was 34 and 31 cattle respectively.

Indigenous breed dominate the national herd size, accounting for 92.7%, the remaining proportion is shared between exotic or cross breeds (33). Among the indigenous breed, Zebu/Nganda breed is the most predominant (70.4% of total national herd) and Ankole breed account for 29.6%. The highest concentration of exotic or cross breeds is in the western region (i.e. 0.30 million cattle, representing 48.5% of total cross breed population), followed by central region. Of the total cross or exotic breeds, adult female dairy cattle account for 48.7% (33). The districts with the highest proportion of cattle owning households rearing exotic-diary or cross breed-cattle were: Bududa, Bushenyi, Kampala, Wakiso, Sironko, Jinja, Kapchorwa, Kabarole, Mukono, and Kiruhura. However, recent study by Campenhout et al. (2019) indicated improvement of dairy herd size composition, with South western milk shed having 87% of animals are of improved breeds (cross breeds) compared to 12.2% reported in the last livestock census. Central milk shed is also catching up with 45% of dairy animals being cross breeds.

By 2018, of the reported 14.8 million cattle, only 4.7 million were milking cows. The highest concentration of milked cows was found in western Uganda which explains the region's contribution to total milk production. While Northern Uganda had the least milked cows (33).

Dairy farming is mainly carried out under three production systems: (i) extensive production systems where small holder farmers own about 90% of all livestock which are under pastoral or agro-pastoral production systems in range lands. Cattle are fed on unimproved pasture without supplementary feeding, (ii) semi intensive production systems/semi-zero grazing, where cattle graze in paddocks or/and feeding them on improved pastures. It's largely practiced by farmers with exotic and crossbreed cattle. In order to increase production, dairy farmers have planted legumes, Napier/elephant grass, and Lucerne/alfalfa to supplement natural pastures, and (iii) intensive production system/zero-grazing where animals are confined in an enclosure and feeds or fodder, concentrates and water brought to them. This common in peri-urban areas such as Wakiso, Kampala and Mukono.

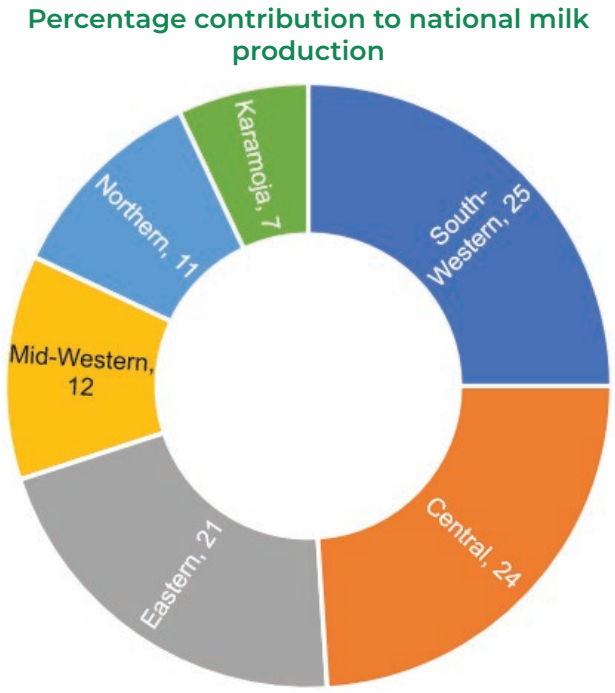


Figure 24: Percentage contribution of different milksheds to national milk production

Herd productivity varies with breed and management. Generally herd productivity is way before potential (i.e. 3 – 6 litres/cow/day against a potential of 22 – 40 litres/cow/day) as shown in Figure 25. Sub-optimal productivity is mainly attributed to:

Low genetic potential of breeds owned by farmers. The major challenges with breed improvement are: (a) the limited capacity/skills of the farmers to identify the right breed/bull with the right genetics. For most farmers, quality breed is mainly attributed to skin colour, (b) limited capacity of farm managers and workers to timely detect a cow on heat and (c) limited access to quality artificial insemination (AI) services and semen

Poor animal nutrition - Limited adoption of alternative technologies to conserve pastures (e.g., hay and silage making) and where commercial feeds exist on the market, it's of unauthenticated quality and expensive

Limited access to sufficient and clean water especially during dry spells which has been worsened by changes in weather patterns i.e. more prolonged dry spells. There are few valley dams and solar powered valley tanks to provide water for animals during dry season

Disease outbreaks such as foot and mouth disease. Pest and disease surveillance is still weak.

Limited knowledge & skills on dairy and farm management practices among farmers and farm workers which greatly affects the productivity potential

Apart from low cattle productivity, farmers are also grappling with low milk quality which result in 20 -40% post harvest losses (34) attributed to: (i) limited knowledge on good milking and handling practices among farmers, (ii) Intentional adulteration of milk by some farmers and aggregators which compromises final product quality, (iii) use of poor quality vessels during milking and milk transportation i.e. some farmers still use plastic buckets for milk and plastic jerrycans during milk transportation. This increases likelihood of microbial contamination since they are difficult to clean.

A study by Majalija et al. (2020) highlighted the different community practices that significantly contribute to milk quality deterioration in Nakasongola district (35) as presented in Figure 26.

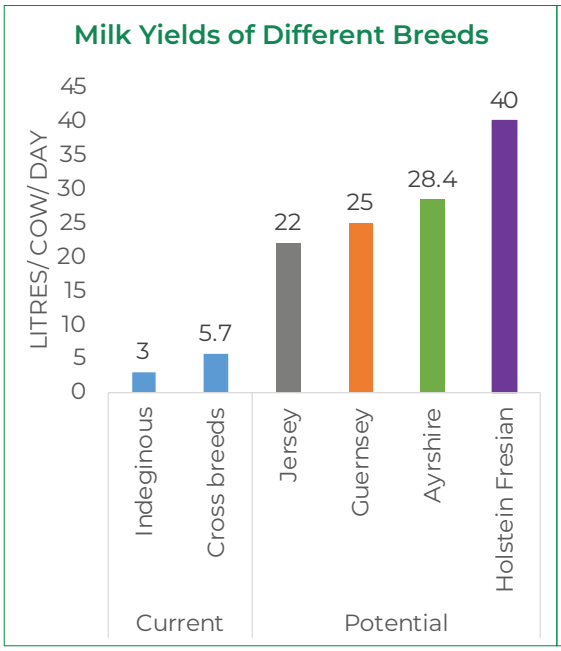


Figure 25: Milk yields of different breeds

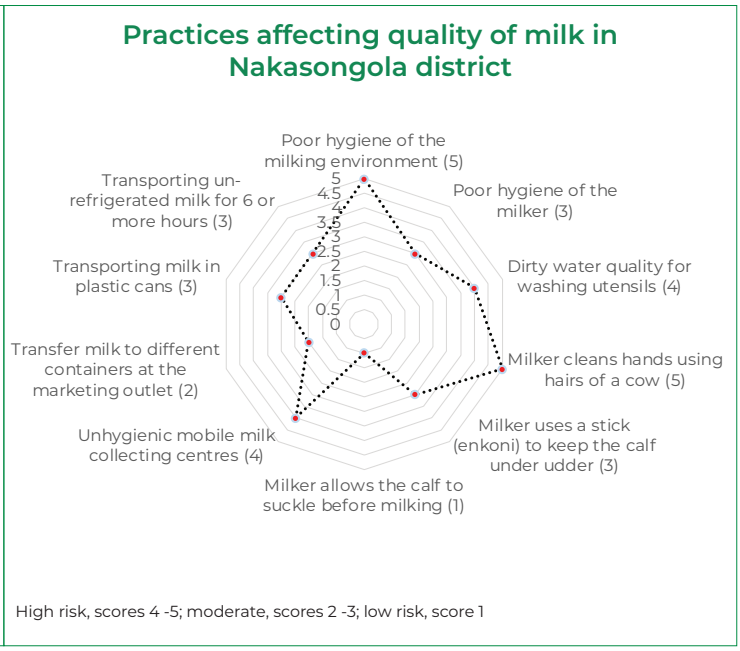


Figure 26: Practices affecting quality of milk

4.4.2 Transport and aggregation

Small scale rural traders play a critical role in aggregation and off-take of raw milk from dairy farmers and its transportation to central bulking/collection centres, processors or direct sale to rural consumers. Farmers mainly sell milk at farm gate to rural traders, although some milk is delivered either by known transporters attached to milk collection centres or farmers deliver by themselves. Rural traders handle 48 - 53% of milk marketed by farmers. For instance in South Western and Central Uganda, 53% and 48% respectively of milk to collection centers is delivered by rural traders (9). Apart from selling to milk collection centres, traders also sell some milk to milk shops and rural consumers.

From the farmers to collection centres, milk is transported using bicycles, motorcycles or small pick up trucks in jerry cans or aluminum tanks. Although it is illegal to use jerry cans, majority of dairy actors (mainly rural transporters and traders) still use them. The low adoption of aluminum cans could be attributed to high equipment cost. Adoption of aluminum tanks is highest in South Western Uganda at 58.8% (among traders and transporters) mainly because the value chain is more formal compared to other milkshed. Transporting milk using plastic Jerry cans increases incidences microbial contamination since they are difficult to clean thoroughly.

Milk is delivered to collection centre with cold chain facilities (milk coolers) within 2 -4 hours after milking given its high perishability (35). Milk is tested before cooling to -4 degrees Celsius to reduce spoilage and enzymatic activities. Thus, milk collection centers play a critical quality assurance function especially for formal channel as milk awaits further transportation (by bulk transporters) to processors. In most cases the minimum volumes transported by large transporters is 5,000 litres, thus milk is not always transported on a daily basis. During wet season, milk stays at collection centre for 1 - 2 days and 3 - 4 days during dry season. Some of the processors have invested in large transportation trucks, however there are several independent private sector players who have invested in mobile milk tankers to provide a service. Registered milk tanker with DDA by 2020 were only 164, while businesses running freezers were 190 (37).

Approximately 455 licensed milk collection centres with total national milk collection centre capacity of 2.21 litres per day against daily national production of 7.7 million litres exist (37). Highest concentration of milk collection centres is in South Western (accounting for 70% of the total installed capacity), followed by Central milk shed (Figure 27). Even with the limited cooling capacity, some centres operate at sub-optimal level, attributed to poor management, high operational costs since most cooling tanks use diesel powered generators to run cooling tanks, among other factors.

In South Western milk shed, milk coolers are owned by individuals or companies (46%) and farmer cooperatives (41%) followed by processors (12%), with government owning less than 1% (38). For milk collection centers run by farmer cooperatives, apart from bulking and chilling the milk, milk collection centres, are instrumental for service provision to dairy farmers to enhance loyalty, boost production and quality. For instance, milk collection centers provide: (i) soft loans to their suppliers/farmers, (ii) conduct trainings on milk production and hygiene, (iii) provide aluminum cans to suppliers, (iv) supply animal medicines and vaccinations, (v) supply feed supplements, (vi) offer veterinary services, (v) arrange transport for milk from farmers (9). This model presents promising results, if scale up can solve services access challenges faced by diary farmers.

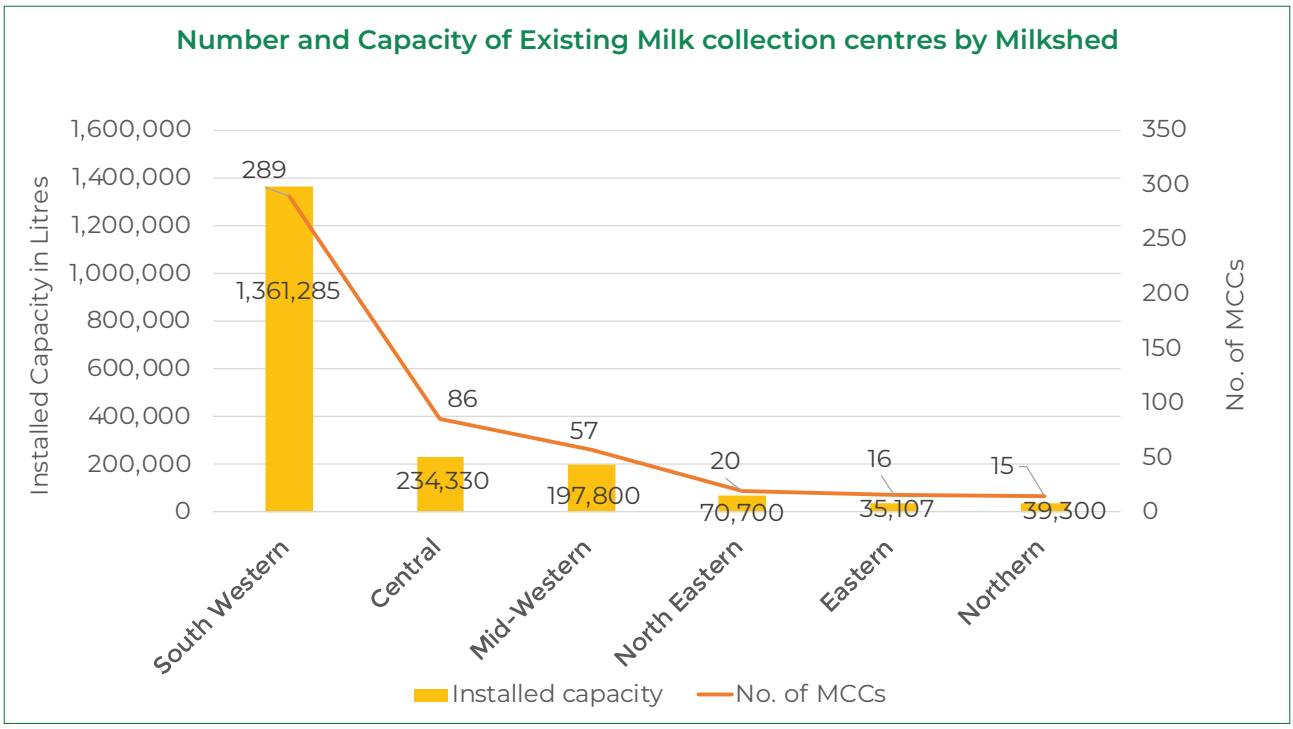


Figure 27: Existing DDA licensed milk coolers in Uganda

4.4.3 Processing

Approximately only 34% of marketed milk is processed in Uganda (20). The national installed processing capacity has increased from 2.72 million litres per day in 2017/18 (from 100 companies) to 2.89 million litres per day in 2020 to current 3.1 million litres in 2021 (from 116 companies) (37). By 2020, South western and central milk sheds account for 99.44% of total installed processing capacity. South western accounts for 71.03% (2,054,810 litres per day), central accounts for 28.41% (821,970 litres per day), northern account for 0.38% (10,900 litres per day), North Eastern account for 0.1% (2,815 litres per day), Eastern account for 0.07% (1,900 litres per day) and mid western account for 0.02% (550 litres) as shown in Figure 28

There are four types of milk processors in Uganda categorized based on the installed processing capacity i.e. large scale processors (with installed capacity between 65,000 litres and 800,000 litres per day), medium scale processors (with installed capacity between 3,000 litres and 24,000 litres per day), small scale processors (with installed capacity between 200 litres and 2,000 litres per day), and cottage processors (with installed capacity between 15 litres and 150 litres per day) (20). Of the total installed capacity, large scale processors account for 94.5% (2,735,000 litres per day), medium scale processors account for 4.3% (124,200 litres per day), the rest is shared among small and cottage processors. Only south western and central milksheds have investments in large scale processing (Figure 28). Northern, North Eastern and Eastern milk sheds only have small scale and cottage processors. In 2020, licensed processors were 33, of these 9 large scale processors, and 13 medium scale processors. Majority of the processing capacity is located in major producing areas i.e. in South western milksheds. A few processors such as Brookside are found in Kampala. Processing operations are regulated by Dairy Development Authority that certifies or licences all milk actors in the country.

Major processors include: Jesa dairy farm Ltd, Amos Dairies, Brookside, and Pearl Dairy Ltd. Major products processed include pasteurized milk, powdered milk , casein, cream; ice cream; yogurt, Cheese, UHT milk , ghee, and butter (Figure 29).

Processors are mainly supplied (with raw milk) by milk collection centres through large scale transporters. However with stiff competition (from other processors and informal channel),

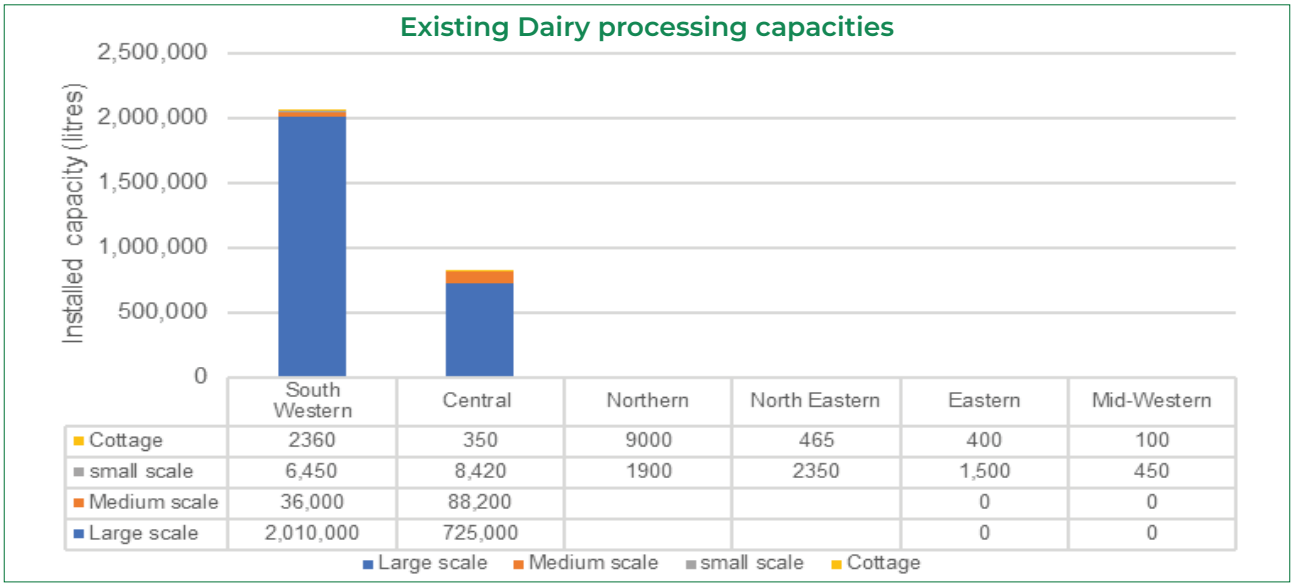
processors also procure milk in small volumes (as low as 8 litres) from rural traders (9). This is very common in South Western milk shed. The low supply of raw milk contribute to the under utilization capacity (at 40 -60%) of most established processing facilities (8). This implies that there is still room to absorb more milk from farmers to process high value products which can increase country's forex.

Apart from processing, some processors such as Amos Dairies, Pearl Dairies Ltd, Brookside ltd, Birunga Dairies Industries, Jesa farm dairy Ltd, Lakeside Diaries Ltd, Sameer Agriculture and Livestock Ltd, UNGA Group Ltd, GBK Dairy Products Uganda Ltd, and Ahmed Raza Foods Industries Ltd, also double as exporters or distributors of processed milk products to retailers.

On the upstream of the value chain, some processors have (i) invested in transportation trucks, (ii) provide credit financing, and (iii) train dairy farmers and MCCs on improved dairy production and milk hygiene to boost volumes and quality of raw milk procured for increased processing facilities utilization.

Generally, the processing node is constrained by: (i) limited compliance to good hygiene, safety practices and standards, (ii) limited processing skills and outdate technology, (iii) limited access to market information to guide future investments, (iv) high cost of power and access to portable water, and (vii) access to credit for both infrastructure and working capital.

With expansion of export markets, there is a huge potential for tapping into high-end and high value dairy products such as Whey, Casein, Butter and Oils, cheese and curd (39).



	South Western	Central	Northern	North Eastern	Eastern	Mid-Western
Cottage	2360	350	9000	465	400	100
small scale	6,450	8,420	1900	2350	1,500	450
Medium scale	36,000	88,200			0	0
Large scale	2,010,000	725,000			0	0

Figure 28: Existing dairy processing capacity in Uganda

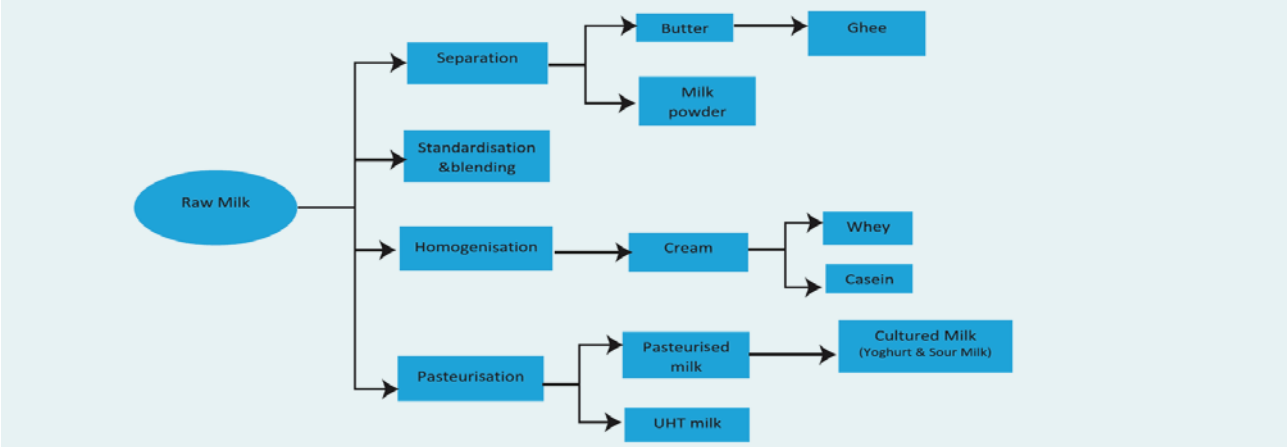


Figure 29: Dairy Products flow in Uganda (39)

4.4.4 Distribution (importers, exporters, wholesalers and retailers)

The main players at the distribution node are retailers (supermarkets and grocery shops located in major towns), hotels and restaurants, wholesale distributors and exporters for formal channel. However, informal channel which handles 66% of the marketed milk products (mainly raw milk) is dominated by bicycle or motorcycle traders/hawkers/vendors, urban cooling centers/milk coolers, shops and farmers (selling to neighbors). Under informal channel, raw milk is mainly hawked in jerry cans and a few mobile vendors use aluminum cans . Milk is sold to final consumer packed in polythene bags, using plastic cups and bottles as units of measure. The biggest challenge with this channel is adulteration (adding water) by traders and lack of cold chain facilities which result in high losses or spoilage.

For processed products, processors use different distribution models and engage different players to reach the final consumers (mainly middle class). The first business model is where processors have invested in distribution infrastructure (including refrigerated distribution trucks and depots) and human resource (marketing officers) to reach retailers (supermarkets and grocery shops) or retailers pick products from company depots. Jesa Dairy Farm Ltd has adopted this model. The second model is where private companies or individual distributors are given tenders to distribute products to different retailers (supermarkets and grocery shops) in defined markets. The distributor makes a deposit with the processors as security to have access to a certain value of products to be distributed. Distributors enjoy special distributor price and exclusive distribution rights for specific markets. However, its important to note that there processors who employ both models. For export market access, processors manage the distribution or logistics themselves.

Apart from locally produced dairy products, the country imports dairy products such as infant milk formulas, milk powder and cheese. The major imported brands for the different products are SMA, Nan, Cow&Gate, Similac, Isomil, Lactogen, and Enfamil (for infant milk formula), and Neste nido and Safa (for mild powder). The import products distribution channel is not so different from the local value chain i.e. integrates into local distribution system for processed products. Major importers of dairy products into the country run established warehouses, which are used to distribute products to supermarkets and Kikuubo market. Most retailers of imported dairy products pick the products from Kikuubo. Market. In total there are 38 licensed exporting and importing business by DDA in Uganda as of 2020 (37).



4.5: Dairy VC supporting Functions

In the dairy sector, input suppliers can be categorized into: (i) forage/fodder and feed supplement suppliers, (ii) Breed improvement service providers such as bulls and AI, (iii) suppliers of veterinary drugs and vaccines, (iv) equipment suppliers for production, post harvest handling, transportation and processing, (v) suppliers of processing additives and packaging materials.

4.5.1: Fodder and feed concentrates

Most of the milk in Uganda is produced from rain-fed natural pastures. A few farmers grow and preserve fodder crops (such as Napier and legume crops) for dry season. This explains sharp drop in milk output during dry spells because of decline in quantity and quality of pastures. However, farmers keeping improved dairy cattle are slowly learning to plant improved pastures/ fodder crops. Preferred types include grasses such as Panicum maximum, Pennisetum clandestinum, Chloris gayana, Bracharia brizantha; herbaceous legumes such as lab lab (Dolichos lablab), centro (Centrosema pubescens), Desmodium spp, stylo (Stylosanthes guianensis), siratro (Macriptilium atropurpureum), alfalfa or lucern (Medicago sativa), Chamaecrista rotundifolia; tree legumes mainly calliandra (Calliandra calothyrsus), leucena (Leucaena leucocephala), and gliricidia (Gliricidia sepium) as well as bulk forages, mainly Napier, Guatemala grass, Giant setaria, , forage sorghum and maize (40).

Under semi-intensive system (paddocking) common forage species grown by farmers include: Rhodes grass, Brachiaria ssp., Napier grass and Natural grasses and legumes. For extensive system (free range natural grass lands), Rhodes grass (Chloris gayana), Natural grasses and Brachiaria (Brachiaria ssp.) are the most grown. Lastly under intensive system (zero-grazing), Napier grass (Pennisetum purpureum) Maize (Zea maize) and Rhodes grass (Chloris gayana) are the most used forage (40).

Silage making is the preferred preservation method (67%) and hay coming second (28%). Hay is the preferred option for Rhodes grass and other natural pasture grasses incl. legumes (40).

However, supply of quality pasture seeds also remains another challenges with a few existing seed companies dealing in pasture seed (Table 2) and with limited last mile distribution networks. Lastly, access to silage micron bags for silage processing is a challenge and equally expensive

A few commercial businesses dealing in hay or silage do exist which also deter growth of this market. So trading is largely informal because where trading exist its mainly from medium and large farmers. Its also important to note that a few farmers have embraced hydroponics for fodder production.

According to Creemers and Aranguiz (2019), the five top most factors that hinder forage production and perseveration in Uganda include: (i) limited awareness, knowledge and skills on improved forage production,(ii) limited mechanization, (iii) Limited availability of forage seeds or plant material (iv) absence of a milk market and (v) financial constraints (40).

Feed concentrates/supplements use among farmers to supplement grazing is low or non-existent, amidst abundance of cereals and pulses in Uganda. Most of the available commercial feeds from feed suppliers are of unauthenticated quality and usually expensive. For the few farmers who use supplements, majority of farmers (56%) use feed ingredients such as maize bran alone without other ingredients for a complete or balanced ration. Thus, feed quality assurance remains a major challenge especially from small and cottage feed processors. Some of the prominent dairy meal or concentrates suppliers include: Koudijs, Mutima Feeds limited, Ugachick Feeds limited, Impala Feeds limited, Kuku Feeds limited, Nuvita Feeds limited and Biyinzika Feed Suppliers limited (41).

Table 2: Major forage companies and traded species in Uganda

Company	Type of organization	Forage seed
Simlaw Seeds Company	Private	Boma rhodes, sugar graze, nutrifeed, desmosium, lucern
East Africa Seeds (U) Ltd	private	Lucern
Rhino Seeds Africa Ltd	Private	Maize, sorghurm, Rhodes grass, napier grass, desmodium, cow peas, pigeon peas
National Forestry Authority	Government	Calliandra, Sesbania, Leucaena (trichandra)
NARO Holdings Ltd	Private	Rhodes grass . Desmodium, Lucern, Lablab, Napier grass, Branchiaria, Centrosema, Siratro
ROBRAN Holdings Ltd	Private	Branchiaria, Rhodes grass, Foxtail, kikuyu grass, guinea grass, napier grass, desmodium, lablab, alfalfa, centrocema, mucuna, Calliandra, Sesbania, Leucaena, Gliricidia

4.5.2: Breed improvement service providers

Although livestock breeding services are critical for improved herd productivity, access to artificial insemination (AI) services remains low among farmers. Its estimated that less than 5% of dairy farmers use AI services (9). Therefore, bull/natural service remains the main method used (42). However the challenge is the limited capacity/skills of the farmers to identify the right breed/bull with the right genetics. For most farmers, quality breed is mainly attributed to skin colour.

Suboptimal use of AI services is mainly attributed to: (i) few services providers which affects timely access, (ii) high cost and unreliability, (iii) AI purported to produce more bull calves than females, (iv) limited awareness among farmers about the benefits and access to AI services and (v) low conception rates i.e. farmers argued that with natural service, bull owners

did not charge money for repeat services which was not the case for AI (43), (vi) poor rural infrastructure such as nitrogen tanks and irregular supply of nitrogen to preserve the semen, (vii) shortage of trained AI technicians, and (viii) limited capacity of farm managers and workers to timely detect a cow on heat. Consequently, there has been rampant inbreeding that has resulted into herd depression manifested by a decline in production and productivity (44).

The role of providing embryos of superior quality from proven suppliers to improve genetics in Uganda rests on NAGRC&DB (a government agency under MAAIF). Specifically NAGRC&DB is responsible for leading commercialization of animal breeding activities in Uganda; carrying out development activities that enhance animal genetic improvement and productivity, and regulating import of genetic materials. However, NAGRC&DB has not been able to provide quality breeding stocks to farmers expectations due to loss of most stock and destruction/or poor management of farm infrastructure (44). Thus, there is a need to revitalize NAGRC&DB farms as centres of excellence to provide livestock feeds and demonstration of improved farm management practices to farmers.

With liberalization of semen importation and provision of AI services, a few private sector service providers (e.g. Wagaba Farms Ltd, Africa Breeders Service, World Wide Sires) do exist although with limited coverage.

However, its also important to promote improved breeds that are well adapted to climate, management and diseases. At times improved breeds perform worse than the cross breeds under current conditions. For instance, Friesians are not resilient to east coast fever.

4.5.3: Suppliers of veterinary drugs and vaccines

Major suppliers of veterinary drugs and vaccines include MTK Uganda Ltd, Global Vet (U) Ltd, Norbook (U) Ltd, Quality Chemicals Ltd, Coopers (U) Ltd, ERAM and many others. Most of the veterinary drugs are imported. Major suppliers distribute to last mile through a network of certified veterinary drug shops (by National Drug Authority) spread across the different milk sheds.

In the past, there has been a growing concern of counterfeit and fake veterinary drugs which has increased parasite or disease resistance and excessive use of drugs especially acaricides and antibiotics which are traced in milk (45). Most farmers mix different acaricides, use wrong formulations/quantities and frequently apply them which is causing tick resistance. Lastly a few farmers promptly and frequent deworm their animals to avoid disease outbreaks which ultimately increase milk production.

Generally, access to quality veterinary drugs is affected by limited last mile networks of the major drugs importers and wholesaler, which result in frequent stock outs; and lack of cold chains to stock vaccines

4.5.4: Equipment suppliers (for production, post-harvest handling and processing)

Major equipment suppliers at production include suppliers of chuff cutters for pasture and folder management; water pump suppliers, and constructors of water dams. With respect to chuff cutters, the major suppliers are BRAZAFRIC, and Engineering Solutions Ltd. Water pumps are mainly supplied by solar now. And most valley dams have been constructed by government through mechanization project run by MAAIF.

Most commonly used harvest and post harvest equipment include: (i) aluminum buckets

and cans or milking machines, (ii) cooling tanks and insulated mobile cooling trucks, mainly imported, (iii) milk testing equipment (such as lactometers) and reagents, (iv) processing equipment and additives are mainly supplied by Snowman Group, PROMACO Ltd, and many others.

4.5.5: Veterinary and extension service providers/skilling and Training

In Uganda veterinary service provision is liberalized and decentralized. Animal health service providers include government through district veterinary office, private sector, and livestock farmers themselves. Private sector players include veterinarians, paraprofessionals/animal health technicians and trained community based animal health workers. In most cases, government veterinary services (through district veterinary officers, MAAIF, NARO, and NDA) are limited to vaccination, tsetse control, disease surveillance, enforcement of drug related policies and trainings (mainly in collaboration with NGOs). However, their services are insufficient and normally inconsistent, which could be attributed to limited funding and human resource, staff absenteeism. This partly contributes to inadequate regulation and supervision of private sector players (46).

Some of the private players, especially veterinarians and animal health technicians also run drug shops. They are mainly involved in procurement and distribution of veterinary medicines, clinical diagnosis and treatment, vector (tse tse and tick) control, breeding services and vaccination activities. Access to veterinary services is affected by few existing trained veterinary service providers and where they exist the scale is limited.

However, a few ICT based farms like Juguza app have come up to provide farm management platforms and advisory services to dairy farmers using mobile phones. SNV through TIDE-II project, working with different private sector players has also introduced has three digital tools for dairy advisory and extension services. For example, Rumen8 is a computer based diet formulation ration balancing tool that supports dairy farmers to increase margin-above feed costs by optimising cow rations for different cow groups; E-Dairy platform developed by ZED Africa provides visualised training and instructional materials at three levels (farmer, lead farmer and extension worker); and Dairy Competence Builder (Vet Effect) used to build capacity of cooperative extension workers on planning and training. (47)

Capacity building of veterinary professionals is mainly conducted by Makerere University College of Veterinary Medicine, Animal Resources and Bio-security (COVAB), Bukalasa Agricultural College and Arapai Agricultural College.

4.5.6: Information

Value chain actors mainly receive information through mobile phone and radios. Majority of the information is accessed for fee. The information shared along the value chain is mainly on milk prices, and extension. A few private market information providers exist. These include Farmgain, Infotrade and many others. Information they normally provide is related to prices and its access is mainly subsidized by NGOs.

4.5.7: Finance

Access to financing remains low within the dairy value chain. For instance Campenhout et al. 2019 reported that only 9% and 20% of interviewed farmers in central and South Western watershed respectively had taken loans to invest in their dairy businesses (9). On the other hand 21% of traders and transporters reported to have accessed loans in south western milkshed, while 12.4% were reported in central milk shed. Value chain actors mainly obtain financing from village savings and loans associations (VSLA), friends and family, banks and cooperatives (milk collection centres). Prominent financial institutions providing credit to dairy sector include Uganda Development Bank Limited (UDBL), Microfinance Support Centre (MSC), and DFCU Bank. However, their no tailored financial products targeting the dairy value chain.

Credit accessed by dairy farmers is mainly used to treat animals (44%) or buy improved cows (34%) (9). While traders used the money to buy more milk from farmers (30%), buy motorbikes (27%) and some indicated that they used the money to buy cows, implying that some traders are farmers themselves.

4.5.8: Research and Development

Mandate to develop new livestock (including dairy) technologies in Uganda lies with National Livestock Resources Research Institute (NaLIRRI). NaLIRRI is one of the 6 research institute under the National Agricultural Research Organisation (NARO) which focus on livestock and apiculture research. Key activities conducted at NaLIRRI include development of livestock vaccines and disease diagnostics, livestock breeding, the ethno-veterinary research, livestock feed and food safety, forage breeding and agronomy, the development of strategies for the control of diseases, parasites and vectors, ration formulation and evaluation and improving the diagnostic capacities and control strategies of the brucellosis disease (47).

However, NALIRRI's performance has remained sub-optimal because of lack of expertise especially to develop vaccines, lacks equipment and facilities and limited commercialization of developed technologies. This could explain reliance on importation of vaccines.

4.5.9: Rural Infrastructure

State of rural infrastructure has a big bearing on the efficiency of the value chain. Generally, there has been considerable improvement in the state of rural roads which has helped dairy farmers and traders transport their milk to milk collection centres for marketing. However, apart from roads, electricity, clean water, dug kits, milk and feed testing kits, semen preservation systems, processing facilities, cooling centres, ICT infrastructure are equally critical for growth of the value chain.

4.5.10 Value chain relationships /VC Governance

Dairy value chain consists of both vertical and horizontal linkages. Vertical linkages ensures product flow from the farm to the end consumer and most of these linkages are informal. Few or no processing firms have contracts with farmers, rather transactions are based on mutual trust. At national or regional level, there no umbrella organisations/vertical associations/ platforms that bring all the different categories of dairy value actors together to address sector challenges and advocacy.

However, horizontal associations at processing, trading and production nodes do exist mainly for advocacy and maximizing economies of scale (in case of farmer associations). Existing business membership associations at national level through which DDA engages with private sector include:

- Uganda Crane Creameries Co-operative Union (UCCCU) is the national umbrella body or tertiary cooperative for dairy co-operatives in Uganda. UCCCU is active in the 12 districts of South and mid -Western Uganda with total of 140 subscribing primary cooperatives and 10 district unions. UCCCU's members produce over 700,000 liters of milk daily, collected at 140 collection centers across south western Uganda. UCCCU has also invested in 10 milk tankers and 120 coolers (48). Working with different development partners, UCCCU supports its members to increase productivity through increased extension access, institutional capacity development of member cooperatives, market and financial access.
- Uganda Dairy Processors Association (UDPA), formed in 2003, brings together large medium and small scale dairy processing companies. UDPA is the national voice of the dairy processing industry, representing the public policy and regulatory interests of Uganda's dairy processors.
- Uganda National Dairy Traders Association (UNDTA) is mainly for traders (such as transporters, cooling operators, farmers, and vendors) that are involved in procurement and marketing of raw milk. Apart from traders, UNDTA's membership also consists of small processors and farmers. UNDATA now has more than 1,000 members and handles more than 300,000 litres of milk per day (48). UNDATA promote, manage, and upgrade operations, including the collection, transportation, and marketing of quality dairy products in Uganda and to export markets.

At regional or district level, farmer cooperatives do exist especially in South Western milk sheds are most of these run the milk collection centres. However, generally all existing national or regional membership associations are weak and for some, members are unaware of their activities. Some of the associations have failed mainly because of governance and management challenges.

Apart from dairy actor associations, there are a few support associations in place such as:

- Uganda Veterinary Association (UVA) – a voluntary organization which brings together veterinary professionals advocating for the highest professional standards, integrity, ethics, and service with focus on improving animal health, productivity, welfare, and the livelihood of the community.

Generally, processors and milk collection centres seem to be the glue of the value chain with powers to influence prices.

4.6.1 Development Partners

Generally, there are few on-going and past development investments in the dairy sector in comparison with other key agricultural sectors like cereals. Apart from active development partners in the Dairy value chain presented in the table below, in the past the following development partners (though do not have active projects now), have had a significant contribution to dairy sector growth. These include: Send a Cow, Heifer International through the East African Dairy Development (EADD I & II).

Table 3: Active development partners in the Uganda

Development Partner & size of project	Geographical area	Ongoing Interventions	Period
aBi Development Ltd	• Kampala • Kiboga district	• Alfasan Uganda Ltd for production of quality and affordable veterinary medicine (including acaricides, and vaccines), and train and increase awareness on veterinary drug use in the market • Project with Jesa Farm Dairy to establish milk coolers and training farmers in improved dairy management.	2017 - 2020
SNV – The Inclusive Dairy Enterprise (TIDE II) project (49)	Western (Bushenyi, Ibanda, Isingiro, Kamwenge, Kazo, Kiruhura, Lwengo, Lyantonde, Mbarara, Mitooma, Ntungamo, Rukungiri, Rwampara and Sheema districts)	• Skilling in improved dairy management • Sustainable forage intensification including promoting on-farm pasture improvement and forage crop production and preservation • Supporting agricultural contracting models for fodder production intensification on farms • Enhancing access to commercial finance for farmers through their cooperatives • With GoU, piloted processor led school milk program to expand domestic milk products market	Jan 2020 – Dec 2023
IFC and Global Agriculture and Food Security Program (GAFSP) Private Sector Window	Mbarara	• Investment of $8 million in Pearl Dairy establish a milk processing plant, milk collection centers and cold-storage infrastructure. • Training of 50 dairy development executives, who are now providing guidance to 500 farmers on techniques to enhance productivity and implement good agricultural practices	2017 -
Heifer International • EAYIP project • Jinnai Dairy Development Pilot Project (JDDP)	Kiboga and Kyankwazi Gulu and Omoro	• Promoting agri-hubs • Test a dairy micro- leasing model	2016 – 2021 2016 - 2022

4.6.2 Government projects (on-going and pipeline – NDPIII)

A few dairy development projects have been implemented in the past such as livestock disease control project and Regional Pastoral livelihood Improvement Project (its covers other livestock apart from dairy). However, dairy sector is support through DDA vote and NAADS. Over the past few years, the following has been implemented by government towards the development of the sub-sector: (i) strengthening capacity of DDA to execute its mandate, (ii) installation of milk collection/cooling centres, (iii) human capital development through establishment of Entebbe Dairy Training School, (iv) training of different value chain

actors, and (v) herd genetic improvement through distribution of in-calf heifers. Within NDP III, projects concepts/ideas under consideration which contribute to dairy sub-sector development include: Relocation and Operationalisation of the National Livestock Resources Research Institute (NaLIRRI) from Tororo to Maruzi; Dairy products value chain development project; and Enhancement of capacities for pests, vectors and diseases management project. (Domestic Production of pesticides, acaricides, herbicides)

4.7: Enabling Environment

4.7.1: Institutional, policy, legal and business environment

There are several existing supportive policy frameworks to guide development of the dairy sector such as vision 2040, National Development Plan III, laws, regulations and policies.

Development of the sector is guided by National Development Plan III (2020/21 – 2024/25) which priorities agro-industrialisation, export promotion and private sector development strategies for increased commercialization and competitiveness of agricultural production, agro-processing, and export of selected agricultural commodities (including dairy). Other strategies influencing dairy sector include: (i) livestock development strategy and (ii) animal disease control strategy.

At sectoral level, the Agriculture Sector Strategic Plan (ASSP) of 2020/21 – 2024/25 guides the development of agriculture (including livestock). Key planned investments highlighted in the ASSP for the development of livestock sector (dairy inclusive) are:

Specific policies that guide dairy development and livestock sector as a whole include; (i) The National Policy for Delivery of Veterinary Services which covers clinical services, tick and tsetse control, veterinary pharmaceuticals and diagnosis, trade, veterinary public health, and animal welfare. The policy highlights the role of government in conducting regular testing to detect diseases, surveillance and monitoring of diseases (including zoonoses), management of outbreaks and regulation of diagnostic laboratories by MAAIF, (ii) National Veterinary Drug Policy which addresses veterinary services provision. Specifically, it addresses supply (manufacture, procurement, storage, distribution) of quality drugs, legislation and inspection of veterinary drugs, and supervise the licensing of veterinary drug outlets, (iii) National Animal Feeds Policy of 2005 that provides a framework for managing and regulating animal feeds industry and (v) the Antimicrobial Resistance National Action Plan (AMRNAP) (2018– 2023) which provides guidelines for awareness creation and control of anti-microbial Resistance - AMR (50).

Policies are supplemented by 6 acts i.e. (i) Animal Diseases Act which relates to management of animal diseases, (ii) Animal Breeding Act, 2001 which established the National Animal Genetic Resources Center and Data Bank, to promote, regulate, control, market, import, export, and quality assurance of animal and fish genetic materials, (iii) Dairy Industry Act of 1998 which established Dairy Development Authority (DDA) to promote and control production, processing and marketing of milk and dairy products, (iv) Food and Drugs Act Chapter 278 which highlights provisions for prevention of adulteration of food and drugs (v) Veterinary Surgeons Act which makes provision for registration of practitioners of veterinary surgery and for other matters connected with and incidental to the practice of veterinary surgery, and (v) Cattle Traders Act which makes provision for the licensing of cattle traders, i.e. any person engaged in the business of purchasing cattle for the purposes of resale or slaughter.

Policy reforms within the dairy sub sector has resulted into its rapid transformation. DDA, an entity established by act of parliament (Dairy Industry Act, 1998) and one of the eight agencies under Ministry of Agriculture Animal Industry and Fisheries - MAAIF, is responsible creating an enabling environment for dairy sector development and its regulation in a sustainable manner. DDA is supposed to: (i) register and license milk processors and traders; (ii) support dairy farmers' marketing organizations; (iii) advise Government on milk standards and coordinate the enforcement of those standards in liaison with the Uganda National Bureau of Standards; (iv) control and regulate dairy and dairy-related import and export activities in conformity with the External Trade Act, but without violating the Animal Diseases Act; (v) implements Government policy designed to promote the development of the dairy sector; (vi) support various dairy development activities such as dairy extension, dairy breeding, dairy research, dairy training, dairy products development and general market promotion, including promotion of dairy export(s); (vii) Act as arbitrator in any conflict between dairy companies and processors; (viii) Coordinate all dairy processing and marketing promotional activities, such as seminars, trade fairs and workshops; (ix) Pool dairy processing and marketing data; (x) Advise the Government on research priorities of the dairy sub sector (51).

In addition, under MAAIF there is a Directorate for Animal Resources (DAR), whose objective is to support sustainable animal disease and vector control, market oriented animal production, food quality and safety; for improved food security and household income. The directorate has three departments: (i) animal production, (ii) animal health and (iii) entomology.

Other critical support agencies to the dairy sector include:

UNBS – formulate, promote and enforce use of dairy products standards

UIRI – for new milk products development and commercialization

Uganda Veterinary Board – established by act of Parliament (The Veterinary Surgeons Act 1958, Cap 277) whose mandate is to ensure that animal health services are offered by qualified, registered and licensed veterinary professionals under its regulatory supervision. Board's activities are not limited to registration of professionals and their premises of practice; establishment of standards for training, practice and professional conduct of veterinary professionals; provision of guidance and support for continuing professional development programmes and community education.

National Drug Authority (NDA) – licenses and regulates veterinary medicines and supplies, in addition to inspection/monitoring of drug shops.

National Animal Genetic Resources Centre and Data Bank (NAGRC&DB) - established by the Animal Breeding Act, 2001 is one of the statutory semi-autonomous bodies of the ministry of Agriculture, Animal Industry and Fisheries (MAAIF) mandated with improvement and commercialization of animal genetic resources

National Agricultural Research Organisation (NARO) - Apex body, established by an act of Parliament in 2005, that coordinates all agricultural research activities in the NARS in Uganda. Livestock research is coordinated by National Livestock Resources Research Institute – NaLIRRI, Tororo (one of the NARS), whose mandate is to carry out research on livestock diseases and technologies. Once technologies are implemented by NALIRRI, they are passed on to MAAIF for implementation. However, NALIRRI's performance has remained sub-optimal because of lack of expertise especially to develop vaccines, and lacks equipment and facilities. This could explain reliance on importation of vaccines

District Veterinary Office – which is directly under MAAIF is responsible for regulating and supervising veterinary activities in the district, provide technical support to different stakeholders, report disease outbreak to the ministry and lead vaccination campaigns

From the above analysis, its clear that the country has sufficient laws, policies and strategies to transform the sector, what is need is to update some laws that might be outdated (e.g. cattle trading act, 1943), increase funding to the sector, ensure effective implementation of existing laws (for example prevalence of adulterated inputs/vet drugs and poor quality animal feeds due to weak regulation of agro-inputs market). Adulterated vet drugs could explain mixing of acaricides by farmers and excess use of antibiotics

4.7.2: Dairy rules, regulations and standards

To effectively regulate the industry, DDA developed the "The Dairy (Marketing and Processing of Milk and Milk Products) Regulations, 2003", Statutory Instruments No. 26 of 2003 (26) and as amended in 2006 and 2015 (37) which: (i) allows DDA to register and accredit all dairy operators in the country, (ii) DDA to support and facilitate dairy processing firms and milk traders to implement Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Points (HACCP) and to comply with the requirements for International Standards Organisation (ISO) certification, (iii) ban use of plastic receptacles/equipment for handling/ transporting milk which is very common under informal channel

In summary, the Dairy (Marketing and Processing of Milk and Milk Products) Regulations, 2003 focuses on (i) processing of milk or milk products, (ii)) marketing of milk or milk products, (iii) operating of a factory in which milk is processed or is intended to be processed, (iv) controlling a store used or intended to be used for storage of milk or milk products, (v) the business of transportation of milk or milk products and (vii) dealing in dairy equipment

To promote hygienic practices at all levels, DDA and UNBS developed code of hygienic practice for milk and milk products which gives guidance on: (i) milk production i.e. looking at environmental hygiene, nature of premises, animal care, milking and milk handling equipment, health and hygiene of handlers, hygienic milking practices, collection, storage and transport of raw milk; (ii) Handling and processing facilities i.e. nature of premises, facilities and equipment, personnel, maintenance and sanitation, pest control and waste management; (iii) control of operations i.e. hazards control, hygiene control system, incoming material requirements, processing, packaging, laboratory control, management, supervision, documentation and records, recall procedures, transportation, product information and consumer awareness; and (iv) Sale of milk and milk products i.e. provides provisions/ requirements for vending outlets, health and hygiene of vendors, as well as transportation and selling of milk and milk products

UNBS and DDA have been instrumental in development of different milk products standards which have been harmonized and adopted at EAC regional level to increase market access for Ugandan products. Some of the applicable standards include (52):

US EAS 67:2019 - specifies requirements, sampling and test methods for raw cow milk.

US 163: 2019 - specifies the hygienic requirements for production, handling, processing, storage, transportation, marketing, distribution and sale of milk and milk products

US EAS 49:2019 - specifies requirements, sampling and test methods for milk powders and cream powder intended for direct human consumption or for further processing.

US EAS 69:2019 -specifies requirements for pasteurized milk

US CODEX STAN 221-2001 -applies to unripened cheese including fresh cheese, intended for direct consumption or further processing.

These have been harmonized at EAC regional level to facilitate trade. However full adherence by value chain actors remains a challenge as witnessed by recent ban of Uganda's dairy products by Kenya on account of not meeting standards.

4.7.3: Other legal instruments governing the sale of milk and milk products

Other important legal instruments governing the sale of milk and milk products include the Public Health (sale of Milk and Milk Products) Rules, and Kampala City (Sale of Milk and Milk Products) Ordinance (27)

4.7.4: Operating Licenses and Fees

Dairy Development Authority (DDA) requires all individuals and companies intending to undertake dairy related businesses to register and to pay annual registration fees. Fees vary with the nature of business and can be obtained from DDA offices. On a regular basis, DDA carries out inspections of all facilities used to handle and/or process milk.

DDA licenses businesses in line with the Dairy (Marketing and Processing of Milk and Milk Products) Regulations, 2003 and as amended in 2006 and 2015. In 2020, 880 businesses were registered and licensed countrywide. Of these, 164 were milk tankers, 455 were cooling premises, 38 were exporters or importers, 190 were freezers, and 33 were processors. However, because of the prevalence of informal channel, most businesses are not licensed (37).

4.8: Employment along dairy value chain

There is no specific study on labour markets in dairy value chain, especially given its informality. However, the dairy sub-sector is among the strategic sub-sector with immense job creation potential directly or indirect through support subsectors. Several people are employed at (i) production (with estimated 1.663 million households owning cattle) as family workers or hired labour (given that its labour intensive), (ii) trading where majority are involved in rural milk aggregation and transportation, (iii) processing where several people especially women and youth are employed in processing facilities, and (iv) at distribution and retailing of value added products. For instance dairy cooperatives with coolers employ between 3 -4 full time employees (9) and dairy processing plants employ between 10 and 50 full-time workers (27)

Apart from direct job creation potential within the value chain, dairy has a strong multiplier effect to other support sub-sectors. For instance there are several people employed in (i) manufacture and distribution of veterinary drugs, (ii) provision of veterinary services, (iii) manufacture and distribution of milk processing additives and packaging materials, (iv) manufacture of production and processing equipment, (v) in regulation and quality assurance and many others. More untapped potential exist in virgin areas such as pasture production, animal feeds and concentrates, ICT for dairy farm management and many others.

4.9: Return on Investment along Dairy value chain

4.9.1: Gross margins along dairy value chain in Kyegwegwa district

Profitability analysis along dairy value chain as conducted by World Bank in Kyegwegwa district (2020) shows that (53):

A dairy farmer level a gross profit of UGX 279,625 from each Ankole cow per year kept under free range system. This increases to UGX 369,750 from each Ankole cow per year if the production system is changed to a paddocking system on a 0.25 acre land. While adoption of improved breeds (cross breeds) under paddocking system with moderate animal husbandry practices increases the profit to UGX 959,000 per cow per year (Figure 31). If cross breeds under paddocking system are supplemented with pastures, profitability increases to UGX 4,117,600 per cow per year. However, changing production system for improved breeds (cross breeds) from paddocking to zero grazing reduces profitability to UGX 4,006,400 per cow per year

Milk coolers and retailers of fresh milk each make a gross margin of UGX 300 per litre (figure 32).

At processing level, large processors producing UHT milk and milk powder make a gross profit of UGX361 per litre and UGX 325 per litre respectively. Ghee processors earn the most profit of UGX 1,300 per litre (Figure 32)

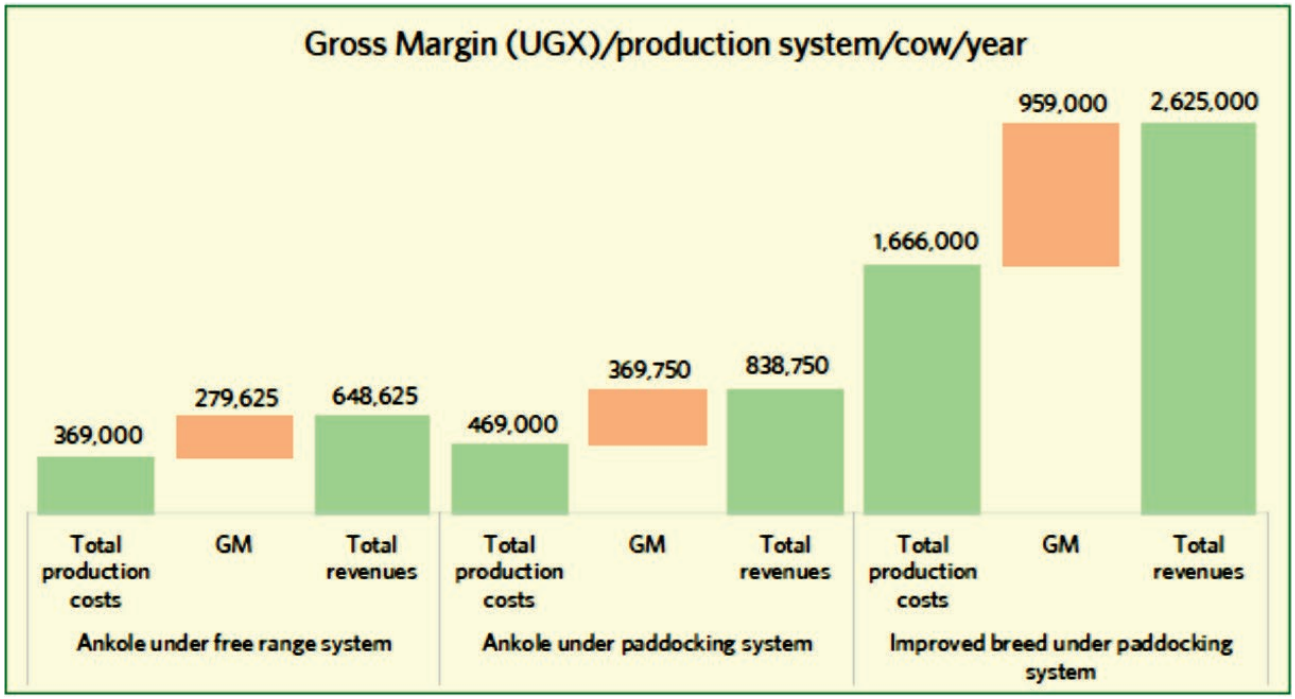


Figure 31: Farm level gross margins in UGX per cow per year (adopted from World Bank, 2020)

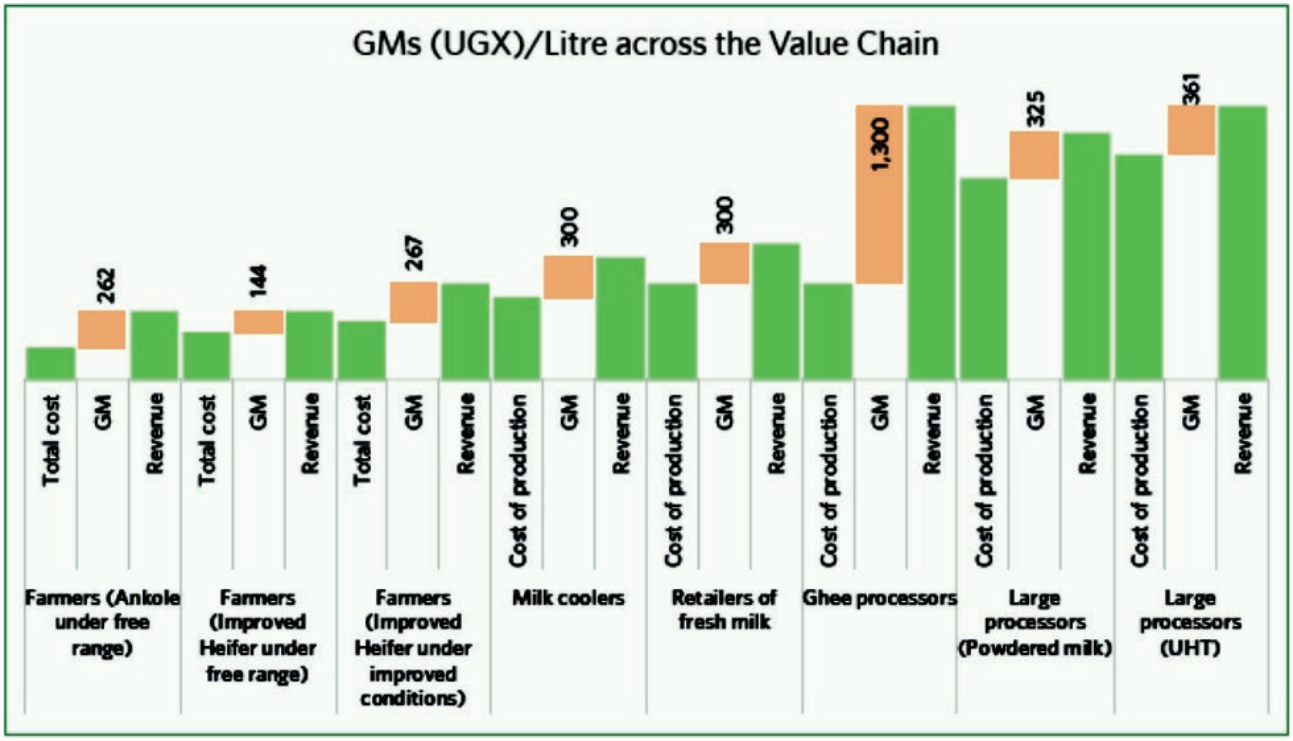


Figure 32: Gross margins in UGX/ litre across the dairy value chain (adopted from World Bank, 2020)



5. Attractiveness of dairy Value chain in Uganda

Porters five forces of dairy value chain in Uganda

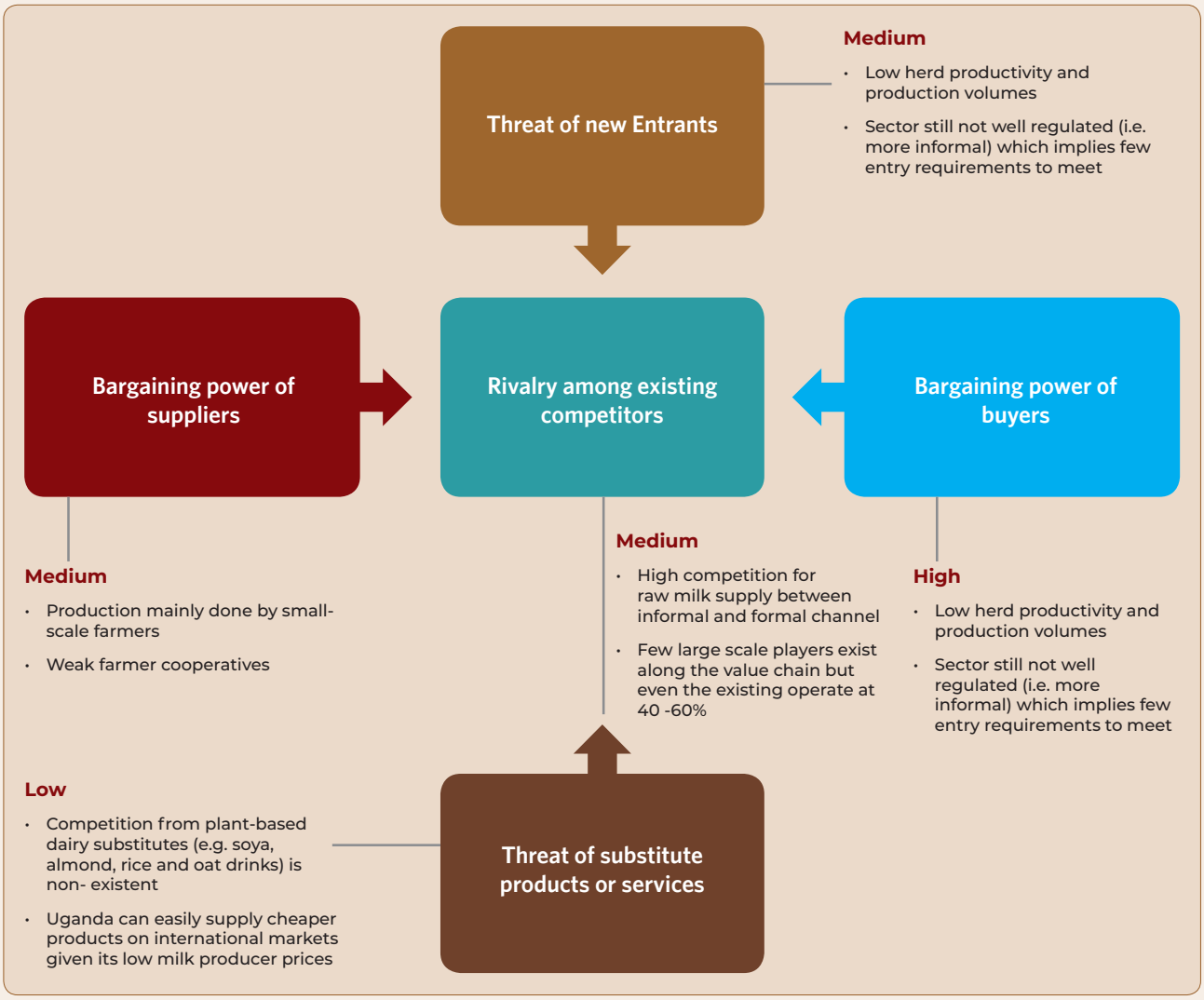


Figure 33: Dairy sector attractiveness in Uganda



6. PESTLE ANALYSIS

Table 4: PESTLE analysis of the diary subsector

	Political	Economic	Social	Technological	Legal	Environmental
Positive	• Dairy is among the 10 prioritized value chains in Uganda • Dairy sub-sector development is institutionalized with supportive frameworks and policies • Existence of regional trading blocks(such as COMESA & EAC) which Uganda is a member that allows for easy market access	• Growing middle class increasing purchasing power • Existing investments by private and public sector which is under utilized • Regional milk deficit evidenced by per capital consumption of 60litres/capita/day against recommended 200litres/capita/day	• Population increase and urbanization • High youth population • Existence of horizontal and vertical linkages/ associations within dairy value chain • No or very few milk substitutes on Uganda market	• Availability of developed technologies • Increasing adoption of ICT in dairy value chain to increase efficiency	• Existence of framework and several dairy policies, laws and regulations	• By products such as cow dung can be processed into other products such as bio-methane (purified biogas), bio-electricity, organic pesticides and fertilizers, liquid soap and livestock feed.
Negative	• Unexpected import ban on Uganda's milk products by Kenya • Political disputes within the Great lakes region affecting market access. e,.g border closure between Uganda and Rwanda; and civil wars in South Sudan and DRC • There are few on-going projects by government and development partners targeting dairy	• High cost of capital from formal financial institutions	• Youths are not interested in agriculture which has increased labour costs	• Low commercialization and adoption of developed technologies • Existing animal breeds not climatically adapted thus affecting their productivity	• Some of the policies are outdated, while enforcement of many policies is weak due to funding, fewer staff and politics	• Dairy is a major contributor of green gas emissions (especially methane) from enteric fermentation and animal manure management • Unpredictable weather patterns affecting raw milk supply



7.:

NARO's (NaLIRRI's) performance and capacity gaps in relation to addressing key value chain issues

National Livestock Resources Research Institute (NaLIRRI) is one of 16 semi-autonomous Agricultural Public Research Institutes (located at Nakyesasa in Tororo district) established for the purposes of providing livestock research services under the policy guidance of the National Agricultural Research Organization (NARO). NaLIRRI's mandate is to conduct research and related services in Livestock Health, Nutrition, Breeding, Socio-economics, Marketing and Apiculture. This is achieved through: (i) generation of technologies, (ii) strengthening agricultural research extension interface and (iii) strengthening agricultural research capacity. Ongoing research works by NaLIRRI are presented in Table 5 (54).

To increase uptake of on-going research efforts, NaLIRRI has: (i) undertaken multi-locational trials for improved pastures in preparation for official release by the national variety release committee, (ii) NARO produced over 2 metric tons of foundation seed for chloris gayana that was availed to farmers to rehabilitate over 300 acres of degraded pasture in the cattle corridor. Other pastures being promoted include gayana, lablab, brucharia spp, and (iii) piloted starter culture formulations with at least 2 cottage industries which has improved the quality of traditionally produced products

Table 5: NaLIRRI's performance and capacity gaps analysis

Key issues affecting dairy industry within NaLIRRI mandate	Ongoing efforts by NaLIRRI
Low genetic potential of breeds owned by farmers	• NARO has continued to improve and conserve indigenous cattle breeds notably Ankole cattle mainly at MbaZARDI, Small East African Zebu at Serere and Nganda cattle at Kamenyamigo to safeguard against genetic erosion • NARO has introduced and evaluated the performance of Viking Jersey calves under intensive production systems
Poor animal nutrition due limited access to quality pastures/feeds	• Four Lablab candidate lines namely NAROLAB-1, NAROLAB-2, NAROLAB-3 and NAROLAB-4 with high levels crude protein raging between 27.7 and 31% as compared to commercial lablab variety (Rongai variety) with crude protein content of 24.5%. • Efforts are underway to assemble, characterize and evaluate over 1000 lines of forage indigenous germplasm in East and Southern Africa for food and feed to safe guard against genetic erosion • Two feed formulae for cattle (1 dairy meal and calve starter). • Assorted seeds of 5 improved pasture varieties including NARO Napier 1, 2, 3 and Kakamega and Brachiaria mulato were produced and distributed at Mbarara ZARDI
Disease and parasites outbreaks such ticks and FMD	• Establishment of animal health diagnostics laboratory that serves the sub-Saharan African region in rapid diagnostics of animal diseases • Four anti-tick vaccine candidates namely Rhipicephalus appendiculatus (NARO-RA), Amblyomma variegatum (NARO-AV), Rhipicephalus decoloratus (NARO-RD) and a cocktile vaccine (NARO-CV) have been formulated and evaluated on indigenous and Friesian crosses at Nakyesasa station. In addition, evaluation of foot and mouth disease vaccines, and vaccines against ASF virus is on going.
Limited knowledge and skills on improved dairy management & processing	• Developed different management protocols e.g for use of fertilizers for lablab production, napier stunt disease management
Inferior milk products quality and high post harvest losses	
Limited access to low cost raw milk quality assessment tools/ technologies	
High cost of running cooling centres because most of them are powered by generators	
Limited access to portable water especially at production	
Huge untapped potential for high value dairy products such as casein, milk powder, cheeses, butter etc.	• Milk fortification to improve on micronutrient status through development of safe and stable milk-based nutraceutical products with anti-ulcer, diabetes and cancer properties are ongoing. • A total of four (4) starter culture formulae for processing milk products (1 for ghee; 2 for yogurt and 1 for probiotic yoghurt) were developed
Limited investment in quality control systems such as transit cold chain facilities	

8. Strategic analysis and recommendations for NARO

For greater impact, research should be driven by the current and future dairy market dynamics. Such dynamics include the following:

- Incomes and population growth expected to positively influence consumption of fresh dairy products
- Urbanisation and changing lifestyles towards consumption of animal-based food products
- Growing regional trade which might have a big influence on milk powder export growth
- Food safety concerns especially use of antibiotics
- increasing trend towards sustainable practices (to reduce GHG emissions) such as water access and manure management are additional areas where policy changes could have an impact
- Climate change which will affect traded volumes and ultimately price volatility
- COVID 19 impacts affecting consumption of certain products such as cheeses (in form of pizzas and burgers) which are consumed away from home
- Changes in trade policies and environment in different countries
- Reducing landholding as a result of population pressure which will call for adoption of intensification production systems

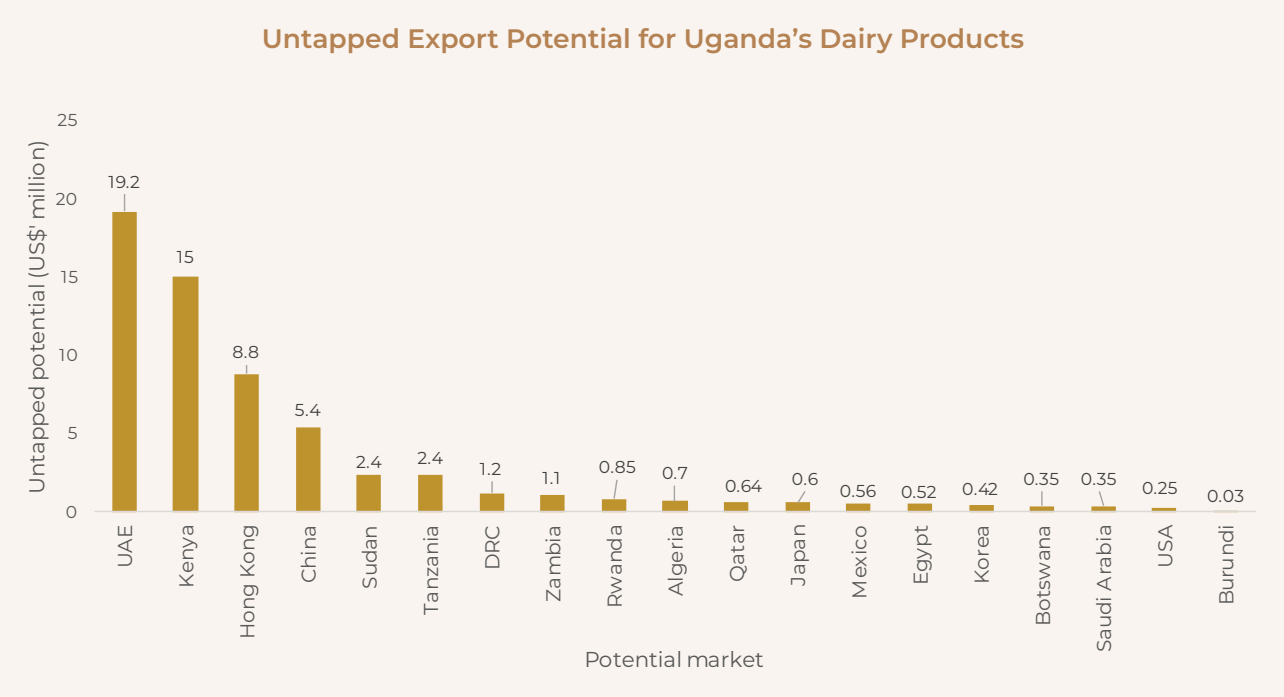


Figure 34: Uganda's dairy exports untapped potential

Existing and emerging opportunities

- First Uganda's current per capital milk consumption (63litres/capita/year) is still way below the recommended 200 litres/capita/year by WHO
- Apart from domestic markets, there is a huge current untapped dairy export potential for Uganda in current and potential markets which stands at US$ 66.9 million (representing 44% of the total export potential). In the terms of products, the highest potential is in liquid milk at US$40.7 million (representing 49% of total liquid milk potential), followed by low fat milk powder at US$22.3 million (representing 57% of total low fat milk powder export potential), and lastly sweetened milk powder at US$3.9 million (representing 37.5% of total sweetened milk powder export potential). Others include casein and butter (55).
- Overall UAE presents the highest dairy potential at approximately US$19.2 million (mainly for liquid milk), followed by Kenya with estimated untapped market potential of US$15 million (mainly for liquid milk and powder), followed by Hongkong at US$ 8.8 million (for milk and milk powder), China at US$5.4 million (for milk and milk powder), Sudan at US$2.4 million (for powder), Tanzania at US$2.4 million (liquid milk and powder), DRC at US$1.2 million and Zambia with US$1.1 million (for powder, liquid milk and casein).

a) Milk Powder

- The markets with greatest potential for Uganda's milk powder exports are United Arab Emirates, Hong Kong and Sudan (Figure 35). United Arab Emirates shows the largest absolute difference between potential and actual exports in value terms, leaving room to realize additional exports worth $1.8million (55). Among the markets Uganda can tap into, China has the biggest demand potential for milk powder, represented by the size of the bubble. However, Uganda would have to compete with the global top exporters for such as market.

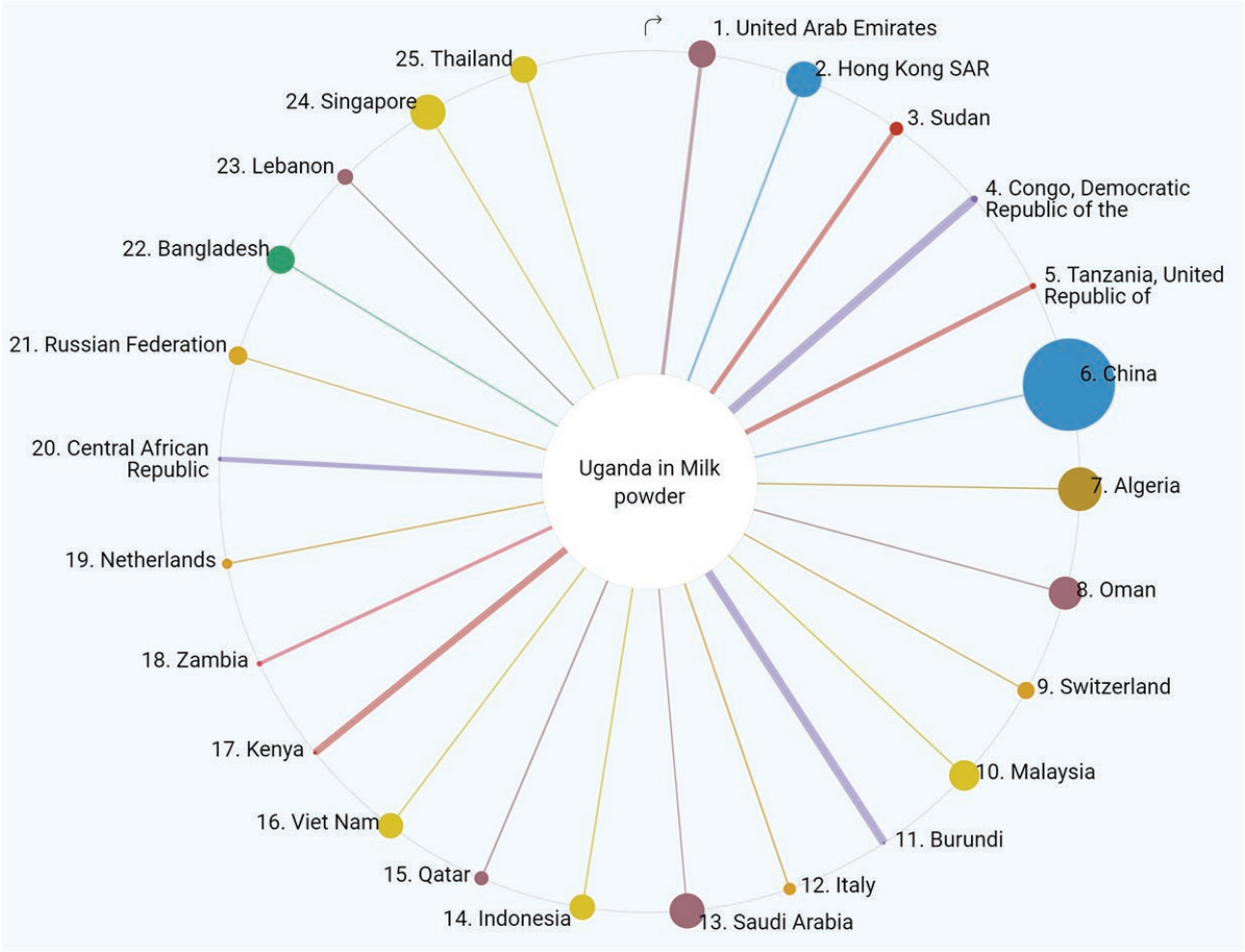


Figure 35: Uganda's milk powder exports untapped potential

N.B: Number (1 to 25) represents the ease of market access by Uganda's products, while the size of the bubble represents the size of available

b) Casein

- The markets with greatest potential for Uganda's casein exports are United States, Germany and Mexico (Figure 36).
- Globally, USA is the market with highest demand potential. Already Uganda is supplying this market, thus focus should be on how to building on existing trade linkages to foster more exports.

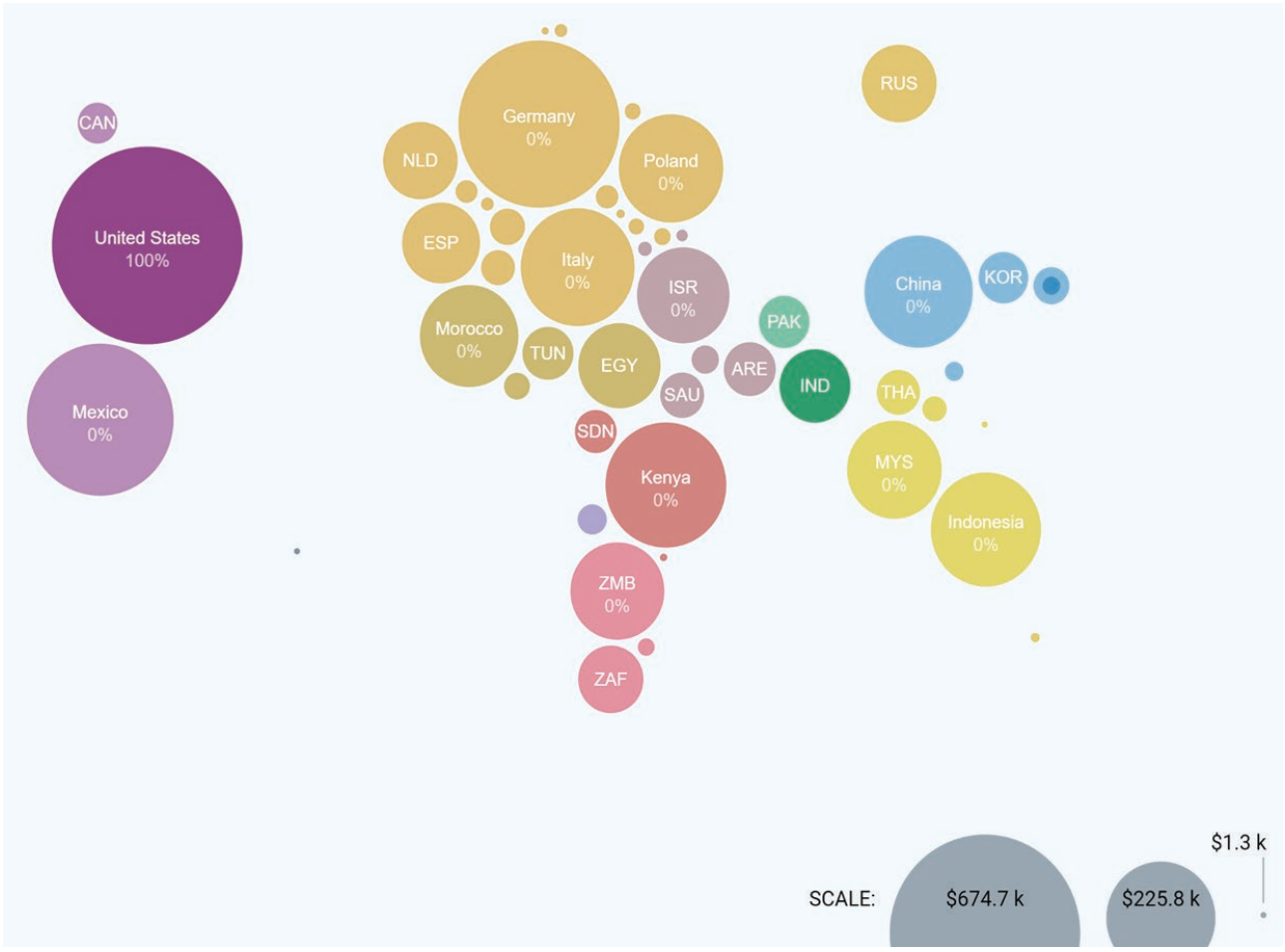


Figure 36: Uganda's casein exports untapped potential

9.

Export markets with highest untapped potential for Uganda's dairy products

c) Butter

- The markets with greatest potential for Uganda's butter exports are United Arab Emirates, Morocco, Hong Kong and Japan (Figure 37). United Arab Emirates shows the largest absolute difference between potential and actual exports in value terms, leaving room to realize additional exports worth US$290,8000.
- However, globally China has the highest demand potential for Butter.

So what?

Given the good trade relations between Uganda and China, Uganda can easily tap into this market

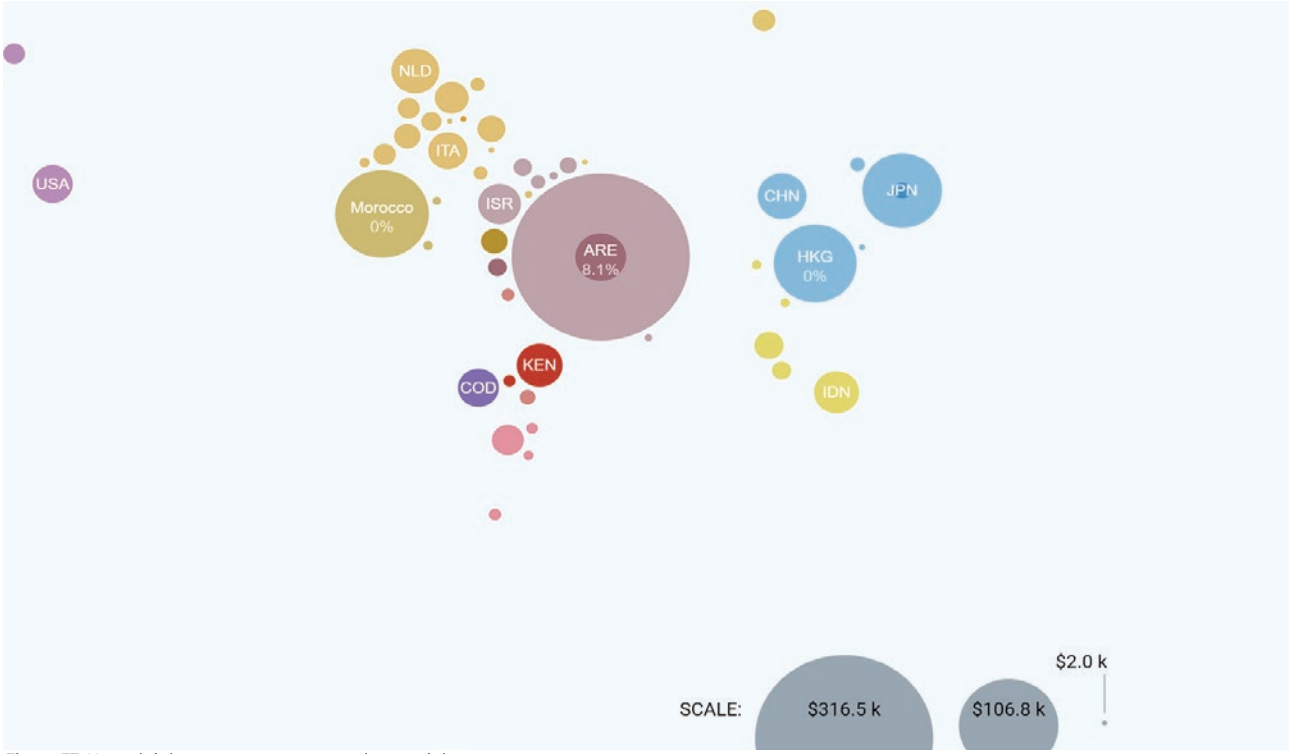


Figure 37: Uganda's butter exports untapped potential

N.B: Number (1 to 25) represents the ease of market access by Uganda's products, while the size of the bubble represents the size of available

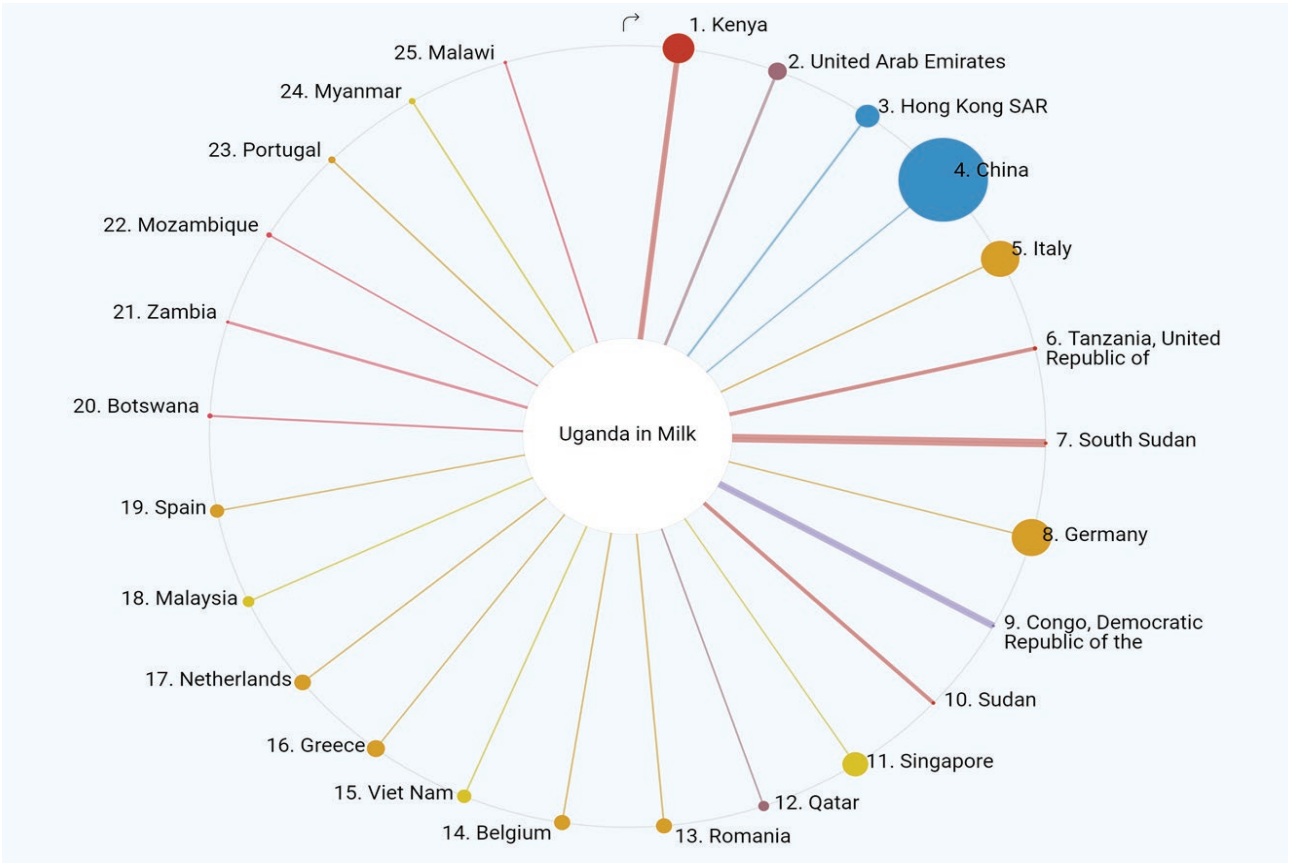


Figure 38: Uganda's butter exports untapped potential

10.

Key bottlenecks Limiting Commercialization of Developed Technologies

Technology and knowledge are critical in fostering value chain efficiency and competitiveness. However, technology development in itself is not enough. Commercialization and the distribution of the technology, ensures that innovations are scaled-up and sustainable. First, commercialization is the process by which products, knowledge/services, and technologies are introduced to the market for purchase. Apart from patenting and licensing, other forms of technology transfer can also be in form of contract research, consultancy, personal exchange, spin-offs, incubators, science parks and joint university-industry supervision of PhDs (56).

Although the technologies have been developed, value chain actors, especially farmers are not putting them in practice. This results in a large difference between the average productivity of value chain actors and crop or herd potential due to.

- Weak linkages between research and private sector players who play a critical role in commercialization of such technologies. Furthermore this is worsened by the limited distribution networks by research institutions and capability to market such technologies.
- Sometimes the developed technologies are not necessarily superior (in terms of user preferences) or responding to evolving market needs than what is already existing. Real needs of users are met due to limited involvement of relevant stakeholders during technology development process which is critical for buy-in.
- Developed are costly in terms of acquisition, operation and maintenance. Often times technologies are not accompanied by adequate information yet the two are interconnected.

- Information asymmetry, partly attribution to weak research – extension – end user linkages to facilitate timely and effective dissemination of research products for enhanced awareness and adoption.
- Focus has been more on knowledge transfer or dissemination of research results (through publications, trainings, workshops, seminars, grants, and fellowships) rather than technology commercialization
- Mass production (producing the product at a commercial scale) is often the most expensive aspect of the development process as it usually requires investment in a facility, equipment, and workers
- Breeding focus has been more inclined towards improved resistance and agronomic characteristics, with less emphasis on consumer tastes and preferences
- Limited funding directed to research. Breeding cycle is very long and costly
- Limited quality assurance and control during mass production which may result into inferior products and can pose a reputational and financial risk to the research institution
- Limited access to demonstration trails by end users i.e. often times, trails are done at research stations which are distant from end users. It is important to note that adoption occurs in a social context that has local characteristics, an aspect that should be taken into consideration from the development until the transfer of technology

11:

Success factors for commercialization research products

In 2017, Partnering for Innovation, a USAID-funded program, conducted a study to assess the critical success factors for commercialization of already existing publicly-funded agricultural research products, services, and technologies across its eight partnerships (57). Critical success factors highlighted by the report include:

- **Clearly defining the role of the research institution as a resulting product is handed off to a company, including how its role is funded.** It is important to determine the role the research institution will play in the commercialization process (manufacturer of the product in case of inhouse production/spin-off, licensor, consultant, supplier/service provider, etc.) and how that role will be supported financially (project funding, fee-for-service, royalties, etc.).
- **Address intellectual property from the beginning.** There are three aspects to consider in regard to intellectual property: a) ownership of the research itself (public domain or owned by the research institution), b) protection of the company's own proprietary information, and c) implications for further research or development work
- **Establishing quality control during mass production.** One of the risks in commercialization is that the company might not produce a quality product. Research institution should seriously consider building in a certain level of quality training and assurance. During the technology transfer process, companies may need technical assistance with quality control and/or regulatory compliance. Research institutions may also incorporate quality requirements as a condition of licensing agreements. These services can be paid for either through the royalty payment structure or on a fee-for-service basis.
- **Recognize that research is just one part of R&D.** Commercialization takes considerable time and resources. Companies invest significant resources and take risks to develop products resulting from publicly-funded research. Research institutions often have limited awareness of the work companies do to bring a product to market – including building a facility, designing and setting up the production process, building a supply chain, establishing distribution/logistics channels, marketing, and regulatory compliance.

- **View the smallholder farmer as a customer.** During the commercialization process, there is a shift in thinking from viewing the farmer as a participant/beneficiary to viewing the farmer as a customer. For the product to sell, a company needs to understand smallholder farmer needs and wants, and convince the customer that the product addresses those needs and wants better than alternatives. The customer will not buy the product simply because it is there or because the researcher has shown that it remedies the research question he/she set out to answer. While the researcher may incorporate some aspects of this thinking into his/her research, there is a definite shift in thinking during the commercialization process with the company seeing the farmer primarily as a customer. Marketing to smallholder farmers often requires more hands-on approaches.

- **Understand the motivation, and the responsibilities, of the Researcher.** There is a need to Understand the motivations for researchers, their institutions, the companies they work with, and donors to design research processes that result in smoother commercialization. While technology transfer offices can be helpful in navigating legal issues and providing general advice for working with commercial partners, the researcher ultimately "champions" and then manages the commercial relationship with a company. Similarly, on the company side, having a champion who advocates for the idea and sticks with it through the challenges is important. This necessitates a commitment from the company's management to dedicate the necessary financial, time, and staff resources.

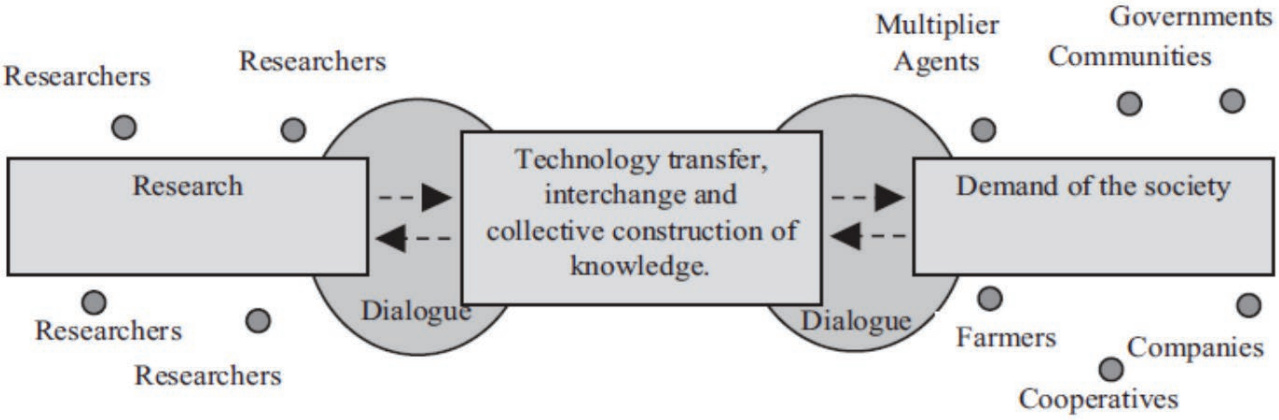
- **Value relationships and networking.** Establishing a platform for networking and relationships between researchers and commercial entities is very important. When available, entities such as accelerators, like business incubators or centers for innovation, can play a valuable role in connecting researchers and companies, and helping to bridge the gap between the language of science and the language of business. Being more purposeful and explicit in communications and networking may bring more research to the commercial market.

- **Involve the private sector in research early on.** Early engagement of private sector in development process is very critical as it brings different perspective and idea. There are different forms that private sector involvement can take, both formal and informal. At a higher level, advisory boards or stakeholder groups can provide a forum for companies to share their perspectives on the bigger picture issues that they see and provide input on the strategic direction of research. At a more technical level, they can provide feedback on the direction of the market and feasibility.

13.

Proposed roadmap for unlocking commercialization of research products

Generally, for research to be effective, there is need to foster dialogue between society, companies and researchers. Its paramount to encourage both private companies and public research institutions to engage in innovation development process. Interactions between different players during research process are presented in Figure 39 as proposed by Da Silva et al., 2019 (59).



Technology commercialization process for already existing research products as adopted from Feed the Future Partnering for innovation is presented in figure below (57):

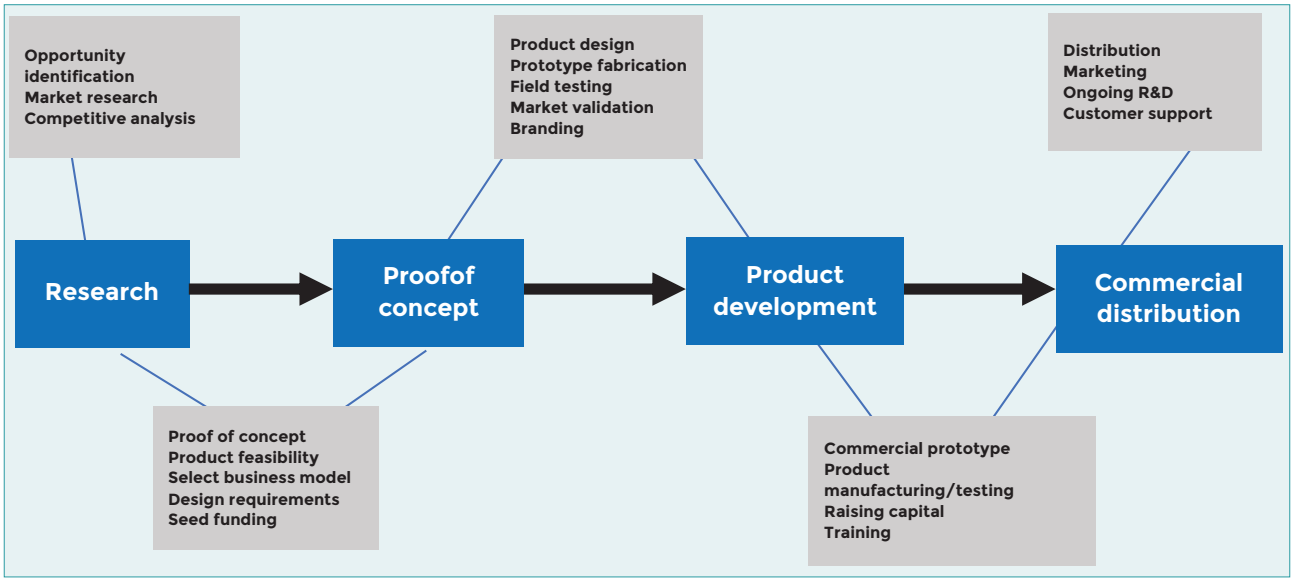


Figure 40: Major phases and steps in technology commercialization process (adopted from USAID, 2017)

14.

Key Activities involved in Commercialization of existing Research Products

Partnering for Innovation, a USAID-funded program (2018) highlighted the following key activities to be critical during commercialization of existing technology from public research institution (57)

1. **Research:**
    - *Opportunity Identification*: Identifying a potential research question to shed insight or even solve an agricultural development challenge with a product, service, or technology innovation.
    - *Market Research*: Answering research questions about market trends and consumer preferences.
    - *Competitive Analysis*: Identifying potential "competitors" to researching agricultural challenges or developing products to solve them.
    - *Proof of Concept*: To provide verification that an initial concept, method, approach, product, service, etc. will eventually be put into practice or use.
    - *Product Feasibility*: To assess whether a proposed concept, method, approach, product, service, etc. will be practically realizable.
    - *Select Business Model*: Planning for what type of business model will best create value, sales, and profit for a new product or service; usually based on market research.
    - *Design Requirements*: Documentation of the minimum physical and functional needs of the basic product/service design to perform its purpose.
    - Seed Funding: Identify and secure funding for limited production or manufacture of a new product or service, usually to test its market readiness and to make adjustments based on market response.

2. **Proof of Concept:**
    - *Product Design: Designing initial product models.*
    - *Prototype Fabrication: Manufacturing initial product models.*
    - *Field Testing: Testing initial product models in real-life situations with potential customers.*
    - *Market Validation: Verifying, through field testing, that the initial product model is viable for mass market sales. Sometimes includes adjusting or reconfiguring product design.*
    - *Branding: Assigning a particular name to the product for marketing and sales purposes.*
3. **Product Development:**
    - *Commercial Prototype: The final product/service prototype that matches all requirements including for branding.*
    - *Product Manufacturing/Testing: Testing and finalizing the product/service for mass market distribution and sales.*
    - *Raising Capital: Identifying and increasing funds for covering manufacturing and other costs related to products and services.*
    - *Business Launch: Formal designation of an operational product line or business.*
    - *Training: The process of teaching the workforce to understand and sell products/services.*
4. **Commercial Distribution:**
    - *Distribution: Developing and maintaining commercial distribution channels, or modes, for delivering products and services to end consumers.*
    - *Marketing: Strategies and channels for raising awareness and interests from potential customers about products and services.*
    - *Ongoing R&D: Ongoing research and improvements to products and services to improve sales and profit.*
    - *Customer Support: The provision of information and knowledge to customers on the use of the product or service.*

15.

Specific recommendations for the activity

Table 6: Specific recommendations for the activity

Theme	Activity	Recommendations
Continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand	Facilitate the release and commercialization of varieties developed under previous and ongoing research efforts	• Organize periodic networking events to bring together researchers with value chain players and enablers • Strengthen linkages with extension agencies and development partners to leverage networks for catalysing technology commercialization • Advocate for conducive investment climate to incentivize private sector to commercialize innovations such as taxation policy, and subsidy scheme for new products to lower product price for market demand generation while covering development costs • Facilitate access to capita for product development • Establish trails on farmer plots for easy buy in.
	Develop improved crop and animal production and management technologies in response to emerging threats and market demands	• Undertake market research for identifying market demand in advance of research project and attempts to scale up and commercialize specific technologies with proven market demand • Adopt interactive development of knowledge and technologies with intended end users rather than development of technologies for potential users • Develop dairy breeds or intensify evaluation of breeds that are adopted to local conditions • Intensify research on high end milk products such as casein, cheese
Strengthening NARO's institutional sustainability in the marketplace	Consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding	• Develop and implement policies, legal frameworks and guidelines for management of IP, technology transfer/commercialization and partnership with industry • Establish Technology Transfer Offices to support researchers through the formal and administrative aspects of technology commercialization • Build capacity of staff/researchers in modern technology transfer and commercialization process, • Strengthen linkages with business incubators and science parks to sharpen entrepreneurship • Equip NARS with adequate equipment and funding of research daily operation expenses (consumables) • Establish innovation fund/vouchers to support spin-offs/start-ups or SMEs commercialize developed products



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17.

Data gaps that might require in-depth analysis

Missing Information	Potential Source
Domestic Markets	
• What's the market share of each processed dairy product? • Which products are projected to have a bigger market share? • What will drive their demand? • What needs to be done to capture the different products markets?	DDA
• Which kind of investment is needed to tap into high end dairy products such as casein, baby formulas, Whey, Cheese and curd.	DDA/Processor
• Milk prices (farm gate and retail) for the last 2 – 3 years? • Prices of different processed milk products for the last 2 years? In relation to major import brands • Prices at the different nodes of the value chain for pasteurized milk and milk powder to help us determine value share across the chain?	DDA
• What's the performance of the value chain in other milk sheds apart from central and western?	DDA
• Average volumes handled by a rural trader and transporter per week?	Different VCAs
• Apart from buying from the farmers, which other services do rural traders provide to the farmer?	DDA
• What's the minimum volumes transported by transporters?	
• What's the average cooling capacity of each collection centre?	Rep of cooling centre
• On average what volume is handled by each cooling centre per week? What is the utilization capacity during dry and wet season respectively?	
• What are the major challenges affecting cooling centres' performance?	
• What are the major challenges faced at aggregation and transport node?	
• By numbers and capacity, what's the distribution of processing facilities by milk shed?	DDA
• Who are the major processors and their market share?	
• Which processor drive different dairy products markets?	
• Which products are mainly produced by (i) large scale processors, (ii) medium scale processors, and (iii) small and cottage processors?	Processor
• Which processors also double as exporters?	
• Support or services rendered by processors to boost the performance of the value chain apart from just processing?	
• Which processors have invested in transport trucks?	
• Major challenges at processing node?	DDA
• Volumes handled by a typical bicycle milk vendor and vending cooling centres/milk cooler per week?	
• Which processors have invested in distribution depots?	
• Prominent dairy exporting companies for different products?	DDA
• Who are the major importers of dairy products in the country and which model do they use to sell their products?	
• On average, how many dairy distributors, supermarkets, depot outlets and milk shops do exist?	
• Volumes handled per week by distributor, supermarkets and retail shops respectively?	
• Apart from providing cold chain facilities to keep the quality integrity of the products, which other services do wholesalers provide in the value chain?	Different VCAs
• What are the current and future innovation (technological and knowledge/practice) needs at each node of the dairy value chain?	
• What should be done to increase utilization of new innovations along dairy value chain?	

Support institutions	
• What's the role of NAGRC &DB and how different is it from NaLIRRI especially when it comes to breed improvement?	DG for NAGRC &DB and DG NaLIRRI
• How many licenced semen importers exist in Uganda and who are they?	
• Who the major AI service providers and where they are located?	
• What challenges exist in relation to breed improvement? i.e from suppliers perspective and farmers perspective?	DDA
• Who are the major suppliers of different production, post harvest and processing technology such as water pumps, chuff cutters, aluminum buckets and tanks, milk testing equipment and processing equipment?	
• Which kind of information do different value chain actors receive	DDA or different VCAs
• How do they receive the information? Attach percentages to each channel?	
• Challenges in receiving the information?	
• Major sources of finance for the different value chain actors?	DDA and Different VCAs
• Which are the major financial institutions providing credit to dairy sector?	
• What are the challenges with financial access?	
• What are the on-going projects in the dairy sub-sector both by government and development partners?	DDA
Enabling environment	
• Operating fees for the different value chain actors?	DDA
• What's the cost of trading licence from LGs?	
• Number of people employed along the dairy value chain?	
• Gross margin analysis at different nodes of the dairy value chain? i.e available analysis by MAAIF assumes that a farmer has 50 cows and has 100 acres which is not true? From literature a typical small-scale farmer (who are the majority) has 3 -5 cows. But also, the practices considered in the analysis don't reflect a typical smallholder farmer.	DDA and different VCAs
• Past and on-going efforts by NaLIRRI to address key value chain challenges?	DG of NaLIRRI
• How have they been scaled up and commercialized?	
• Which challenges have been encountered in identification, development and commercialization of different dairy technologies and practices?	Researchers at NaLIRRI
• What needs to be done to increase efficiency at each stage of research development?	
• What is the proposed model for increasing commercialization of innovations and ensuring self-sustainability of NaLIRRI?	
• What are the key recommendations to the project for?	
o Facilitating faster release of already developed or ongoing research products?	
o Development of new technologies in response to market trends and climate threats?	DDA
o Improving institutional capacity of NaLIRRI to be more sustainable and not solely depend on government and development funding?	







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