BIRUNGA DAIRY INDUSTRIES:
BUSINESS EXPANSION PLAN

AUGUST 2024

Table of Contents

1. EXECUTIVE SUMMARY

1.1. The Company & its Founders

1.2. The Company's Market Opportunity

1.3. The Company's Assets, Products & Technology

1.4. The Company's Financial Projections

1.5. The Company's Proposed Financing

2. PROJECT OVERVIEW

2.1. Description of the Project

The Project is the proposed expansion of Birunga Dairy Industries' production capacity and the diversification of its products to include spreadable butter, butter oil, cheese, casein, and whey powder.

2.2. Target Market

The Company's target market has mostly been the export of its UHT milk to cities around East Africa, especially Kigali in Rwanda, Bujumbura in Burundi, Juba in South Sudan, and Lira, Kampala, and other districts in Uganda.

The target market in the near term will continue to be these East African countries, including Nairobi, and cities in Tanzania. This will especially be the case for the spreadable butter and cheese. With respect to the butter oil, casein, and whey powder, the Company will broaden the scope of the target market to find the most optimal customers across the globe.

2.3. Rationale For Expansion

The Company's rationale for the expansion is 2-fold. The first reason is to diversify its product portfolio, from only UHT milk and yoghurt to include spreadable butter, butter oil, cheese, casein, and whey powder. While casein and whey powder are by-products of the butter, butter oil, and cheese production, the Company's decision to produce these by-products is also informed by the growth of the markets for both products, with the global casein market estimated to grow by an annual average rate of 4-7% over the period to 2033. The whey powder global market, on the other hand, is estimated to grow at between 6% and 10% over the same period.

Second, the Company's decision to expand production is to take advantage of the growth of Uganda's dairy industry whose raw milk production has grown by an annual average of 11% over the last 8 years.

2.4. Business Expansion Strategy

The Company plans to carry out an expansion based on product diversification to introduce butter (dairy spread) and processed cheese, along with buttermilk and whey, their respective byproducts.

This shall involve undertaking capital investments and expanded operations to introduce the new products to the market. The marketing of the products shall follow a 2-phase where, initially, the major products (i.e., butter and cheese) shall be marketed within East Africa, and then after 2-3 year period, shall then be marketed in the wider African and Middle Eastern markets. This is laid out in the table below.

Table 1: Birunga Dairy Industry's Expansion Strategy

PHASE OF EXPANSION	DETAILS OF PHASE OF EXPANSION	TIMELINE
PHASE 1:	This phase shall commence with the intensive investment in capital assets and expanded operations to include butter (dairy spread), butter oil, processed cheese (Cheddar, mozzarella, and cream cheese),	3 Years

	acid casein, and whey powder to the Company's product catalogue. The investment in capital assets (i.e., CAPEX) shall go towards: i. Purchase of land for expanded production; ii. Cost of civil works for production and storage environment and waste management facilities; iii. Cost of machinery, including milk reception, processing, packaging, and storage (cold storage) for all 4 products; iv. Cost of industrial generator (650Kva??) and other electricity stabilizing equipment; v. Cost of milk collection trucks; vi. Cost of cold distribution trucks; vii. Extra laboratory equipment; and viii. Extra office furnishing and equipment. The investment in expanded operations (i.e., OPEX) shall go towards; i. Increased production, and selling and distribution staffing requirement; ii. Purchase of increased raw milk requirement; iii. Purchase of other processing inputs; iv. Purchase of cleaning supplies; v. Payment for increased utilization of utilities, including electricity, water, and internet; and vi. Cost of developing and implementing a marketing strategy. In this phase, the Company shall focus on marketing its major products – including UHT unflavoured and flavoured milk, yoghurt, butter, and cheese within the East African region, while the acid casein shall be marketed to global processors that use it as a raw material.	
PHASE 2:	The 2nd phase of the expansion shall focus on expanding the market for the Company's products beyond the East African region to other African countries and the Middle East. In this phase, the Company shall focus on sourcing for high-quality milk with a higher fat-content in order to sustain the quality of its products for the high income export markets. The cost of this phase of the expansion shall include: i. Increased cost of raw milk purchases due to a requirement for higher quality; ii. Cost of developing a marketing strategy to highlight the higher quality of the products; iii. Cost of implementing the marketing strategy, including business development content creation, and marketing; and iv. Cost of additional certification, e.g., Halaal, Hazard Analysis of Critical Control Points (HACCP).	2 Years

3. PRODUCT DESCRIPTION

3.1. The Company's Current Products

Table 2: Birunga Dairy Industries' Current Products

CATEGORY	PRODUCT
Milk	Ultra Heat Treated (UHT) milk
	Flavoured milk (vanilla, chocolate, and strawberry)
Yoghurt	Plain & flaovured (vanilla and strawberry) yoghurt

3.2. New Products & Services

Table 3: New Products To Be Produced By Birunga Industries.

PRODUCT	DESCRIPTION	UNIQUE SELLING POINT (USP)
Butter/Dairy Spread	The Company intends to produce high quality, full-fat butter, with both salted and unsalted versions. This butter shall be meant for use as a spread for confectionaries, baking, and cooking purposes. The butter shall be packaged in both 250g and 500g packets.	The Company sources its raw milk from the south-western region of Uganda where the majority of farmers still keep the local Ankole cattle breed. These cattle, though lower yielding in terms of volume of milk offtake in comparison to Holstein-Friesian and Jersey breeds produce higher fat-content milk at 5.25%[1] compared to 3.79% and 5.09% for Holstein-Friesian and Jersey breeds, respectively[2]. Raw milk for butter is usually required to have between 3.5% and 4.5% fat content. It is expected that this will lead to a higher quality of full-fat butter produced.
Butter Oil	Butter oil, often referred to as anhydrous milk fat or ghee in some cultures, is a type of dairy product that is essentially butter with most of the water and milk solids removed. **Butter oil composition:** • **Fat Content:** Butter oil is nearly 100% milk fat, with minimal moisture content, typically less than 1%. This high fat content gives it a long shelf life and stability at higher temperatures compared to regular butter. • **Milk Solids:** Unlike butter, which contains milk solids that can burn at high temperatures, butter oil has these solids removed, making it ideal for cooking at high heats without burning. **Butter oil characteristics:**	

[1] Characteristics of Ankole Longhorn cattle and their production environments in South-Western Uganda: milk offtake and body measurements (2003) (https://biometrics.ilri.org/Publication/Abstract/AnGRInfBul34.pdf)
[2] A comparison between Holstein-Friesian and Jersey dairy cows and their F_1 hybrid on milk fatty acid composition under grazing conditions, (2010)
(https://www.sciencedirect.com/science/article/pii/S0022030210002080)

	• **Texture:** At room temperature, it's softer than regular butter due to its high fat content but can be quite firm when cold. • **Flavor:** It has a rich, buttery taste, often more concentrated than regular butter. Depending on the method of production, it might have a slightly nutty flavor, especially if it's been heated to the point of browning the milk solids before removal (similar to ghee). **Uses of butter oil:** • **Cooking:** Its high smoke point makes it excellent for sautéing, frying, and baking where you need fats that won't break down at high temperatures. • **Baking:** It can be used in place of butter in recipes, providing a richer flavor and different texture due to its lack of water content. The butter oil shall be packaged in 195Kg drums, with a focus on marketing to local and foreign food processing industries.	
Hard Cheese	The Company also intends to produce processed cheese of 3 varieties, namely: i. Cheddar; and ii. Mozzarella. The choice of cheese varieties has been chosen based on insights from global[3] and Middle East & Africa (MEA)[4] market analyses which show that they are the varieties that dominate the markets, respectively. These 2 varieties shall be packaged both as blocks and shredded cheese. This is meant to reflect the insights from the aforementioned market research that shows that globally, the most popular form is block cheese, while in the MEA market, hard cheese is the largest segment, but softer cheese is the fastest-growing due to its versatility in cooking. The cheese shall be packaged as 250g and 500g blocks and sachets of shredded cheese.	The option for packaging shredded cheese is meant to align the Company with the growing trend towards cheese varieties that can be used during cooking, especially for sandwiches, pizza, and pasta.
Cream Cheese	The Company shall also produce cream cheese, a soft cheese variety whose consumption, both globally and within the MEA regions, is growing	The option for producing cream cheese from the buttermilk is also meant to align the Company with the growing trend towards cheese varieties that can be used during

[3] Processed Cheese Market (2021) (https://www.factmr.com/report/157/processed-cheese-market)
[4] Middle East & Africa Cheese Market Research Report (2023) (https://virtuemarketresearch.com/report/middle-east-africa-cheese-market)

	fastest due to its versatility in cooking and in use as a spread for sandwiches[5]. The cream shall also be packaged in 250g and 500g tetra Pak brick packs.	cooking, especially for sandwiches, pizza, and pasta.
Acid Casein	Casein refers to a family of proteins found in milk, specifically making up about 80% of the proteins in cow's milk. **Composition of acid casein:** • **Protein Content:** Acid casein is primarily composed of casein proteins, which make up about 80% of the proteins in cow's milk. These proteins are precipitated out of milk using acid, hence the name "acid casein." • **Moisture:** It typically contains around 8-12% moisture, which can vary based on processing methods. • **Ash:** There's a small amount of ash content, which includes minerals like calcium and phosphorus. **Characteristics of acid casein:** • **Appearance:** Acid casein usually appears as a white to pale yellow, slightly granular powder or fine particles. • **Solubility:** Unlike sodium caseinate, acid casein is not soluble in water but can be dispersed in alkaline solutions or under specific conditions where it can hydrate and form gels or stabilize emulsions. **Uses:** • **Food Industry:** o **Cheese Making:** It's used in the production of processed cheese and cheese analogs where it provides texture and meltability. o **Edible Films:** Can be used to create edible films for food packaging due to its film-forming properties. o **Protein Fortification:** Added to foods to increase protein content without significantly altering flavor. • **Non-Food Applications:**	

[5] Middle East & Africa Cheese Market Size (2024-2030) - https://virtuemarketresearch.com/report/middle-east-africa-cheese-market

	○ **Adhesives:** Acid casein is used in the production of glues, particularly for wood and paper. ○ **Textiles:** In the past, it was used to make fibers for textiles, although this is less common today. ○ **Paints and Coatings:** It can be used in the formulation of paints, providing a binder that's biodegradable. The acid casein shall be packaged in 25Kg kraft bags for the export market.	
Whey Powder	Liquid whey is the byproduct of the cheese making process. About 90% of the raw milk used for making cheese turns out as liquid whey, the byproduct. The liquid whey then goes through a clarification and pasteurization process before it is concentrated and dried into a powder. Whey power is then used as a raw material in a multitude of industries, including: i. The Food and Beverage industry where it is used in bakery products, confectionery, dairy products, and beverages; ii. The Sports Nutrition and Dietary Supplements industry where it is used for protein powders, meal replacement shakes, and nutrition bars; iii. By Infant Formula manufacturers; iv. The Pharmaceutical Industry where it is used for tableting, capsule production, and medical nutrition v. The Animal Feed Industry to make livestock feed and pet food; vi. The Cosmetics Industry for skin care products and hair care products; vii. The Biotechnology Industry for fermentation media, and production of enzymes and probiotics; and viii. The Agriculture Industry for fertilizers, and soil amendments. The whey shall be packaged in 25kg kraft bags.	The production of whey powder shall also align the Company with the growing use of whey in making formulations for a wide range of foods to harness its beneficial properties. Whey proteins are rich in bioactive peptides, possessing bioactive properties such as being antioxidant and antihypertensive as well as having antimicrobial activities, which, when ingested, confers several health benefits. These peptides have the potential to be used as an active food ingredient in the production of functional foods. In addition to their bioactivities, whey proteins are known to possess enhanced functional attributes that allow them to be utilized in broad applications, such as an encapsulating agent or carrier materials to entrap bioactive compounds, emulsification, and in edible and active packaging[6].

[6] Whey Proteins and Its Derivatives: Bioactivity, Functionality, and Current Applications (2020) - https://www.mdpi.com/2624-862X/1/3/16

4. MARKET RESEARCH & ANALYSIS

4.1. The Market Size & Trends

4.1.1. Market Size:

i). Uganda:

Uganda's dairy sector has grown impressively over the last decade, from a total production of 2.08 billion litres in 2015 to over 3.85 billion litres in 2023, an average annual growth rate of 8%[7]. While the biggest market share is for raw milk through informal milk collection centres, the processed milk segment has seen the highest average annual growth of 11% over the same period.

A. Uganda's Butter Market

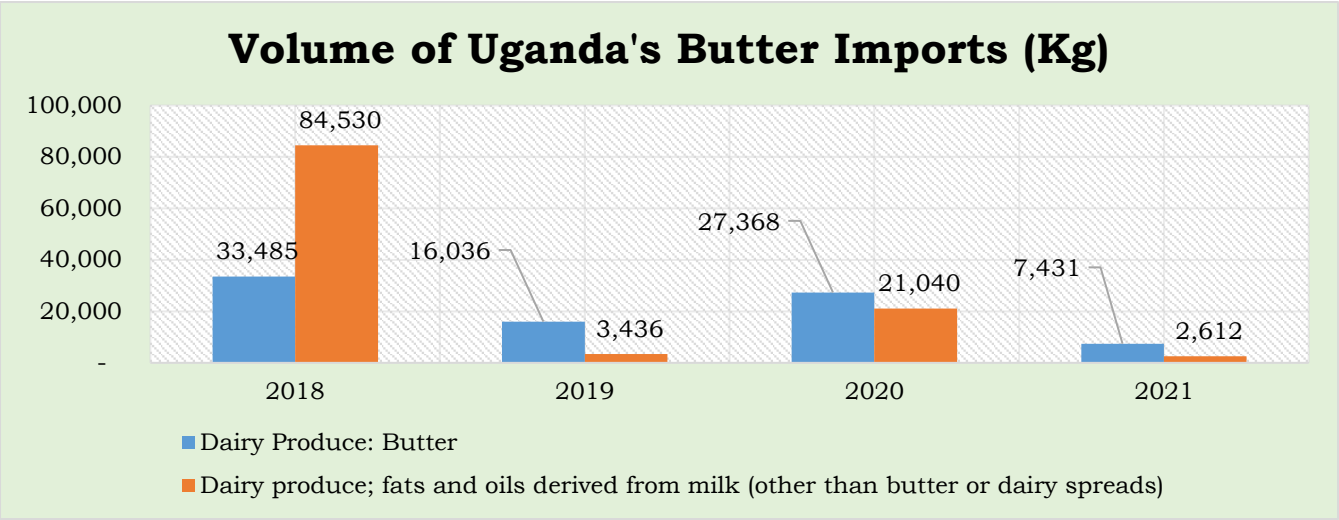
The size of the cheese and butter market in Uganda, by production volumes, is difficult to estimate due to the absence of data specific to the products. However, based on Sub-Saharan Africa's estimated 2022 average per capita consumption of butter of 0.2kg[8], Uganda's annual butter consumption can be estimated at 9,180 tons.

Looking at Uganda's butter trade volumes and values to estimate the market size, imports have dropped from a total of 118 tons in 2018 to 10 tons in 2021, an annual average reduction of 56% (UNComtrade data). This is due to the increased production by large scale local processors Sameer Agriculture & Livestock (SALL), JESA Farm Dairy, and Pearl Dairies.

The butter trade is made up of 2 segments:

- Butter/dairy spreads derived from milk; and
- Fats and oils derived from milk (other than butter or dairy spreads). This latter segment is mostly made up of ghee (i.e., clarified butter) and butter oil.

Figure 1: Volume of Uganda's Butter Imports



[7] https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023

[8] https://www.oecd-ilibrary.org/butter-projections-consumption-per-capita_5jrzxx43116d.xls?itemId=%2Fcontent%2Fcomponent%2Fagr_outlook-2015-table147-en&mimeType=vnd.ms-excel

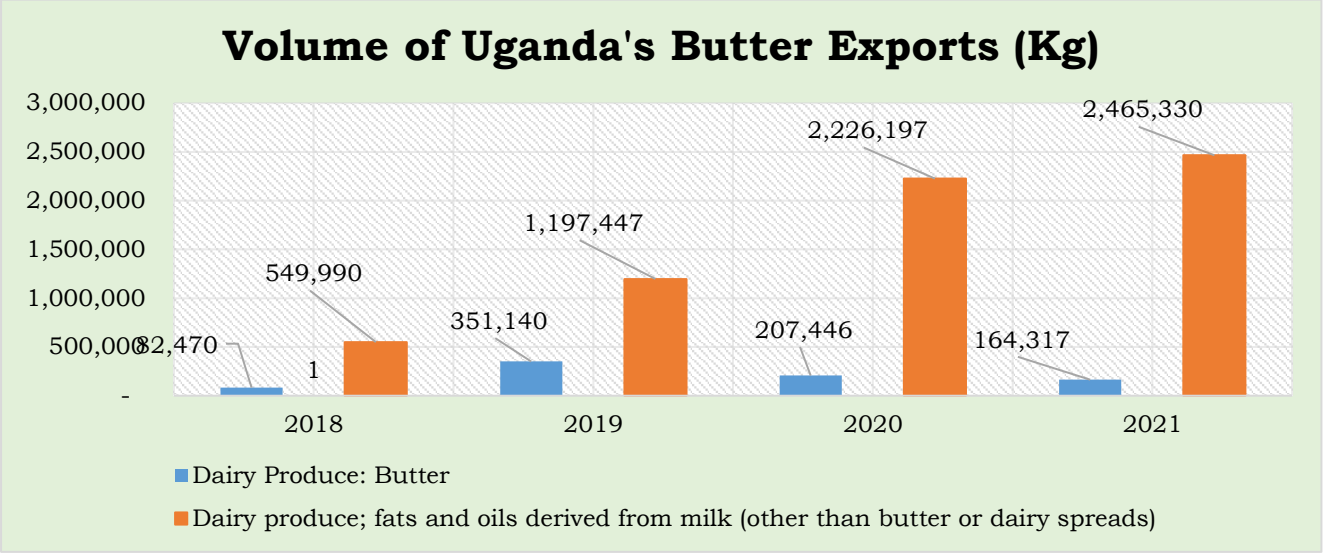
Imports of the butter/dairy spreads segment dropped from 33.5 tons in 2018 to 7.4 tons in 2021, an average annual reduction of 39.5%, while imports of the ghee and butter oil segment dropped from 84.5 tons in 2018 to 2.6 tons in 2021, an average annual drop of 68.6%.

Over the period, the ghee and butter oil segment contributed a total of 57% of the import volumes and 50.5% of the value of imports, while the butter/dairy spreads segment contributed a total of 43% of the import volumes and 49.5% of the value of imports.

In 2023, Dairy Development Authority (DDA) data shows that butter was the 7th most imported dairy product y value, with a total value of US$ 26,951 (0.35% of the total value of dairy imports)[9].

With respect to the export market, total butter exports grew from 632.5 tons in 2018 to 2,630 tons in 2021, an average annual growth rate of 60.8%.

Figure 2: Volume of Uganda's Butter Exports



Exports of the butter/dairy spreads segment grew from 82.5 tons in 2018 to 164.3 tons in 2021, an average annual growth of 11.1%, while exports of the ghee and butter oil segment grew from 549.9 tons in 2018 to 2,465.3 tons in 2021, an average annual growth of 88.9%.

Over the period, the ghee and butter oil segment contributed a total of 88.8% of the export volumes and 90.2% of the value of exports, while the butter/dairy spreads segment contributed a total of 11.1% of the export volumes and 9.8% of the value of exports.

In 2023, Dairy Development Authority (DDA) data shows that butter was the 3rd most exported dairy product by value, with a total value of US$ 12.2m (4.6% of the total value of dairy exports).

Generally, Uganda's butter trade balance grew from a surplus US$ 2.7m (derived from 514.5 tons) in 2018 to a surplus of US$ 11.7m (derived from 2,619.6 tons) in 2021. This equates to an annual average growth rate of 63.2% in value derived from an annual average growth rate of 72% in volume.

[9] DDA Statistical Abstract 2022-23 - https://dda.go.ug/images/1711435540.pdf

B. Uganda's Cheese Market

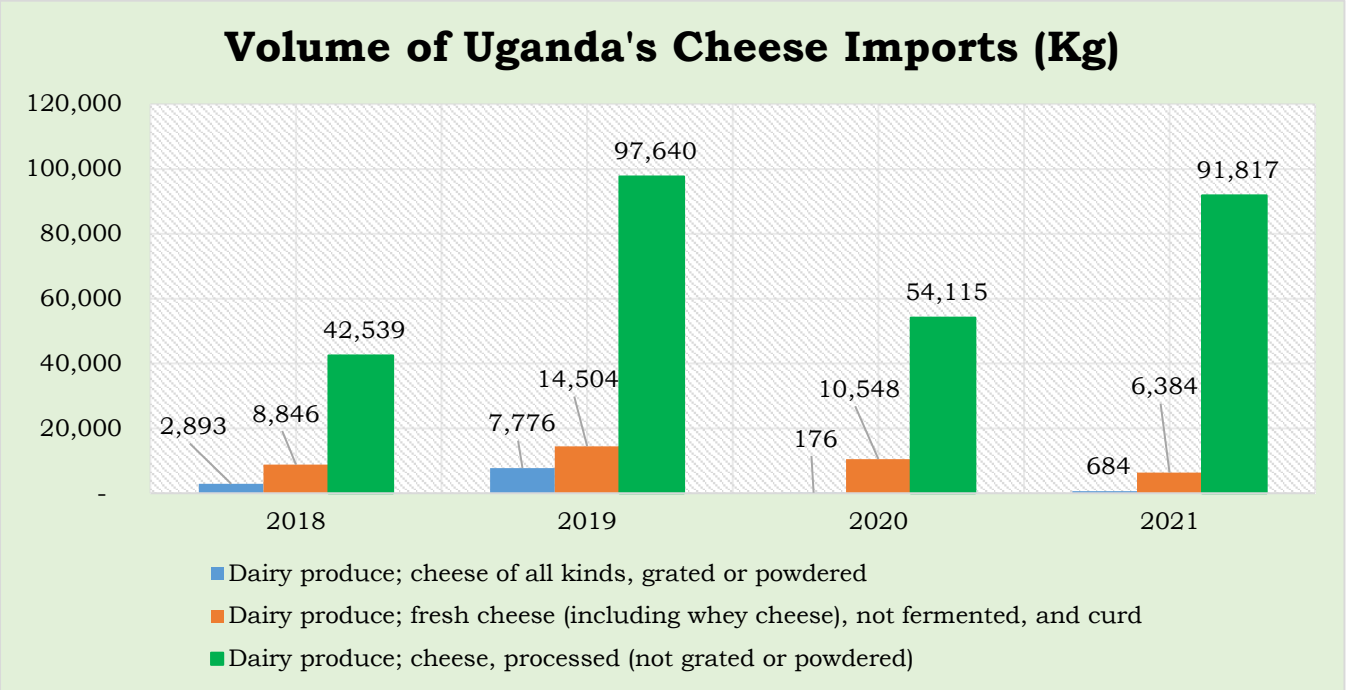
Based on Sub-Saharan Africa's estimated average per capita consumption of cheese of 0.19kg[10], Uganda's current annual cheese consumption can be estimated at 8,742 tons and is expected to grow to 12,181 tons in 2032 – an average annual growth rate of 3.4%, a result of mostly a projected population growth rate of 2.9%[11].

Uganda's cheese trade data is based on 3 segments, namely:

- Processed cheese that is grated or powdered;
- Processed cheese that is not grated or powdered; and
- Unfermented/fresh cheese that includes whey cheese and curd.

Uganda's total cheese imports have grown from 54.3 tons in 2018 to 98.9 tons in 2021, an average annual growth rate of 22.1%.

Figure 3: Volume of Uganda's Cheese Imports



The processed cheese that is not grated or powdered segment contributed 84.7% of the total imports over the 4-year period, while the fresh cheese and the processed grated or powdered cheese segments contributed 11.9% and 3.4%, respectively.

In terms of growth rates, the processed cheese that is not grated or powdered segment was the only growth segment, growing an annual average of 29.2%, while the fresh cheese and the processed grated or powdered cheese segments dropped by 10.3% and 38.2%, respectively.

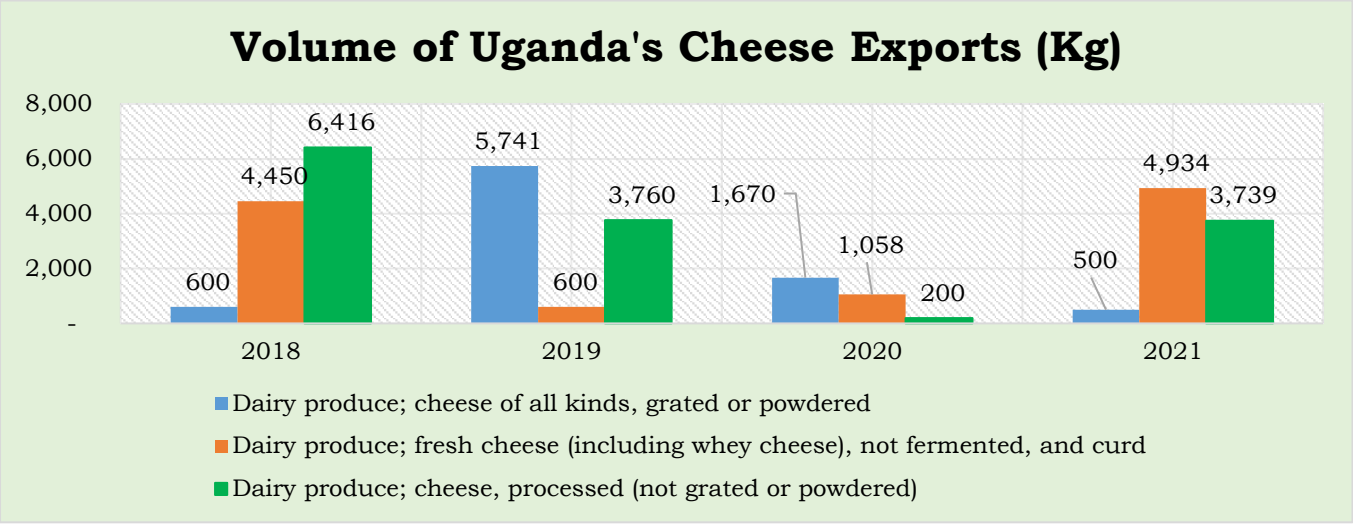
In 2023, Dairy Development Authority (DDA) data shows that cheese was the 3rd most imported dairy product by value, with a total value of US$ 471,475 (6.1% of the total value of dairy imports).

[10] Per capital consumption of cheese in selected regions (2022) https://www.oecd-ilibrary.org/agriculture-and-food/per-capita-consumption-of-cheese-in-selected-regions_c0afd033-en

[11] National mid-year population projections for Uganda (2018) https://www.ubos.org/wp-content/uploads/2018/03/National-Projections_2050RQ.xls

With respect to the export market, total cheese exports dropped from 11.5 tons in 2018 to 9.2 tons in 2021, an average annual drop of 7.2%.

Figure 4: Volume of Uganda's Cheese Exports



The processed cheese that is not grated or powdered segment contributed 41.9% of the total exports over the 4-year period, while the fresh cheese and the processed grated or powdered cheese segments contributed 32.8% and 25.3%, respectively.

In terms of growth rates, the fresh cheese segment was the only growth segment, growing an annual average of 3.5%, while the processed cheese that is not grated or powdered and the processed grated or powdered cheese segments dropped by 16.5% and 5.9%, respectively.

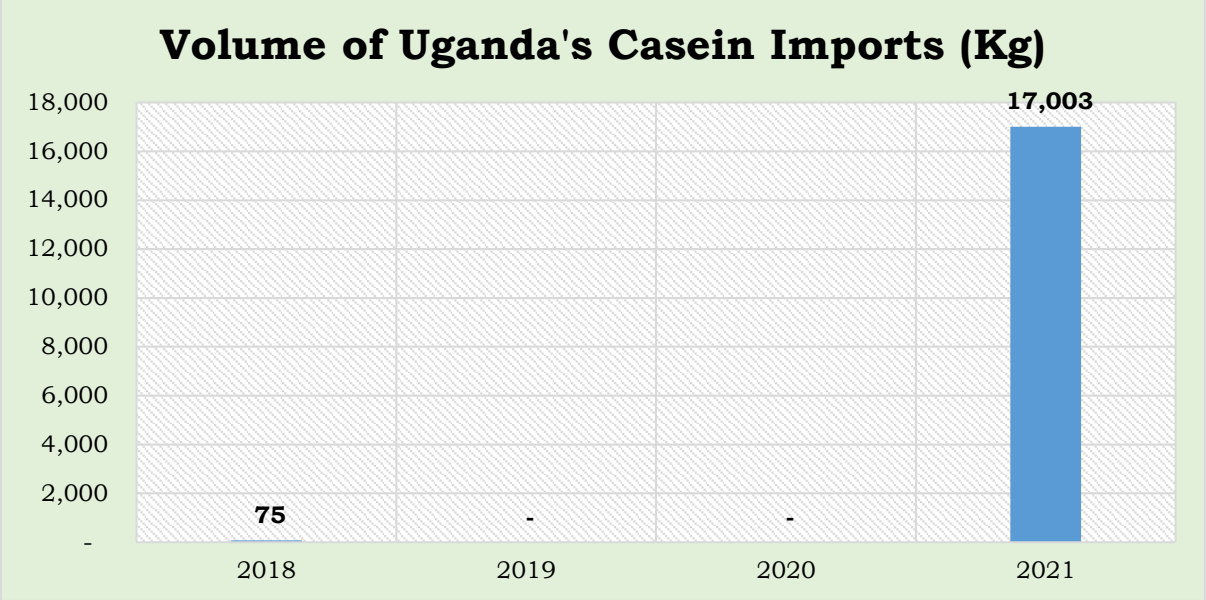
In 2023, Dairy Development Authority (DDA) data shows that cheese was the least exported dairy product by value, with a total value of US$ 77,480 (0.03% of the total value of dairy exports).

Generally, Uganda's cheese trade balance grew from a deficit of US$ 156, 742 (derived from 42.8 tons) in 2018 to a deficit of US$ 212,519 (derived from 89.7 tons) in 2021. This equates to an annual average deterioration of 10.7% in value derived from an annual average deterioration of 28% in volume.

C. Uganda's Casein Market

In Uganda, both the food and non-food industries that use casein as a raw material are still immature, and therefore, its use is still negligible. This is evidenced by the very low levels of imports and high levels of exports. However, over the period 2018 – 2021, although imports were recorded in 2 years, the volume of imports grew an annual average of 509.8% from 75Kg in 2018 to 17 tons in 2021, as shown in the figure below.

Figure 5: Volume of Uganda's Casein Imports

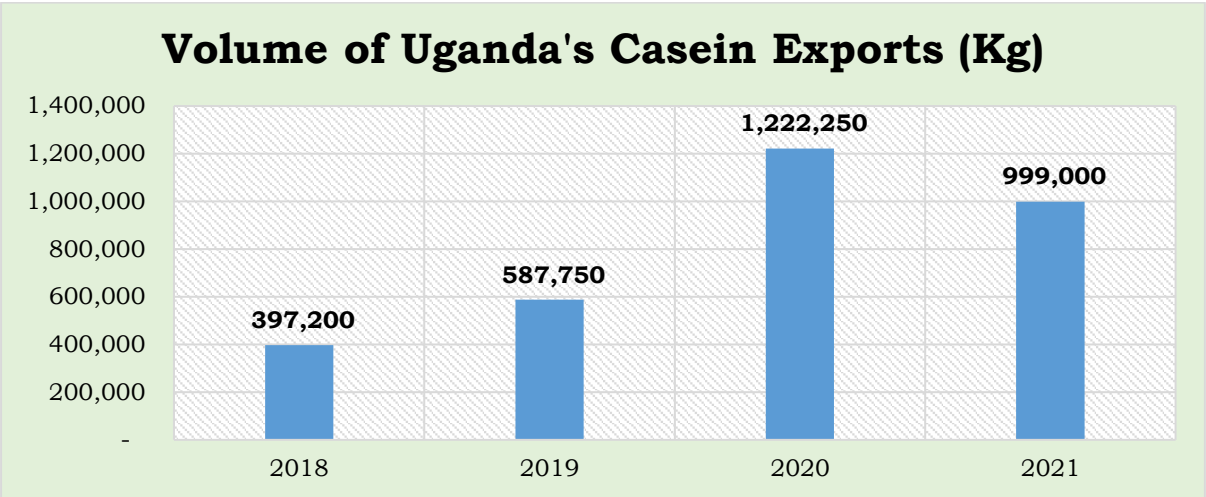


The rate of growth of the value of Uganda's casein imports over the same period has been twice as high, growing from US$ 74 in 2018 to US$ 128,333 in 2021.

According to DDA's Statistical Abstract (203), Uganda, in 2023, imported casein worth a total of UGX 1,855,500 (US$ 501) from Germany.

On the other hand, Uganda's casein export trade is very vibrant, given its production by some of the large processors. Over the 2018 – 2021 period, casein was exported in each year. The total volume of exports over the period grew at an average annual rate of 36%, from 397.2 tons to 999 tons, as shown in the figure below.

Figure 6: Volume of Uganda's Casein Exports



The value of these exports has also grown at a faster average annual rate (52.2%), from US$ 2.08m in 2018 to US$ 7.3m in 2021.

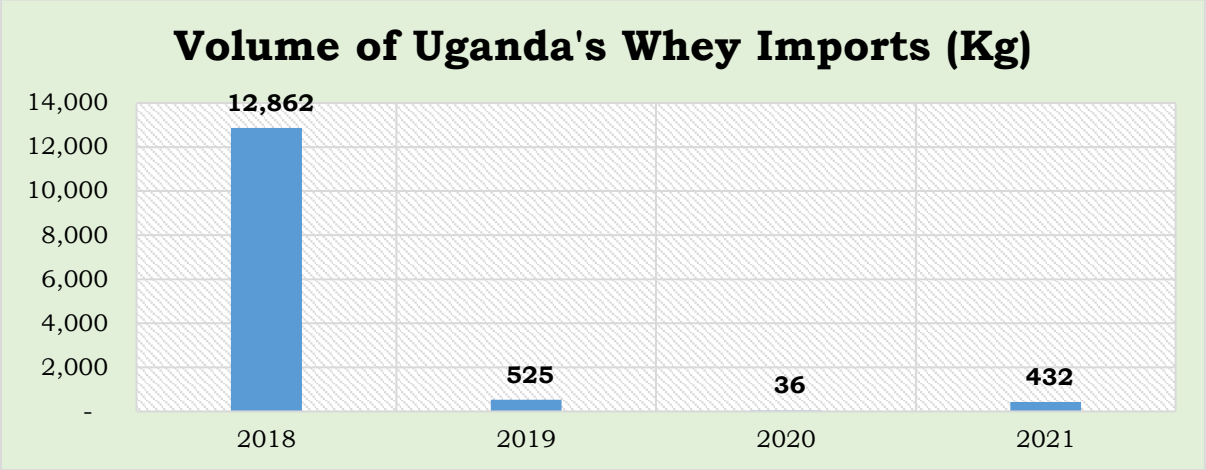
According to DDA's Statistical Abstract (203), Uganda, in 2023, exported casein worth a total of UGX 60,891,520,310 (US$ 16.5m) to United States, India, and Ethiopia.

Generally, Uganda's balance of casein trade has grown at an annual average rate of 51.3%, from a surplus of US $2.08m in 2018 to US$ 7.21m in 2021.

D. Uganda's Whey Market

Uganda's imports of whey are minimal and have reduced steadily over the 4-year period from 2018 to 2021 at an average annual rate of 67.7%, from 12.8 tons to 432Kg. This can be attributed to increased local production by large scale dairy processors.

Figure 7: Volume of Uganda's Whey Imports

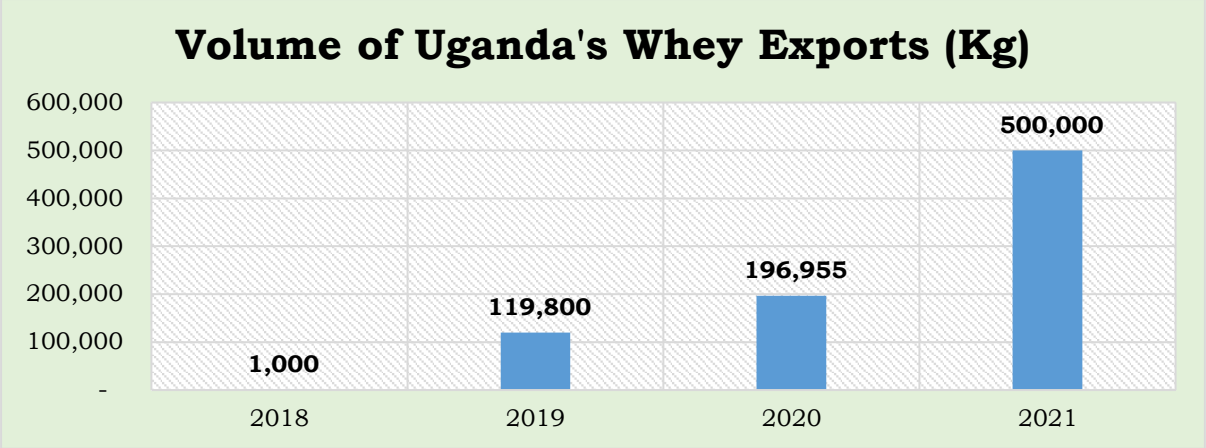


The value of these imports has reduced at an even faster average annual rate of 77.1%, from US$ 20,948 to US$ 251.

According to DDA's Statistical Abstract (203), Uganda, in 2023, imported whey worth a total of UGX 2,377,443 (US$ 643) from Denmark and India.

With respect to the export trade, while export volumes are still low, they have grown incredibly from 1 ton in 2018 to 500 tons in 2021, an average annual rate of 693.7%. The value of these exports has grown even faster, from US$ 298 to US$ 430,201, an average annual rate of 1030.7%.

Figure 8: Volume of Uganda's Whey Exports



According to DDA's Statistical Abstract (203), Uganda, in 2023, exported whey worth a total of UGX 2,052,806,288 (US$ 554,813) to South-Sudan and India.

Uganda's balance of whey trade has grown from a deficit of US$ 20,651 in 2018 to a surplus of US$ 429,950 in 2021, an average annual growth rate of 375%.

ii). Rest of East Africa:

This sub-section presents an estimate of the butter and cheese markets in East Africa, excluding Uganda. This includes Kenya, Tanzania, Rwanda, Burundi, and South Sudan. However, due to absence of data from South Sudan, the estimates based on import and export trade data does not include the estimates of South Sudan's market.

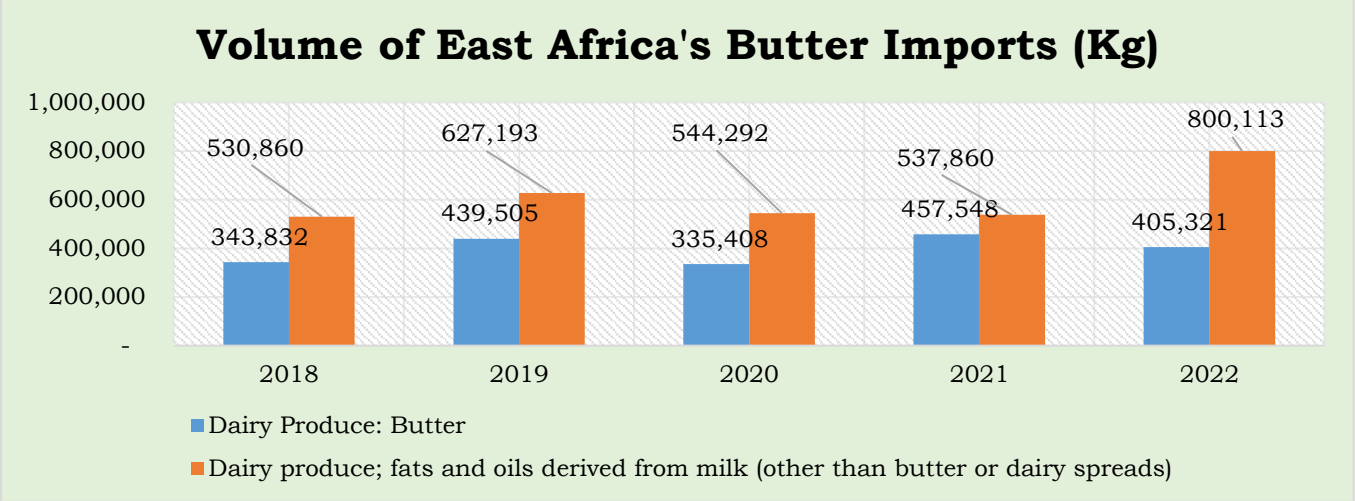
A. Rest of East Africa's Butter Market

The size of the butter market in East Africa, excluding Uganda, by production volumes, is also difficult to estimate due to the absence of data specific to the products. However, based on Sub-Saharan Africa's estimated 2022 average per capita consumption of butter of 0.2kg[12], the region's annual butter consumption can be estimated at a total of 32,930 tons.

Looking at the region's (excluding Uganda and South Sudan) butter trade volumes and values to estimate the market size, imports have grown from a total of 874.7 tons in 2018 to 1,205.4 tons in 2022, an annual average growth rate of 8.3%. (UNComtrade data).

[12] https://www.oecd-ilibrary.org/butter-projections-consumption-per-capita_5jrzxx43116d.xls?itemId=%2Fcontent%2Fcomponent%2Fagr_outlook-2015-table147-en&mimeType=vnd.ms-excel

Figure 9: Volume of East Africa's Butter Imports

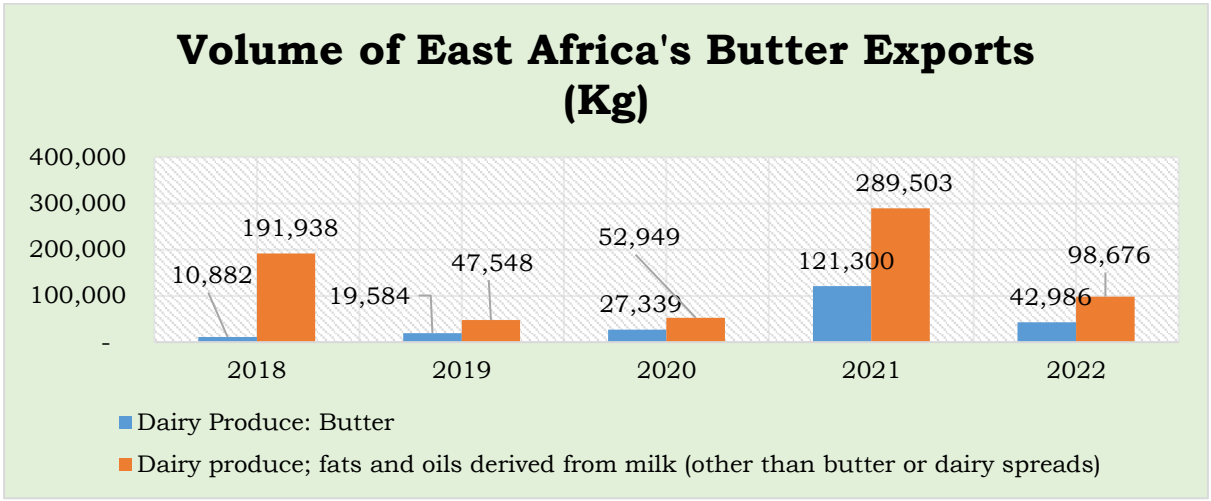


While trade volumes have not exhibited constant growth, total imports of the butter/dairy spreads segment increased from 343.8 tons in 2018 to 405.3 tons in 2022, an average annual growth rate of 4.2%, while imports of the ghee and butter oil segment increased from 530.9 tons in 2018 to 800.1 tons in 2022, an average annual increase of 10.8%.

Over the period, the ghee and butter oil segment contributed a total of 60.5% of the import volumes and 72.4% of the value of imports, while the butter/dairy spreads segment contributed a total of 39.5% of the import volumes and 27.6% of the value of imports.

With respect to the export market, total butter exports dropped from 202.8 tons in 2018 to 141.7 tons in 2022, an average annual reduction of 8.6%.

Figure 10: Volume of East Africa's Butter Exports



East Africa's[13] exports of the butter/dairy spreads segment grew from 10.9 tons in 2018 to 42.9 tons in 2022, an average annual growth of 41%, while exports of the ghee and butter oil segment dropped from 191.9 tons in 2018 to 98.7 tons in 2022, an average annual reduction of 15.3%.

Over the period, the ghee and butter oil segment contributed a total of 75.4% of the export volumes and 68.6% of the value of exports, while the butter/dairy spreads segment contributed a total of 24.6% of the export volumes and 31.4% of the value of exports.

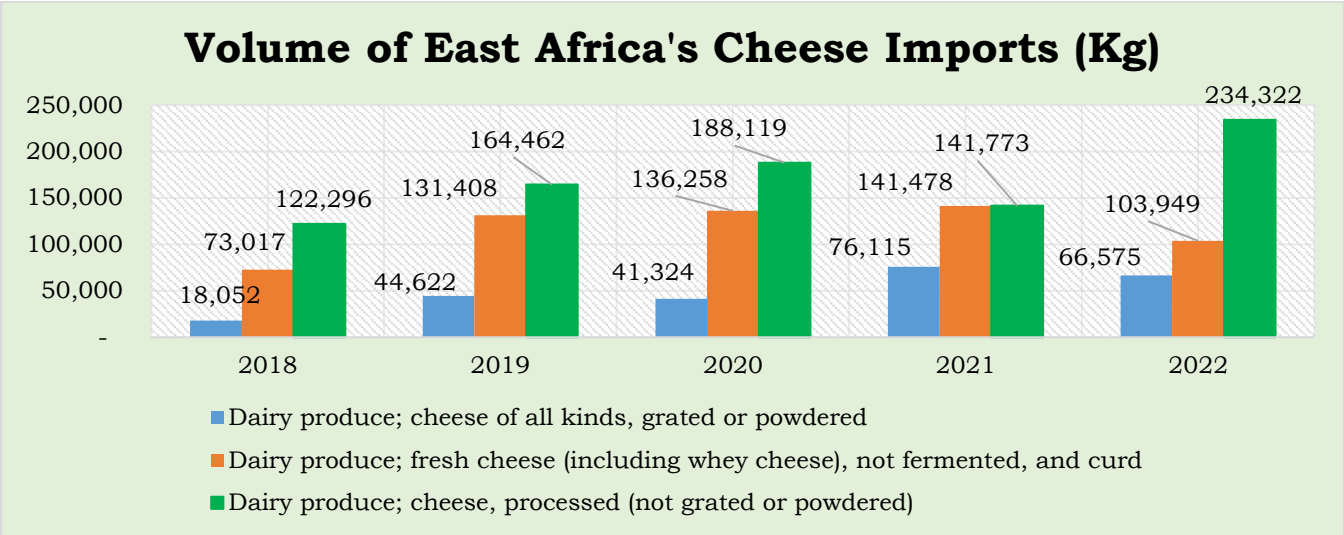
Generally, the region's butter trade balance improved slightly from a deficit of US$ 2.96m (derived from 671.9 tons) in 2018 to a deficit of US$ 2.45m (derived from 1,063.8 tons) in 2022. This equates to an annual average improvement of 4.7% in value derived from an annual average growth rate of 12.2% in volume.

B. Rest of East Africa's Cheese Market

Based on Sub-Saharan Africa's estimated average per capita consumption of cheese of 0.19kg[14], East Africa's[15] current annual cheese consumption can be estimated at 31,359 tons and is expected to grow to 41,450 tons in 2032 – an average annual growth rate of 2.8%, a result of mostly a projected population growth rate of 2%[16].

East Africa's total cheese imports have grown from 213.4 tons in 2018 to 404.8 tons in 2022, an average annual growth rate of 17.4%.

Figure 11: Volume of East Africa's Cheese Imports



[13] Excluding South Sudan and Uganda

[14] Per capital consumption of cheese in selected regions (2022) https://www.oecd-ilibrary.org/agriculture-and-food/per-capita-consumption-of-cheese-in-selected-regions_c0afd033-en

[15] Excluding South Sudan and Uganda

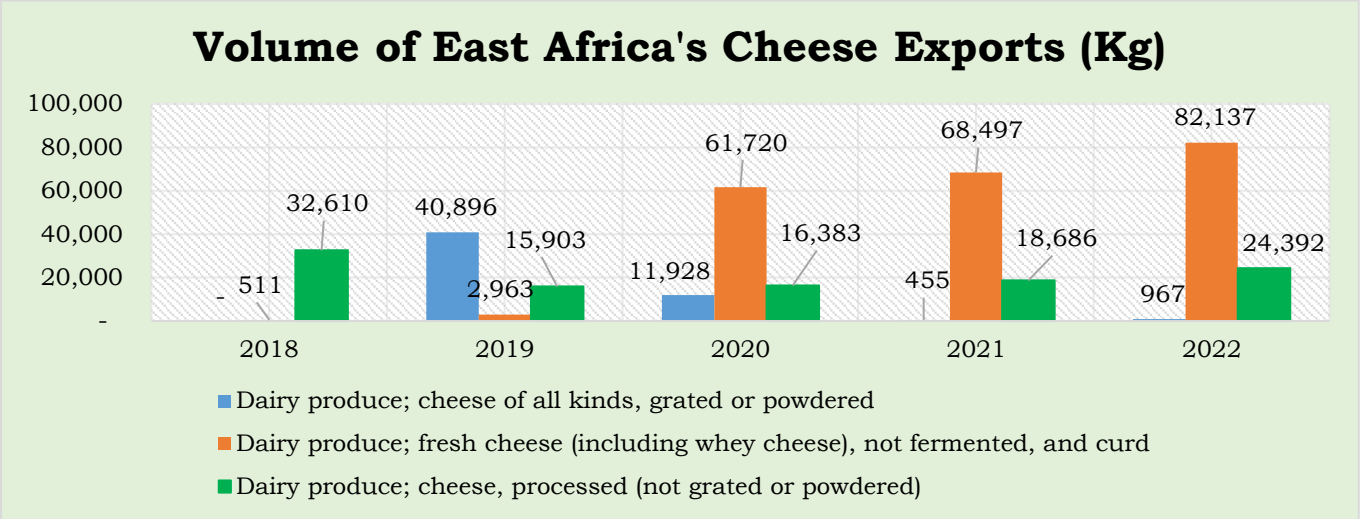
[16] Calculated based on projected population values in 2032 for Kenya, Tanzania, Rwanda, Burundi, & South Sudan

The processed cheese that is not grated or powdered segment contributed 50.5% of the total imports over the 5-year period, while the fresh cheese and the processed grated or powdered cheese segments contributed 34.8% and 14.7%, respectively.

In terms of growth rates, all segments experienced growth over the period, with the processed cheese that is grated or powdered segment experiencing the highest growth rate of an annual average of 38.6%, while the fresh cheese and the processed cheese that is not grated or powdered cheese segments grew by 9.2% and 17.7%, respectively.

With respect to the export market, total cheese exports increased from 33.1 tons in 2018 to 107.5 tons in 2022, an average annual increase of 34.2%.

Figure 12: Volume of East Africa's Cheese Exports



The fresh cheese segment contributed the highest share of exports with 57.1% of the total exports over the 5-year period, while the processed cheese that is not grated or powdered, and the processed cheese that is grated or powdered segments contributed 28.6% and 14.3%, respectively.

In terms of growth rates, the fresh cheese segment was the only growth segment, growing an annual average of 256.1%, while the processed cheese that is not grated or powdered and the processed grated or powdered cheese segments dropped by 7.0% and 71.3%, respectively.

Generally, East Africa's[17] cheese trade balance grew from a deficit of US$ 719,904 (derived from 180.2 tons) in 2018 to a deficit of US$ 1,102,743 (derived from 297.4 tons) in 2022. This equates to an annual average deterioration of 11.2% in value derived from an annual average deterioration of 13.3% in volume.

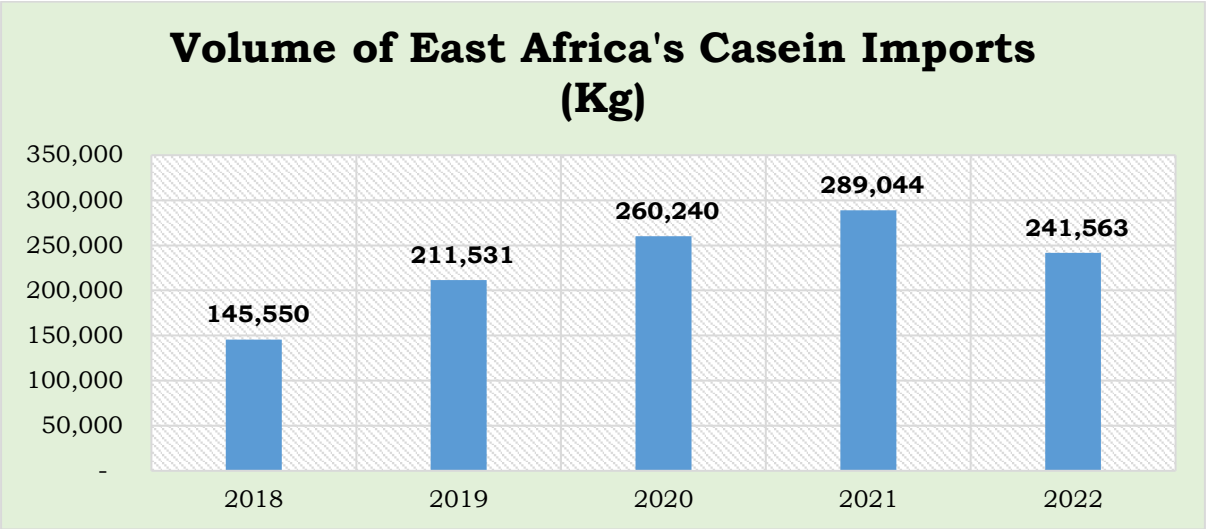
C. Rest of East Africa's Casein Market

Imports of casein by the rest of East Africa have grown steadily between 2018 and 2022, from 145.5 tons to 241.5 tons – an annual average growth rate of 13.5%. The value of these imports

[17] Does not include South Sudan and Uganda.

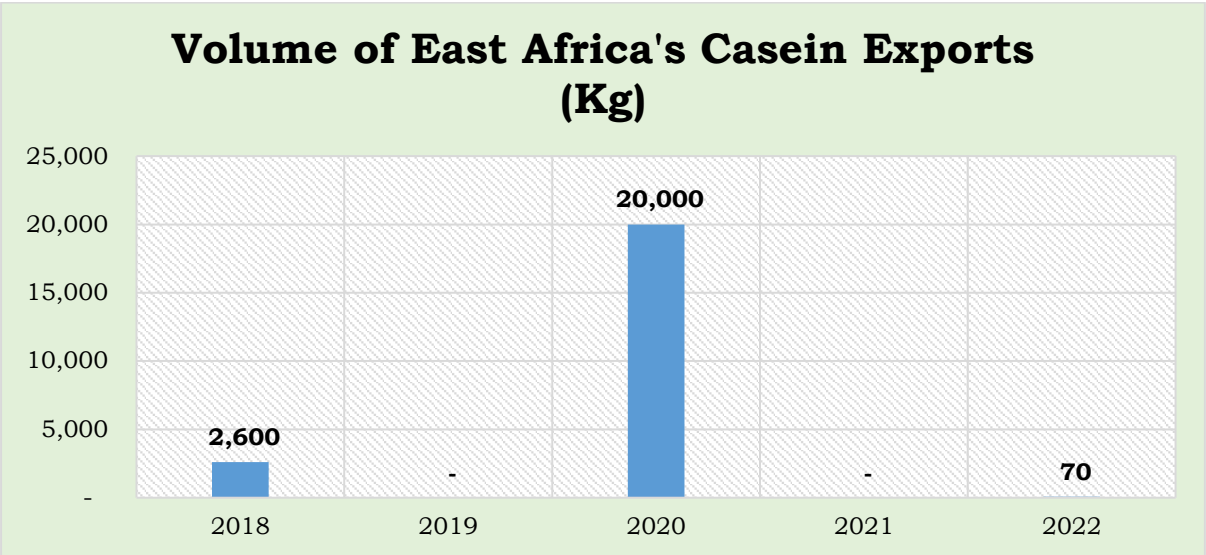
has grown even faster from US$ 864,777 to US$ 2.54m – an average annual growth rate of 31%. This translates to an average annual import volume of 229.5 tons with an average value of US$ 1.35m.

Figure 13: Volume of East Africa's Casein Imports



Exports of casein from the rest of East Africa, on the other hand, are very minimal and have reduced greatly over the 2018 – 2022 period. Export volumes reduced at an average annual rate of 59.5%, from 2.6 tons in 2018 to 70Kg in 2022. The value of these exports has reduced at the same rate (59%), from US$ 22,469 to US$ 633.

Figure 14: Volume of East Africa's Casein Exports

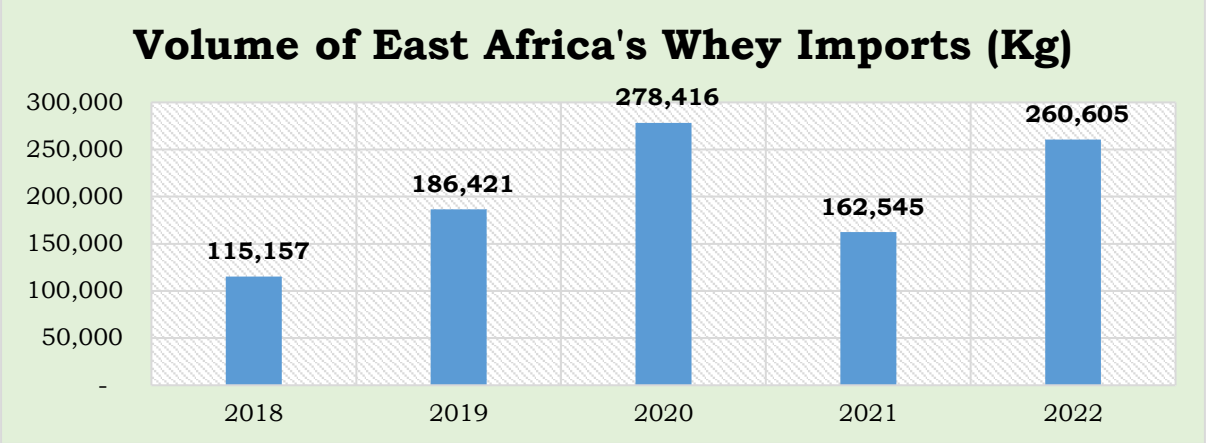


East Africa's balance of casein trade deficit has grown from a deficit of US$ 842,309 in 2018 to a deficit of US$ 2.54m in 2022, an average annual growth rate of 31.7%.

D. Rest of East Africa's Whey Market

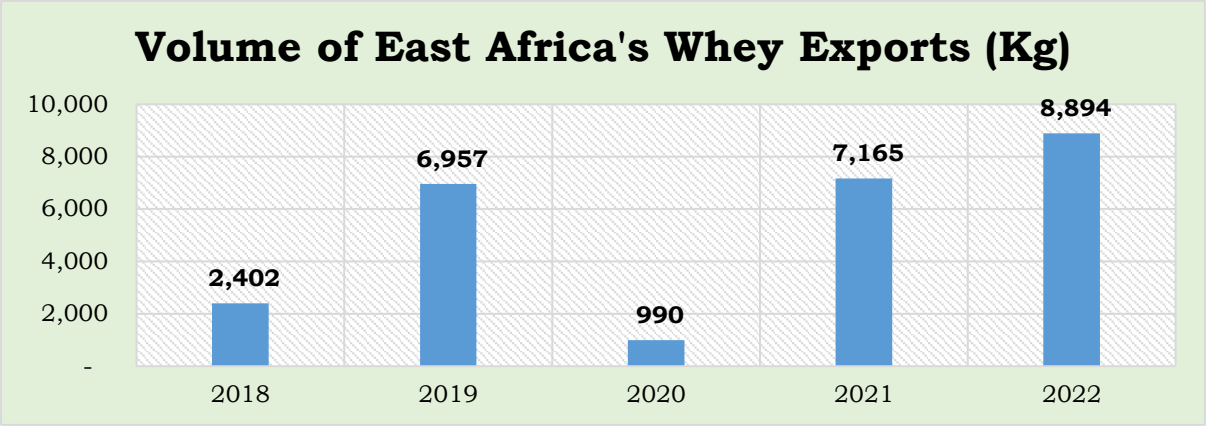
Total imports of whey by other East African countries have grown steadily between 2018 and 2022, from 115.2 tons to 260.6 tons – an average annual growth rate of 22.7%. The value of these imports has grown even faster at a rate of 34.9%, from US$ 169,478 to US$ 561,623.

Figure 15: Volume of East Africa's Whey Imports



With respect to the regions whey exports, the rest of East Africa's export volumes have grown from 2.4 tons in 2018 to 8.9 tons in 2022, an average annual growth rate of 38.7%. The total value of these exports, however, has reduced from US$ 18,993 to US$ 12,534, an average annual reduction of 9.9%.

Figure 16: Volume of East Africa's Whey Exports



4.1.2. Salient Market Features:

A. Milk Production & Collection:

Given that the Company's milk collection is focused wholly on Uganda, and specifically, South-Western Uganda, we highlight some salient features of the milk collection trends in Uganda.

Uganda's dairy sector has grown impressively over the last decade, from a total production of 2.08 billion litres in 2015 to over 3.85 billion litres in 2023, an average annual growth rate of 8%[18]. While the Central region of the country has the highest dairy cattle productivity at 9.8 litres per cow (per day), the South-Western region produces most of the milk (25%), while the Central region produces 24%[19].

With respect to the national dairy herd, about 93% of the cattle kept for dairy is of local breeds, including Nganda, Zebu, Sanga (Ankole long-horned) and Boran. These breeds, at a production rate of 1 – 4 litres per day, produce 10 – 13 times less milk than exotic cows like the Friesian, Ayrshire, Jersey and Guernsey breeds. Farmers, however, prefer the local breeds due to their lower maintenance costs especially when it comes to feeding, but also their intolerance to tick-borne diseases especially the fatal East Coast Fever (ECF)[20]. Some farmers in the cattle-keeping regions and cultures also keep large herds of these local breeds as a status symbol.

There are three fresh milk production systems in Uganda. First, the traditional open grazing and feeding system – with the lowest milk productivity – accounts for 85% of the national cattle stock. The second system involves mixed crop and livestock farms; small-scale firms of approximately ten cattle that graze the cattle during rainy seasons and resort to complementary feeding in the dry season. This mixed system developed following liberalisation and is mostly practiced in peri-urban areas. Lastly, the zero-grazing system is used by large dairy farms of 20 to 100 exotic cattle, mainly in Western Uganda; this accounts for 6% of the total cattle population. The cost per kg of milk produced is three times higher under zero grazing relative to open grazing, but this is compensated by a four-fold higher production per cow. The level of supply differs between rainy and dry seasons, and profit margins are influenced by the prices of feed (costs) and milk (revenue), which are both highly volatile[21].

With respect to milk collection, while the GoU's efforts to change the sector from a focus on the state-owned Dairy Corporation Limited (DCL) to a market-led model with a focus on supporting private processing firms has given room for increased efficiency, 80-85% of the milk collection is still within the informal space. The GoU and development partners have also made significant investments in milk collection centers (MCCs), albeit, with some regional imbalance, where 75% and 15% of MCCs are in the South-Western and Central regions, respectively. There are three organisational structures that characterise the milk collection and trade[22]:

I. Direct delivery to consumers without treatment. This constitutes 20-30% of total milk sales and has the least potential for value addition;

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[18] Dairy Industry in Uganda (2023) - https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023

[19] Factsheet: Dairy sector of Uganda (2019) - https://www.agroberichtenbuitenland.nl/binaries/agroberichtenbuitenland/documenten/rapporten/2019/04/11/factshett-dairy-sector-uganda/Factsheet+Dairy+sector+Uganda.pdf

[20] How TicVac-U will turn Ugandan cows into cash cows - https://ticvac.co.ug/article/how-ticvac-u-will-turn-ugandas-cows-into-cash-cows#:~:text=Unfortunately%2C%20it%20is%20still%20a,is%20spent%20to%20manage%20them

[21] Dairy value chains in East Africa (2017) - https://www.theigc.org/sites/default/files/2017/03/Dairy-chain-brief.pdf

[22] Dairy value chains in East Africa (2017) - https://www.theigc.org/sites/default/files/2017/03/Dairy-chain-brief.pdf

II. Milk is bulked and cooled at MCCs, which then bypasses processors and is distributed directly to consumers. This constitutes 50-60% of total milk marketed; and

III. Milk goes through dairy processors that own and/or operate processing plants and can produce pasteurised packaged dairy products. 15-20% of total marketed milk is processed through this channel.

Regarding the trends in the prices of fresh milk, there is a lot of price fluctuation based on the changing seasons, depending on the availability of rain which determines the amount of water and feed available. For instance, in 2021, farmers in South-Western Uganda were affected by volatility in prices which saw prices drop 25% from UGX 800 (US$ 0.22) in March and April to UGX 600 (US$ 0.16) in May. This was from a high of UGX 1,500 (US$ 0.41) per litre a few months prior[23].

Prices also vary widely between the farmgate (price paid to farmers) and the retail prices (price paid to milk collection centers), with an over 50% variation between the national averages of the 2 prices in 2023[24]. Prices also vary between the different regions of the country, mostly experienced with the farmgate prices. The national average prices for different regions, as of August 2023 is shown below.

Regional Prices of Fresh Milk in Uganda as of August 2023[25]

Region	Farmgate Price (UGX)	Retail Price (UGX)	Price Variation	Farmgate Price (US$)	Retail Price (US$)
South-Western	1,187	1,900	60.1%	0.32	0.51
Central	1,000	1,800	80.0%	0.27	0.49
Eastern	1,328	1,776	33.7%	0.36	0.48
North-Eastern	1,450	1,950	34.5%	0.39	0.53
Northern	1,300	2,000	53.8%	0.35	0.54
Mid-Western	1,200	1,800	50.0%	0.32	0.49
Average	**1,244**	**1,871**	**50.4%**	**0.34**	**0.51**

Over the period 2019 to 2020, the farmgate price rose 8.9%, from UGX 984 (US$ 0.27) to UGX 1,072 (US$ 0.29).

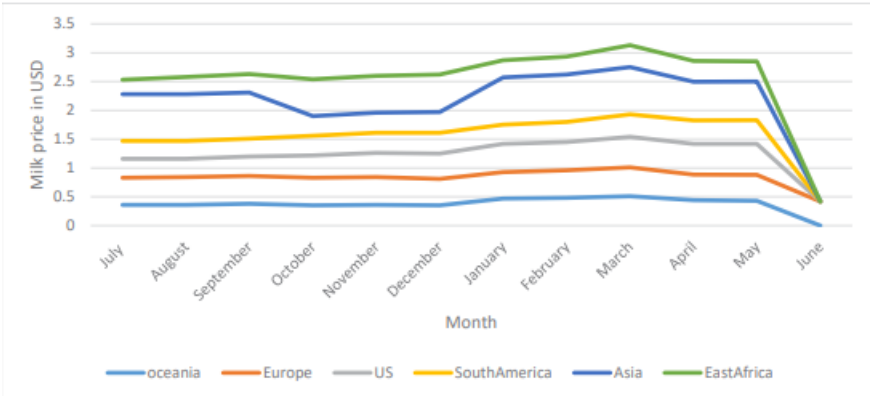
With respect to global prices, the raw milk prices in Uganda and the East African region are higher than the Americas, Europe, Asia, and Oceanea, as shown in the figure below.

[23] Dairy Industry in Uganda (2023) - https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023

[24] As of August 2023.

[25] Dairy Industry in Uganda (2023) - https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023

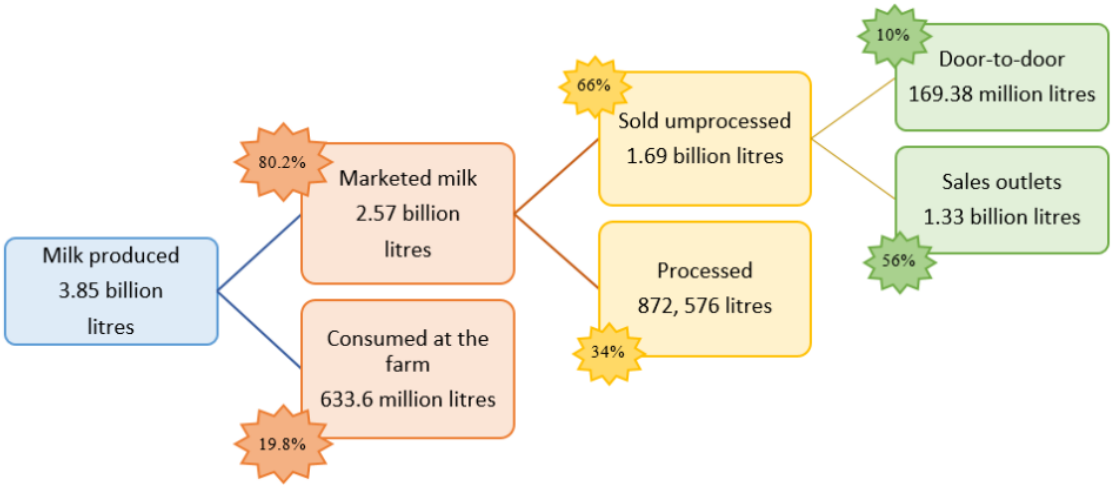
Figure 17: Comparison Between East Africa' Raw Milk Prices Vs the Rest of the World



B. Milk Marketing:

About 80% of fresh milk produced in Uganda is sold in the market. As of September 2023, 80.2% (2,566,400,000L) was marketed while 19.8% (633,600,000L) was consumed at the farm[26]. Only about 34% of the marketed milk is processed into different products, including pasteurised milk, UHT milk, powdered milk, yoghurt, butter, and cheese. This is shown in the figure below that shows the disaggregation of milk at different stages of the value chain in Uganda, as of September 2023.

Figure 18: Volumes of Milk at Different Stages of the Value Chain in Uganda



C. Milk Processing & Distribution[27]:

Although Uganda's milk processing capacity grew four-fold over the 2008 – 2018 period, most dairy processors operate below installed capacity, with the exception of JESA Farm whose business model relies on trust-based relation with milk suppliers. Industry-level capacity utilisation

[26] Dairy Industry in Uganda (2023) - https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023

[27] Dairy value chains in East Africa (2017) - https://www.theigc.org/sites/default/files/2017/03/Dairy-chain-brief.pdf

oscillates between 40-60% between the lean and peak production seasons, implying an upward push on the per-litre processing cost especially in the dry season.

Despite the end of state-controlled processing, the dairy industry is still highly concentrated; the top three processors control 83% of the national installed capacity, and there are just 14 processors for the whole country.

There are currently three distribution systems for processed dairy products:

I. Distribution systems owned and operated by the dairy processor, using trucks to distribute products to distribution outlets;

II. Distribution systems owned by the dairy company but outsourced to independent entrepreneurs; and

III. Grocery retailers and modern supermarkets. Supermarket retailers consider dairy a key product line and market a range of dairy products manufactured by local and regional dairy processors.

Based on 2022 data, UHT long life milk and yoghurt are the top 2 processed products by volume, respectively. Cheese is the 5th most processed, while butter and butter oil are the 9th and 10th most processed by volume, respectively. This is shown in the table below which also shows their average ex-factory price, i.e., price at the factory[28].

Figure 19: Share of Uganda's Processed Dairy Products by Volume & Their Prices-2022

Processed Products	Production % Based on Volume	Ex-Factory Price/Kg (US$)
	2022	2022
UHT long life	62.40%	1.19
Yoghurt	11.60%	3.88
Milk powder	7.10%	0.61
Pasteurized milk	6%	0.66
Cheese	3.10%	6.41
Acid Casein	2.40%	
Ghee	2.30%	3.10
Ice cream	1.70%	
Butter	1.30%	3.73
Butter Oil	0.80%	6.37
Whey Protein	0.80%	
Vito	0.50%	
	100.00%	

Based on 2023 export data from DDA, milk powder, UHT milk, and casein were the top 3 exported products, as shown in the table below.

[28] Derived from Dairy Development Authority (DDA) Statistical Abstract 2021-22 - https://dda.go.ug/images/1705390625.pdf

Table 4: Uganda's Dairy Exports by Value - 2023

PRODUCTS	EXPORT VALUE	EXPORT DESTINATIONS
Milk Powder	UGX 529,021,016,510 US$ 142,978,653	Kenya, South Sudan, Tanzania, DRC, Ethiopia, Malawi, Rwanda, Mali, Burundi, Madagascar
UHT Milk	UGX 323,058,260,751 US$ 87,313,043	Kenya, South Sudan, Tanzania, DRC, Rwanda, Burundi
Casein	UGX 60,891,520,310 US$ 16,457,167	United States, India, Ethiopia
Butter	UGX 45,159,866,599 US$ 12,205,369	Kenya, Egypt, South-Sudan, Tanzania, Oman, DRC, Rwanda, Japan, South-Africa, Sudan, Burundi, Turkey, Netherlands
Ghee	UGX 8,145,989,949 US$ 2,201,618	Kenya, Egypt, Tanzania, Oman, Rwanda, Japan, Sudan, Netherlands
Yoghurt	UGX 7,747,564,120 US$ 2,093,936	Kenya, South-Sudan, DRC, Rwanda, Yoghurt
Whey	UGX 2,052,806,288 US$ 554,812	South-Sudan, India
Cheese	UGX 286,676,209 US$ 77,480	Kenya, South-Sudan, Burundi
Grand Total	**UGX 976,363,700,736** **US$ 263,882,081**	

D. Political Environment[29]:

Kenya's ban on dairy imports from Uganda

Uganda and Kenya have had disputes regarding trade, with the latter banning Ugandan exports into the country on a few occasions. In 2019, Kenya enforced a ban on dairy products from Uganda costing the nation revenues of more than US$ 27m resulting from claims that milk from Uganda was not supplied by farmers but imported in powdered form from other countries and re-formed to be sold as fresh milk. This ban continued on into 2020 seeing a company like Pearl Dairies operating at a little over 14% of its installed capacity, having its merchandise invaded and seized by Kenyan officials as well as having its trucks refused entry at the border. Despite partly lifting the ban on a few companies, that is to say, Brookside, Pearl Dairies, Birunga Dairies, and Lakeside Dairies, there has always been a lingering threat to the Dairy industry in Uganda that Kenya could impose another ban at any time in the future.

[29] Dairy Industry in Uganda (2023) - https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023

Kenya, theoretically, has lifted formal bans but it actively continues to stifle milk trade from Uganda by limiting import permits which are a requirement for market access. The result is that Kenya imports less milk in volume terms compared to its absorption capacity. In March 2023, Nairobi reinstated its 2021 ban on Ugandan milk products, especially powdered milk.

Kenya has the capacity to absorb 700 million litres of Uganda's milk annually, a trading volume that wouldn't disturb local farmers since the country has a milk production deficit of 2.2 billion litres. Despite this, Kenya allows around 200m litres of milk from Uganda annually, a figure that dropped even further following the recent restrictions on Brookside.

As a result, the Ugandan government has been working to open up access to other markets within East Africa including the Democratic Republic of Congo, Ethiopia, Tanzania, Rwanda and Burundi, on top of encouraging local consumption, especially through school milk programs. Government efforts to find new markets for Ugandan milk exports recently paid off with the country's first official dairy exports to Algeria set to kick off starting October 2023. The export deal worth US$500m will see Uganda export milk products to Algeria as part of a trade agreement that will see Uganda export 1.4 billion litres of milk to the North African country.

Dairy production is the Government's priority sectors

One of the priority areas identified by the government as part of its Agro-Industrialization programme of the National Development Plan III for 2020/21 to 2024/25 is increasing the production of milk. With milk as one of the 10 major products identified, the government is directing efforts towards training those involved in the dairy sector, encouraging better methods for the production of feeds and backing dairy farming as a commercial venture.

In addition, the government established the Dairy Development Authority guided by the Dairy Industry Act of 1998 with the aim of increasing the value addition and quality of dairy in order to enhance its competitiveness. The Authority has contributed to the development of the sector through, among other things, building and renovating milk collection centres in districts in the Northern region, and through numerous efforts such as playing a role in milk promotion, improving transnational trade and also keeping a close eye on the domestic and global prices of milk.

Ugandan Government's efforts in milk marketing

The Government is continually seeking new markets for Uganda's dairy in light of the challenges it has faced with fellow East African countries, recently adding Zambia as one of the export destinations. This development has seen Pearl Dairies score a deal to supply Coca-Cola Beverages in Zambia with an annual milk powder consignment of 700 metric tonnes.

Similarly, Algeria was secured as another dairy export destination in 2020 with the first shipment comprising 120,000 metric tons of powdered milk departing in October 2023 as part of an export agreement worth US$500 million which will see Uganda export 1.4 billion litres.

Furthermore, through the Africa Continental Free Trade Area Agreement (AfCFTA), the government was able to obtain a market for Lato milk by Pearl Dairies in South Sudan, Malawi and Ethiopia. Obtaining more markets for the dairy industry is an opportunity for dairy producers, exporters and the industry as a whole to increase production and revenue.

E. Opportunity for Import Substituion:

In 2023, Uganda's dairy exports value outstripped its imports value by a factor of over 34. This shows the self-sustenance of the Country, especially with respect to the dairy products its processors produce, i.e., processed milk, yoghurt, butter and ghee. However, some dairy products are still imported in fairly significant quantities. In 2023, the country's dairy imports amounted to a total value of over UGX. 28.6Bn. (US$ 7.7m), with infant formula, ice cream, and cheese being the highest imports by value, respectively. This is shown in the table below.

Table 5: Uganda's Dairy Imports by Value - 2023

PRODUCT	IMPORT VALUE (UGX)	COUNTRY OF ORIGIN
Infant Formula	13,808,632,776	Kenya, France, Quatar, Ireland, Poland, Mexico, Netherlands, United Arab Emirates, China, Germany, Belgium, Denmark, Rwanda, New Zealand, United States, Lebanon, India, United Kingdom, South-Sudan, Oman, Australia, DRC, Singapore, Switzerland, Canada
Ice Cream	10,176,452,153	Kenya, France, Iran, United Kingdom, United Arab Emirates, Germany, Belgium
Cheese	1,744,460,872	Kenya, France, Austria, Greece, Poland, Netherlands, United Kingdom, United Arab Emirates, Germany, Belgium, Italy, Denmark, Rwanda, United States, Lebanon, India, Canada
Milk Powder	1,247,666,452	Kenya, France, Quatar, Argentina, Japan, Turkey, Greece, India, Milk powder, Mexico, South-Africa, Netherlands, United Arab Emirates, China, Belgium, Italy, Switzerland, Denmark, Malaysia, Rwanda, New Zealand, United States, Hong Kong, India, Saudi Arabia, Oman, Switzerland, Sweden, Saudi Arabia, South-Sudan, Thailand, Oman
Yoghurt	1,057,196,204	Kenya, France, Netherlands, United Kingdom, United Arab Emirates, China, Germany, Belgium, Malaysia, New Zealand, United States, India, Oman
UHT Milk	473,240,533	Kenya, France, South-Africa, Netherlands, United Kingdom, United Arab Emirates, Germany, Belgium, Denmark, Malaysia, Saudi Arabia, South-Sudan, Thailand, DRC

Butter	99,719,764	Kenya, France, South-Africa, Netherlands, United Kingdom, United Arab Emirates, Belgium, Italy, Rwanda, Lebanon, India
Whey	2,377,443	Denmark, India
Casein	1,855,500	Germany
Ghee	899,858	India
Grand Total	**28,612,501,554**	

4.1.3. Casein & Whey Powder Global Market Trends:

A. Casein[30]

- **Market Growth and Size:** The market is experiencing stable growth, driven by increasing consumer awareness of protein-rich diets and the demand for dairy-based products. Market size estimates in 2023 range from US $1.1Bn – US $3.2Bn for around 413 kilo tons. Over the period 2024 – 2032, the global market is expected to grow by an average annual rate of between 3.6% to 6.9% to reach a value of around US $5.9Bn for around 574 kilo tons.

- **Product Types:** There are 3 major types of casein products, namely:

  i. ***Rennet Casein:*** Rennet casein is a primary category in the casein market, known for its use in various food applications. It is obtained through the precipitation of milk proteins with the use of rennet enzymes or acids. This type of casein is popular for its ability to form stable gels, making it an essential ingredient in the production of cheese. Apart from this, its versatility extends to other dairy products, such as yogurts, and it also finds applications in the manufacturing of processed foods, infant formulas, and protein supplements; and

  ii. ***Acid Casein:*** Acid casein is obtained by precipitating milk proteins using acids like hydrochloric acid or citric acid. Acid casein is primarily used in non-food applications, such as the production of adhesives, paints, and coatings. It is valued for its adhesive properties and ability to form a smooth film when dried. Additionally, acid casein is used in cosmetics, particularly in skincare and hair care products.

  iii. ***Caseinates:*** Acid casein is insoluble at neutral pH. It is therefore necessary to treat it with a base to obtain different types of caseinates:
  - Sodium caseinate,
  - Calcium caseinate,
  - Potassium caseinate.

  Caseinates can be manufactured by spray-drying, by roller or by extrusion.

[30] This sub-section is derived from the following market analyses: https://www.expertmarketresearch.com/reports/casein-market, https://www.futuremarketinsights.com/reports/casein-market#:~:text=Casein%20Market%20Outlook%20(2023%20to,US%24%204.9%20Billion%20by%202033., https://www.imarcgroup.com/casein-market, https://www.mordorintelligence.com/industry-reports/global-casein-and-caseinates-market, https://www.persistencemarketresearch.com/market-research/casein-caseinate-market.asp, https://www.researchandmarkets.com/report/casein?srsltid=AfmBOoq2PG5qhBTIJZ5GCLBREG_FspOaI4YZGnb1PZE-1EE4vUYdRHRa

- **Technological Advancements:** Research and development (R&D) efforts are leading to the development of innovative casein-based formulations in pharmaceuticals and cosmetics.
- **Industry Applications:** The market is experiencing high demand from diverse industries, including pharmaceuticals, cosmetics and personal care, and food and beverage (F&B). The pharmaceutical sector, in particular, is witnessing a strong uptake of casein due to its increasing use in tablet formulations to ensure cohesion and integrity. Of all products, sodium caseinate holds a sizeable share of the Global Casein and Caseinate Market. It owes to its ever-increasing adoption as an emulsifier, stabilizer, & food additive in different end-user industries. In the past few years, sodium caseinate has gained immense popularity across various end-user verticals. This multifunctional food additive is increasingly being used as an emulsifier, thickener, & fat stabilizer. It owes to its properties like high nutritional value, superior water holding capacity, incredible emulsification & stabilizing nature, etc. Moreover, with a high amino acid content, it can also be used as a protein supplement. Calcium caseinate is also likely to see sales growth because calcium fortification is becoming increasingly popular. Sports beverages are projected to drive casein market growth.
- **Geographical Trends:** Europe leads the market, driven by strong dairy industries and high-quality standards. However, North America and Asia are emerging as fast-growing markets, driven by changing consumer preferences and expanding industries. The Asia-Pacific region, especially India, China, and New Zealand, is expected to witness the highest growth in sales. Europe, however, is the biggest consumption market.
- **Competitive Landscape:** Key players in the casein market are known for their quality products and global presence. Additionally, competition is intensifying with the entry of new players offering niche products. Major producers include Fonterra Co-operative Group, Westland Milk Products, Nestle, and Danone.
- **Challenges and Opportunities:** While the market faces challenges, such as fluctuating milk prices, supply chain disruptions, and regulatory compliance in the food industry, it also encounters opportunities in developing new casein-based functional ingredients, exploring emerging markets, and addressing health-conscious consumer demands.
- **Future Outlook:** The casein market is poised for continued growth on account of evolving consumer preferences for natural and protein-rich products. Moreover, ongoing innovations in casein-based applications, sustainable sourcing, and expansion into untapped regions are expected to propel the market growth.

B. Whey Protein[31]

- **Market Growth and Size:** The global whey protein market was estimated to be between US $6.51Bn and US $16.72Bn in 2023. This market is estimated to grow steadily at an

[31] This sub-section is derived from: https://www.grandviewresearch.com/industry-analysis/whey-protein-market; https://www.fortunebusinessinsights.com/whey-protein-market-106555; https://www.precedenceresearch.com/whey-protein-market; https://www.verifiedmarketresearch.com/product/whey-protein-market/; https://www.databridgemarketresearch.com/reports/global-whey-protein-market

annual average rate of between 7.5% and 8.9% in the period to 2032, to reach US $13.07Bn and US $33.74Bn in 2032.

- **Product Types;** There are 4 major types of whey protein on the global market, namely:

  i. **Whey Protein Isolates (WPI):** These are a type of whey protein that has been processed to remove most of the fat, lactose, and other non-protein elements. Whey protein isolates are prized for their purity and concentration, making them a preferred choice for many in the fitness and health communities looking to manage their protein intake precisely. Consumer preferences for incorporating proteins in regular foods, as well as rising demand for high-protein and low-fat weight management products, are expected to drive this segment's growth.

  ii. **Whey Protein Concentrates (WPC):** These are a part of whey proteins that remain soluble in the whey after casein precipitates at pH 4.6 and 20°C. These concentrates contain lipids, lactose, and minerals and are a heterogeneous mixture of different proteins. Furthermore, WPC is a low-cost alternative for blending caramel with superior flavor and processability. WPCs are employed in a variety of applications, such as the manufacturing of yogurt, beverages, and dairy desserts. In addition, these concentrates are used to fortify infant nutrition and food products with protein. When WPC is heated and dissolved in water, it presents a gelling property that is helpful in applications in the meat and nutritional industries. These properties are anticipated to contribute to the segment's growth which is the biggest segment, with sales estimated at over 50% of the whey protein market.

  iii. **Demineralized Whey Protein:** This refers to whey proteins from which a portion of the minerals (often referred to as ash in food processing terms) has been removed. Whey can be demineralized to different extents, commonly referred to as 25%, 50%, or 90% demineralized whey, indicating the percentage of minerals removed. The final ash content in these products is usually below 7%. This segment is used in nutritional products including infant formulas, medical foods, or sports nutrition where lower mineral content is desired for dietary reasons or taste; in functional foods including baked goods, confectionery, or dairy products where high mineral content might affect taste or texture, demineralized whey can be advantageous, and as a flavour where its lower mineral content can lead to a milder flavor, which might be preferable in some food products.

  iv. **Whey Protein Hydrolysate (WPH):** This refers to whey protein that has undergone hydrolysis, a process where larger protein molecules are broken down into smaller peptides and sometimes even individual amino acids. They have antimicrobial, antioxidant, and antihypertensive properties and are used in the manufacturing of clinical nutrition, sports nutrition, and infant nutrition products. WPH is also used in the production of baked products, low-fat foods, dietetic foods, and protein-fortified beverages. This segment has a modest but niche market share.

- **Technological Advancements:** Whey protein is a by-product that is obtained from the manufacturing process of cottage cheese and cheese casein. Manufacturers of these products are engaged in making better use of whey as the waste management cost or the cost of treatment is high and there are stringent regulatory policies on the environment. Such policies have been adopted by the government of various nations. One of the techniques that makes use of this by product generates it into a dry powder. The

introduction of the nanofiltration process and ultrafiltration process led to the use of these latest technologies in producing larger quantities of whey.

- **Industry Applications:** The sports nutrition segment held the dominating position in the past. The beverage industry and the food industry make extensive use of whey proteins. There are many health benefits associated with the consumption of energy drinks, confectionery products, and bakery products that make use of whey protein. The use of this product in the food and beverages industry helps in enhancing the flavor of the food product. It is used as a stabilizing and emulsifying agent. All of these factors will lead to the growth of the segment in the coming years. Weight management and sports nutrition are playing a significant role in the growth of the segment. Whey protein is used in the manufacturing of beverages, powders, and bars. Growing recommendations for consuming these protein powders from fitness centers will also increase the sales of the product. The cosmetic industry is also making use of this product in manufacturing procedures. Hair conditioners, hair shampoos, colors, hair dyes, face creams, and eye care products are manufactured with the use of whey protein.
- **Geographical Trends:** While North America is expected to continue being the dominant market segment, the Asia-Pacific region is expected to exhibit the highest growth.
- **Competitive Landscape:** The key players in the whey protein global market include Hilmar Cheese Company, Inc. (U.S.), Saputo Inc. (Canada), and Glanbia PLC (Ireland).
- **Challenges and Opportunities;** Key challenges facing the market include ***Supply Chain Disruptions:*** Issues such as transportation costs, raw material shortages, and logistics can all have an impact on whey protein production and distribution, affecting market stability and price; ***Regulatory Compliance:*** Meeting differing international food safety and labeling regulations necessitates considerable documentation and adherence, which presents regulatory challenges for whey protein makers; ***Price Volatility:*** Changes in dairy prices and foreign exchange rates can have a substantial impact on the cost of producing whey protein, affecting profitability and pricing strategies; ***Consumer Awareness:*** Educating consumers about the benefits of whey protein and debunking preconceptions about its use can be difficult, affecting market growth and acceptance rates worldwide; and ***Competition from plant-based proteins*** whose consumption is being driven by ascending product demand owing to growing consumer awareness about consuming a healthy diet and leading an active lifestyle. In addition, rising innovations in the manufacturing of proteins that contain a broad range of amino acids and perform specific functions, including energy balance, weight loss, muscle repair, and satiety, by various manufacturers, is creating the immense market potential for plant proteins. The opportunities in the market include ***Increasing Health Consciousness*:** Demand is being driven by growing awareness of the health benefits of whey protein, such as muscle growth, weight management and overall wellness; ***Rising Fitness Trends*:** As the global fitness industry grows, more athletes and fitness lovers are embracing whey protein supplements to boost their workout regimens; ***Growing Vegan Population:*** The demand for plant-based protein alternatives such as soy and pea protein are driving innovation in the whey protein industry to meet vegan needs; and ***Expanding Applications*:** Whey protein is finding new applications outside of traditional sports nutrition, such as infant formula, therapeutic nutrition and functional foods, expanding its market appeal.

4.2. Competitive Landscape

As at the end of 2023, Uganda had a total installed milk processing capacity of 3.41m litres/day, with an average operating capacity of 2.31m litres/day, or 68% of the total installed capacity. There were 39 registered processors, with only 14 large-scale processors of capacities of over 500 litres/day. An overview of some of the major large processors is presented below.

Brookside Dairy Limited

Brookside Dairy Limited is headquartered in Kenya and is one of the biggest milk processing companies in East Africa with a presence in over a dozen countries and an established brand reputation for quality for over a quarter of a century. The dairy products it produces include fresh, long-life, flavoured and fermented milk, yoghurt, butter, cream and ghee Fresh Diary began its operations in 1967, and it is involved in the production of dairy products that include fresh, long life and flavoured milk, yoghurt as well as cream, butter and ghee.

Brookside purchased Sameer Agricultural & Livestock Ltd in 2015 and now owns the 51% stake in Fresh Diary, previously held by Sameer while 49% remains in the hands of the Government of Uganda. The company's major brand in Uganda is Fresh Diary and it is one of the leading dairy brands in Uganda, especially for fresh, long life and flavoured milk as well as yoghurt.

Jesa Farm Dairy

Jesa Farm Dairy, which was established in 1987 and has grown to become one of the largest milk processing companies in Uganda and East Africa. The company started its milk processing journey in 1989 and now produces an assortment of dairy products that include yoghurt, UHT milk, Pasteurised milk, butter, cheese and cream. It enjoys a considerable market share in Uganda and has a daily production capacity of over 200,000 litres.

Pearl Dairy Farms Limited

Pearl Dairy Farms Ltd is a dairy processing company located in Mbarara specialising in the production of nutritious and high-quality dairy products. It is the producer of the Lato brand, a beloved and fast-growing brand in Uganda that includes products such as liquid and flavoured milk, butter oil, Ghee, powdered milk, butter and yoghurt. The company processes about 400,000 litres a day from farmers.

Amos Dairies Uganda Limited

Amos Dairies Limited is a dairy processing company situated in Mbarara that has majored in the production of ghee and casein protein powder since its inception in 2013. It is part of New Delhi-based Amos Dairies Limited located in India with the majority of the products produced in Uganda exported to other countries. It also produces whey, butter, and anhydrous milk fat/butter oil, and supports close to 10,000 farmers from whom it buys raw milk.

Paramount Dairies Limited

Paramount Dairies commenced operations in 1992 in Mbarara where its headquarters are currently still located. It a prominent producer of cheeses that include Mozzarella, Gouda, Cheddar, Parmesan, Edam, Feta, Colby and Jack cheese as well as creams like Fresh, sour, whipping, double cream and ghee.

4.2.1. Porters' Five Factor Analysis

I. Threat of New Entrants

i. Low differentiation

Milk value addition is still low in the dairy industry in Uganda, with a short list of companies processing milk to produce quality branded dairy products. However, established milk processing companies like Jesa Dairies, Fresh Dairy and Pearl Dairies have an upper hand when it comes to brand name strength and brand loyalty thereby creating a barrier to entry for newcomers who have to spend inexplicably on creating brand awareness to reach the levels of brand recognition and loyalty comparable to those the established brands enjoy.

ii. Scale and experience

The established milk processing companies are large-scale processors, who enjoy lower unit production costs. New entrants would have to attain a similar scale to be able to enjoy economies of scale. This is exacerbated by the high level of capital investment required to attain the scale as well as the experience that incumbents have gained - in the form of equipment, production and facilities costs for new entrants. Therefore, with scale and efficiency, incumbents are well-positioned to operate more efficiently than newcomers who haven't learned the tricks of the trade yet. This is exemplified by Pearl Dairies' collaboration with Tetra Pak which resulted in the expansion of the former's processing capacity with the installation of a UGX 9.25Bn (US$ 2.6m) packaging line, as well as Jesa's expansion involving construction of a larger 2,700 m^2 facility in 2021. This level of capital investment signals the ability to absorb heavy sunken costs for incumbents, which can act as a barrier to entry for new and smaller potential entrants who are not well-capitalized.

iii. Government action

The Government of Uganda has supported and continues to focus efforts and funding towards the dairy industry. Dairy is one of the National Development Plan's (NDP 3) ten priority commodities selected by the government for the positive contribution it makes towards improving food security as well as generating export earnings, where it accounted for 3.4% of the total exports (the third largest share after coffee with 10.9% and fish & fish products with 5.9%) in 2018. The Ugandan government has also allocated funds towards development of the dairy sector by funding the Dairy Development Authority with UGX 2.5Bn (US$ 675,675) in 2022 for the procurement of milk-processing plants in different districts.

This factors above show that the threat of entry into the Uganda's dairy industry is medium.

II. Bargaining Power of Suppliers

i. Concentration of suppliers

The dairy industry does not have just a few suppliers dominating the industry but is instead dominated by many smallholder farmers, each with a proportionately low level of production. The dairy industry in Uganda is comprised of tens of thousands of dairy farmers and the livestock sector is reportedly a source of revenue for 4.5 million Ugandans. Because of this low concentration, the suppliers, who are the farmers in this case, are left with very low bargaining power.

ii. Threat of supplier competition

Farmers (suppliers) are still incapable of cutting out buyers serving as middlemen in the sale of their milk because they often do not have the capacity to trade directly with the final consumers. It is also largely due to the fact that the raw milk purchased by consumers is mostly purchased from third-party vendors such as dairy shops and that most dairy products purchased by the final consumers are more often processed by dairy processing plants that purchase milk from farmers but not by the farmers themselves. Consequently, considerable value is lost during the selling process to middlemen for instance, where a farmer would have received UGX 600 per litre as paid by the processor, he only gets about half (UGX 300) with the middlemen charging for services that include transportation and keeping the milk chilled.

iii. Low switching cost

The milk buyers, who in this case are the dairy processing plants, cottage industries, and milk collection centres are not largely dependent on particular milk suppliers making it easy to switch between suppliers and hence keeping the switching cost very low. This is because there are many dairy farmers in the country who can supply these processors with milk to supplement the milk produced by enterprise-owned farms that some processing companies operate, e.g., Jesa Dairies operates a 600-ha farm with 650 Friesian cows whose milk is taken directly to the dairy plant, showing that Jesa does not rely entirely on external suppliers of milk.

From these factors above, the deduction is that the bargaining power of suppliers is low.

III. Bargaining Power of Buyers

i. Low switching costs

The cost incurred by a consumer in shifting from one milk vendor to another is low, especially for local customers who have a strong preference for unprocessed milk that is mostly undifferentiated, cheaper and with very minimal value addition. This is also similar for processed products by established brands such as Jesa, Fresh Dairy (Brookside) or Lato (Pearl Dairies) as well which face strong competition within each product category. This means the cost of switching between brands is low.

ii. Concentrated buyers

The concentration of buyers for processed dairy products is low given that majority of the products are sold to a wide range of distributors and traders who then sell it to an even wider range of customer.

The bargaining power of buyers/customers in Uganda's dairy industry is, therefore, medium to fairly high.

IV. Threat of Substitute Products

Dairy products are not a staple food for most communities in East Africa where staple foods consist mainly of non-animal products like maize, millet, bananas, and potatoes. There are also wide variations in the frequency of the consumption of dairy products, e.g., almost 90% of Kenyan respondents report eating dairy products within the previous 7 days, while in Uganda only 36% did.

In addition, dairy products also face high levels of income elasticity in East Africa, especially in rural areas. This means that if prices increase or incomes drop, the possibility of switching from, or eliminating dairy products from consumers' diets is high.

The threat of substitute products for the dairy industry, therefore, is medium.

V. Competitive Rivalry within the Industry

i. Low differentiation

Differentiation of processed dairy products in Uganda is generally low, with few product options that include pasteurised and UHT milk, flavoured UHT milk, yoghurt. These products have little to no variations between them, with most variation coming from packaging styles and material. While demand for milk is forecasted to increase, this demand is expected to be in favour of fresh, unprocessed milk, which is largely undifferentiated but still preferred by a large number of domestic consumers. This increases the intensity of competition in the dairy sector.

ii. High seller concentration

The dairy industry in Uganda is dominated by a few large dairy processors who control more than half the market share for processed milk and dairy products. These include; Brookside Dairy Limited, Jesa Farm Dairy, Amos Dairies Uganda Limited, Pearl Dairy Farms Limited and Paramount Dairies Limited. These are all roughly of similar sizes, and therefore, together, can exert considerable influence on the market. This fairly consolidated nature of the industry lowers the competition between rivals.

Based on the 2 factors above, it can be concluded that there is a medium level of competition between industry rivals.

Conclusion

From the Porter's five factor analysis above, the overall level of competition within Uganda's dairy industry can be said to be fairly low to medium. This is mostly due to the high level of industry concentration, with a few large market players. The entry of more large processors would increase industry competition, and this would have to be matched by an increase in product variation and diversification of markets to reduce competition for the same market.

4.3. Estimated Market Share

4.3.1. Assumptions Used:

A. Cheese

The Company's general strategy for the expansion into cheese production is to focus on import substitution. East Africa's cheese import data is presented in the table below (UNComtrade data).

Figure 20: Estimated Volumes of East Africa's Cheese Imports

ANNUAL IMPORTS OF CHEESE		
Particulars	**Year**	**Volume (Kg)**
Uganda		
Hard Cheese	2021	92,501
Fresh Cheese	2021	6,384
Rest of East Africa		
Hard Cheese	2022	300,897
Fresh Cheese	2022	103,949
Total East African Imports of Cheese (Kg)		**503,731**

B. Butter

The Company's strategy as it enters the butter segment is to participate in the export market and promote export growth. East Africa's butter export data is shown in the table below.

Figure 21: Estimated Volumes of East Africa's Butter Exports

ANNUAL EXPORTS OF BUTTER		
Particulars	**Year**	**Volume (Kg)**
Uganda		
Butter (Dairy Spread)	2021	164,317
Butter Oil & Ghee (Clarfied Butter)	2021	2,465,330
Rest of East Africa		
Butter (Dairy Spread)	2022	42,986
Butter Oil & Ghee (Clarfied Butter)	2022	98,676
Total East African Exports of Butter (Kg)		**2,771,309**

4.3.2. Projected Market Share:

A. Cheese

The Company's target is to substitute at least 10% of East Africa's current import trade volumes. This translates to an annual production of approximately 50.5 tons or about 168Kg per day.

About 78% (39.5 tons per year or 132Kg per day) of this will be processed hard cheese varieties like cheddar and mozzarella and 22% (11 tons per year or about 36Kg per day) of fresh/soft cheese varieties.

B. Butter

The Company's target is to produce and market about 10% of East Africa's export volumes, both as a dairy spread and oil. The equates to an estimated annual production of 277 tons or about 923Kg per day.

Keeping with the export market trends, about 7.5% of the production will be for butter/dairy spread, while the rest will be butter oil. This means about 20.7 tons of butter/dairy spread will be produced annually (about 70Kg per day), while about 256 tons of butter oil will be produced annually (about 854Kg per day).

C. Casein

The Company will produce casein as a by-product of the production of butter and cheese. Based on a conversion ratio of 30Kg of acid casein produced from every 1000l of raw milk processed for butter and butter oil, the Company's projected volume of casein production is estimated at 825Kg/day (247.5 tons/year) which translates to an estimated 25% of Uganda's total export volumes in 2021.

D. Whey Powder

The Company will produce whey powder as a by-product of the production of cheese. Based on a conversion ratio of 54kg of whey powder from every 900l batch of liquid whey, the Company's projected volume of casein production is estimated at 75kg/day (22.5 tons/year) which translates to an estimated 4.5% of Uganda's total export volumes in 2021. It is also around 8.6% of the total imports of the rest of East Africa in 2022.

5. SALES, MARKETING, & DISTRIBUTION PLAN

5.1. Envisaged Sales Strategy

The Company will continue to focus on selling some of the new products to the East African region, including butter, butter oil, and cheese. The volume of these products imported by the respective East African countries is shown below. The Company will also continue with its current sales strategy of partnering with wholesalers in different cities within these countries.

Figure 22: Butter & Cheese Imports by Other East African Countries

2022 BUTTER & CHEESE IMPORTS BY OTHER EAST AFRICAN COUNTRIES (KG)				
Country	**Butter (Dairy Spread)**	**Butter Oil & Ghee (Clarfied Butter)**	**Hard Cheese**	**Fresh Cheese**
Kenya	19,140	376,607	206,705	34,313
Tanzania	327,519	413,372	80,803	11,266
Rwanda	18,813	3,714	7,581	2,189
Burundi	39,849	6,420	5,808	56,181
	405,321	**800,113**	**300,897**	**103,949**
Total Butter & Cheese Imports (Kg)	**1,205,434**		**404,846**	

With respect to butter oil, however, the Company will also seek out a wider international market, with a focus on countries that are already importing butter oil from Uganda, including Egypt, South-Sudan, Oman, DRC, Japan, South-Africa, Sudan, Turkey, and Netherlands.

With respect to casein and whey powder, the Company will also look to makes sales within East Africa, specifically to Kenya and Tanzania. Kenya imported 241.6 tons of casein and 198.1 tons of whey in 2022. On the other hand, Tanzania imported 51 tons of whey in 2022. The Company's focus for these products, however, will be the wider international market, beginning with the countries that currently import these products from Uganda, including United States, India, Ethiopia, and South-Sudan.

The Company will continue with its current sales strategy of partnering with wholesalers in different cities within these countries. It will also look to make these sales at the average market rates within these cities and offer the wholesalers average credit period after sustaining relationships with them for between 6 – 12 months. Global average credit periods are 59 days[32].

5.2. Envisaged Marketing Strategy

The Company intends to carry out intensive marketing for its butter and cheese products within the East African cities that it finds wholesale partners. This shall involve engaging a reputable and innovative marketing agency to develop and implement a Marketing Strategy for the whole region. The implementation of this marketing strategy will include development of audio-visual advertising material and managing its roll-out within these cities.

With respect to the butter oil, casein, and whey powder, the Company will dedicate funds to the business development process within each of the target market countries. This will include using various networks to initiate discussions with large scale processors and manufacturers that use

[32] Allianz Trade DSO/WCR Report (2024) - https://www.allianz-trade.com/en_global/news-insights/news/dso-wcr-report.html#:~:text=2023%2C%20a%20record%2Dhigh%20year,the%20largest%20jump%20since%202008.

these products as ingredients or wholesalers of these products within those countries and providing samples to potential large scale customers.

5.3. Envisaged Distribution Strategy

Considering the perishable nature of the primary new products – butter and cheese – the Company will invest in cold transportation by initially purchasing a small capacity (possibly 2 ton) refrigerated truck to transport the products to the customers' cities. As sales grow, the Company will purchase more trucks to meet the demand.

With respect to inventory management, the Company intends to carry out more in-depth research to inform the decision between operating Company-owned distribution outlets within the target East Africa cities, or renting space with commercial cold storage, temperate, and warehouse facilities in these cities. By procuring storage space in these cities, the Company will lower transportation costs given that the factory is located a considerable distance away from all these cities, except Kigali.

6. REGULATORY ENVIRONMENT

6.1. Regulatory Regime

In 1998, the Ugandan Parliament promulgated the Dairy Industry Act, which created the Dairy Development Authority (DDA), the new industry regulator. DDA started its operations in 2000. The former national monopoly known as the National Dairy Corporation – which trades under the Fresh Dairy brand - was privatized in 2006 as part of Brookside Dairy Limited from Kenya. The Ugandan government maintains a minority shareholding.

DDA is in charge of registering and awarding licenses to dairy stakeholders and developing and observing quality standards. Enforcement of these standards is carried out across the country through inspection of dairy handling sites, import and export shipments, equipment used by milk transporters, and milk testing. The consequences of non-compliance include revoking of one's registration license, confiscation or recalling of a product from the market, closing production premises and prosecution. This encourages stakeholders to comply with safety and quality regulations, thereby encouraging the production of better quality dairy products that are competitive and meet international standards for export.

6.2. Legal Structure of the Firm

Birunga Dairy Industries is a wholly owned subsidiary of Dematrade Limited which is also wholly privately-owned.

7. OPERATIONS PLAN

7.1. Geographical Location

The Company's corporate and production premises are located in Kisoro District, in South-Western Uganda. Kisoro District is 130km from Kigali city in Rwanda, 103km from Goma city in the Democratic Republic of Congo, 488km from Kampala in Uganda, 812km from Kisumu in Kenya, 1,113km from Juba in South-Sudan, and 1,122km from Dodoma in Tanzania.

The expanded production operations will be housed in a new factory to be built in Kisoro, next to the Company's current production facility. The new production facility will include:

i. A factory covering … sqm;

ii. Storage space covering …. sqm;

iii. Waste management facilities covering … sqm;

iv. Parking space covering … sqm;

7.2. Supply Chain

I. Raw Milk:

The Company shall continue to source for its raw milk from within the Western region of Uganda and shall source the additional raw milk requirement from both farmers and milk aggregators.

The additional raw milk requirement for butter production can be estimated at:

i. 1,400 litres for producing 70kg of spreadable butter per day (20l of raw milk per kg of spreadable butter);

ii. 25,620 litres for producing 854kg of butter oil per day (30l of raw milk per kg of butter oil);

iii. 1,329 for producing 132kg of cheddar and mozzarella cheese per day (10l of raw milk per kg of hard cheese); and

iv. 90 litres for producing 36kg of cream cheese per day (2.5l of raw milk per kg of cream cheese).

This means the total amount of additional raw milk required for the expanded operations will equal around 28,430 litres per day. This equates to a proposed expansion of 28.4% of Company's current processing capacity, assuming 8-hour days (i.e., single-shift days), or 14.2% assuming 16-hour days (i.e., double-shift days).

II. Packaging Material:

The packaging materials will vary widely depending on the perishability of the product.

a) Spreadable butter will be packaged in 250g and 500g packaging. The packaging will be made from aluminum foil-based laminated wraps, surface treated with lacquer to prevent corrosion and shall have a total thickness of 0.09mm[33]. With these specifications, for each kg of

[33] Packaging of Dairy Products - https://ebooks.inflibnet.ac.in/ftp08/chapter/packaging-of-dairy-products-ii/

spreadable butter, the Company will need about 117 grams of packaging material, translating to a requirement of about 8.2kg of packaging material per day;

b) Butter oil will be packaged in stainless steel drums with a thickness of 1mm – 1.5mm. The drums will have a capacity of 100kg or 200kg, depending on further market research to be carried out. This means the company will require between 4 200kg drums to 8 100kg drums per day;

c) The hard cheeses will be packaged in vacuum-sealed PVDC coated plastic films. About 18g of PVDC coated plastic film is needed for each 500g block of hard cheese, which means about 2.4kg of packaging material will be needed per day for the hard cheese varieties;

d) The cream cheese will be packaged in laminated, lacquered metal cans consisting of Nylon / PVDC Copolymer or polyester/ PVDC copolymer or Nylon / Polyethylene copolymer. For the 36kg of cream cheese produced per day, between 72 (for 500g) and 144 (for 250g) cans will be needed per day;

e) Casein powder will be packaged in Kraft paper bags. With an average weight of 50grams for each 25kg-bag of casein, a total weight of about 495Kg will be needed for the 247.5 tons of casein powder produced per year (1.65Kg/day);

f) Whey powder will be packaged in Kraft paper bags. With an average weight of 50grams for each 25kg-bag of whey powder, a total weight of about 44.75Kg will be needed for the 22.5 tons of whey powder produced per year.

The packaging material will be sourced from various suppliers in various countries depending on price and quality of the material.

III. Energy:

The total additional energy requirement will depend on the machinery being used. For the machinery expected to be deployed for the expanded operations, the estimated daily energy use is estimated below.

Table 6: Estimated Additional Daily Energy Requirement

EQUIPMENT / PROCESS	DAILY PRODUCTION / USAGE	ESTIMATED DAILY ENEGRY USE
Milk reception silos	Receiving 28,430 litres	
Butter Production & Packaging Line	70kg	
Butter Oil Production & Packaging Line	854kg	
Cheese Production & Packaging Line	168kg	

Casein Production & Packaging Line		
Whey Production & Packaging Line		
Butter & Cheese Cold Storage	Storing 1,428Kg (Equal to 1 week of production)	
Butter Oil Storage	Storing 10.5 tons to 20.5 tons (Equal to 2 – 4 weeks of production)	
Laboratory		
ESTIMATED TOTAL ADDITIONAL DAILY ENERGY REQUIREMENT		

The energy will be sourced from Uganda's national electricity distribution utility company, which is currently UMEME Limited.

IV. Water:

The total additional water requirement will also depend on the machinery being used, and other processes including cleaning the production and storage facilities along with the transportation vehicles and parking space.

Table 7: Estimated Additional Daily Water Requirement

EQUIPMENT / PROCESS	DAILY PRODUCTION / USAGE	ESTIMATED DAILY WATER USE
Milk reception silos	Receiving 28,430 litres	No water is added to the raw milk received.
Butter Production & Packaging Line	70kg	No water is used in the butter production process.
Butter Oil Production & Packaging Line	854kg	Water is not used in the butter oil production process, other than as steam in the creation of a vacuum in the vacuum chamber.
Cheese Production & Packaging Line	168kg	For the estimated 132Kg per day production of cheddar and

		mozzarella, the estimated water usage is 363 litres. Cream cheese does not use any additional water in its production.
Casein Production & Packaging Line	825Kg	2,000 litres for every 36Kg of casein powder produced, which translates to 45,833 litres/day (45.83m^3).
Whey Production & Packaging Line	75Kg	Whey protein powder production does not require use of any additional water.
Butter & Cheese Cold Storage	Storing 1,428Kg (Equal to 1 week of production)	No water is used in the storage of butter & cheese.
Butter Oil Storage	Storing 10.5 tons to 20.5 tons (Equal to 2 – 4 weeks of production)	No water is used in the storage of butter oil.
Laboratory		
ESTIMATED TOTAL ADDITIONAL DAILY WATER REQUIREMENT		

The water will be sourced from Uganda's national water and sanitation utility company, which is National Water & Sewerage Company.

V. Starter Cultures:

Starter cultures are used in cheese production for the primary role of producing lactic acid from lactose at a predictable and controlled rate. Controlling acid production during cheesemaking is key to achieving control over curd pH, moisture, and lactose level. The following starter cultures are needed for the cheese to be produced:

a) ***Cheddar & Cream Cheese:*** The starter cultures required for making cheddar and cream cheese are Lactococcus lactis subspecies cremoris or Lactococcus lactis subspecies lactis, and about 0.5Kg is required for each 1,000 litres of milk processed into cheddar, while about 0.01Kg is required for each 1,000 litres of milk processed into cream cheese. This means that about 0.33Kg of starter cultures will be needed for each day of production of an estimated 66Kg of cheddar, and 0.9 grams will be needed for making 36Kg of cream cheese per day;

b) ***Mozzarella:*** The starter culture required for making mozzarella is Streptococcus thermophilus, and about 0.5Kg is required for each 1,000 litres of milk processed into cheese. This means that about 0.33Kg of starter cultures will be needed for each day of production of an estimated 66Kg of mozzarella;

VI. Rennet:

Rennet is the general name for enzymes that act on proteins in milk. In cheese production, it is used to coagulate milk, separating it into curds and whey. Rennet will be used to produce the hard cheese varieties. For the projected daily production of 132Kg of hard cheese, about 39.6 grams of rennet will be needed.

VII. Stabilizers:

Stabilizers are routinely added during cream cheese manufacture to help prevent syneresis[34] during storage. The cream cheese production will use stabilisers like carob bean gum or carrageenan, and for the 36Kg daily production, about 450 grams of stabilisers will be needed.

VIII. Salt:

Salt is very important in cheesemaking, for as well as helping add to the flavour of cheese, it also controls the bacteria that grow inside the cheese, helps with texture development, regulates moisture, and helps preserve the cheese as it ages. Salt is added at a rate of 2.5 grams per litre of raw milk used. This means that about 1.65Kg of salt will be used for the daily production of 66Kg of cheddar and mozzarella cheese, respectively.

IX. Acid:

The type of acid used in the production of acid casein depends on the intended use for the casein being produced. For casein intended for use in the pharmaceuticals, cosmetics and personal care, and food and beverages industries, acetic acid (commonly known as vinegar) or citric acid is often used, while either hydrochloric or sulfuric acid could be used for casein being produced for use in non-food applications, such as the production of adhesives, paints, and coatings. When using acetic acid, about 0.5% - 1% of the weight of the raw milk is used, while citric acid requires about 0.5% - 1.5% of the weight of raw milk. At 1%, this equates to around 10 litres for every 1,000 litres of raw milk processed for butter, butter oil, and casein production. When using hydrochloric or sulfuric acid, about 5-6 litres are used for every 1,000 litres of raw milk processed for butter, butter oil, and casein production. This means for the total 27,020 litres of raw milk processed for butter and butter oil per day, a total of 135 litres of acetic/citric acid – 270 hydrochloric/sulfuric acid will be required.

X. Cleaning Agents

The Company will carry out daily Cleaning-in-Place (CIP) for all sections of the production and storage area. The cleaning chemicals and volume of water required are shown in the table below.

[34] Syneresis in food production is when liquid oozes out of foods such as jams, jellies, sauces, dairy products, surimi and tomato juice, as well as meat and soybean products.

Table 8: Cleaning Agents, Water, & Steam Requirements for CIP

SECTION	CLEANING CHEMICALS	WATER REQUIREMENT	STEAM REQUIREMENT
Raw milk silos			
Butter Production & Packaging Line			
Butter Oil Production & Packaging Line			
Cheddar Production & Packaging Line	• Caustic Soda; • Nitric Acid; • Sodium Hypochlorite; • Quaternary Ammonium Compounds; and • Peracetic Acid		
Mozzarella Production & Packaging Line	• Caustic Soda; • Nitric Acid; • Sodium Hypochlorite; • Quaternary Ammonium Compounds; • Peracetic Acid; • Citric Acid; • Chlorine Dioxide; and • Iodophors		
Cream Cheese Production & Packaging Line			
Casein Production & Packaging Line			
Whey Production & Packaging Line			
Butter & Cheese Cold Storage			
Butter Oil Storage			
Casein & Whey Storage			
Laboratory Equipment			

Floor Space of Entire Production & Laboratory Area			

XI. Standards

The Company shall seek the following food processing certifications of standards:

i. Uganda National Standards Bureau, including UNBS/TC 2-Food and Agriculture Standards - US ISO 17189:2003 for spreadable butter, UNBS/TC 2/SC 2-Food and agriculture Standard- Oilseeds, edible fats and oils - US 1636:2016 for butter oil, and UNBS/TC 200, Milk and milk products - US EAS 1011:2021 for cheddar, US EAS 1013:2021 for cream cheese, US EAS 1012:2021for mozzarella, US ISO 8070:2007 for casein, and US CODEX STAN 289:1995 for whey powder;

ii. ISO Standards for each product for acceptance of products in the global market;

iii. HACCP Standards for the processing plant; and

iv. Halaal Certifications for each product for sale in Muslim-majority countries.

13.3. Facilities, Processes, and Equipment

Table 9: Facilities, Processes, and Equipment Used in the Production Process

FACILITIES	PROCESS	EQUIPMENT
Milk reception silos	**Receiving at the Plant** • **Quality Checks:** Upon arrival at the dairy processing plant, the milk undergoes immediate quality checks. This includes testing for temperature, antibiotic residues, bacterial count, and sometimes somatic cell count. Some plants use automated systems for this. • **Sampling:** A sample is taken from each batch for further detailed analysis which might be done later. **Pre-Processing** • **Clarification:** The milk might go through a clarifier to remove any large particles or debris, ensuring purity. • **Standardization:** Sometimes, the milk is standardized for fat content if the farm milk varies, especially if it's for specific products like cheese where fat content can affect yield and quality. **Storage in Milk Silos** • **Transfer:** Once the milk passes the quality checks, it's pumped into large, refrigerated silos. These silos are designed to keep the milk at a temperature just above freezing to slow bacterial growth.	• Stainless steel raw milk silos with a total capacity of 28,500 litres.

	• **Silo Design:** Silos are typically made of stainless steel for hygiene reasons and are insulated to maintain low temperatures. They can range in capacity from thousands to millions of liters. • **Aeration:** Some silos might aerate the milk by injecting sterile air to promote homogeneity and prevent age gelation, which can occur in raw milk stored for longer periods.	
Butter Production & Packaging Line	**1. Cream Separation** • **Raw Milk Reception:** Initially, raw milk is received and stored in silos, as previously described. • **Separation:** The milk is then processed through a separator to isolate cream from skim milk. The cream, which contains the fat, is what will be used for butter production. **2. Cream Maturation** • **Ripening:** The separated cream might be allowed to "ripen" or mature. This involves holding it at a controlled temperature for a period, sometimes with the addition of bacterial cultures. This step can influence the flavor of the butter. **3. Butter Churning** • **Churning:** The cream is churned in a continuous butter churner. During churning, the fat globules in the cream agglomerate and separate from the buttermilk. This physical action results in butter grains and buttermilk. • **Drainage:** The buttermilk is drained off. It can be collected for other uses or further processing.	**1. Pre-Processing Equipment** i. **Clarifier:** Removes foreign particles from milk or cream. ii. **Separator:** Centrifugal device to separate cream from skim milk. **2. Cream Maturation** i. **Storage Tanks:** For holding cream during maturation. **3. Butter Churning and Processing** i. **Continuous Butter Churner:** Equipment that churns cream into butter by continuous processing. ii. **Buttermilk Separator:** To drain off buttermilk from butter grains. iii. **Butter Worker:** Machine that works the butter to remove excess buttermilk and incorporate air or water.

	4. Working the Butter • **Washing:** The butter grains might be washed with water to remove any residual buttermilk, which helps in extending shelf life and improving texture. • **Working:** The butter is then worked to remove more water and incorporate air for the desired texture. For spreadable butter, this step is crucial as it helps in achieving a softer consistency. **5. Incorporation of Ingredients** • **Additives:** Depending on the product, ingredients like salt, preservatives, stabilizers, or flavor enhancers might be added. For spreadable butter, emulsifiers or vegetable oils might be mixed in to improve spreadability at refrigerator temperatures. **6. Packaging** • **Filling:** The butter is then pumped into packaging machines. For spreadable butter, this could involve: o **Tub Filling:** Many spreadable butters are packed in tubs or containers. The butter is filled directly into these containers using precision filling machines. o **Packaging Material:** Materials like foil-lined tubs or plastic containers are common to maintain freshness and ease of use. • **Sealing:** The packaging is sealed to protect the butter from air and light, which can degrade the product. **7. Cooling and Solidification**	**4. Additive Mixing** i. **Mixing Tanks or Vats:** Where butter is mixed with salt, emulsifiers, or other additives. **5. Packaging Equipment** i. **Filling Machines:** o **Volumetric or Gravimetric Fillers:** For precise filling of butter into containers. o **Multi-Head Weighers:** For packaged products where precise weight is required. ii. **Capping Machines:** For sealing containers or tubs. iii. **Lidding Machines:** For applying lids or foil seals to tubs. iv. **Coding and Labeling Machines:** Apply batch codes, expiration dates, and labels. **6. Cooling and Solidification** i. **Cooling Tunnels or Rooms:** To solidify butter after packaging. **7. Quality Control and Inspection** i. **Metal Detectors:** To ensure no metal contaminants are in the product.

	• **Post-Packing Cooling:** After being packaged, the butter might go through a cooling tunnel or room to set the butter to the desired consistency, especially if it's spreadable butter which requires a specific texture. **8. Labeling and Quality Control** • **Labeling:** Each package is labeled with product information, including batch numbers for traceability, expiration dates, and nutritional information. • **Inspection:** Products undergo quality checks for consistency, weight, and packaging integrity. **9. Storage and Distribution** • **Storage:** The packaged butter is stored in refrigerated conditions before distribution. • **Distribution:** It's then distributed to retailers, keeping the cold chain intact to maintain quality until it reaches the consumer. **Additional Considerations for Spreadable Butter:** • **Texture:** Spreadable butter often has a lower melting point due to additives or processing methods, making it easier to spread right out of the fridge. • **Storage Life:** Emulsifiers and preservatives might be used in higher amounts to extend shelf life while maintaining product quality.	ii. **X-ray Machines:** For detailed internal inspection. iii. **Checkweighers:** To ensure each package contains the correct weight. iv. **Vision Systems:** For checking package integrity, label placement, and visual quality. **Additional Equipment for Specific Processes:** i. **Homogenizers:** If the cream is homogenized before churning, to make the fat globules smaller and more uniformly distributed. ii. **Pasteurizers:** Though not always used for butter, some processes might pasteurize cream before churning for safety or to extend shelf life. iii. **Vacuum Packaging Machines:** For products requiring vacuum sealing for extended shelf life or freshness. **Specialized Equipment for Spreadable Butter:** i. **Emulsifiers:** Equipment for mixing emulsifiers or vegetable oils into the butter for better spreadability. ii. **Phase Inverters:** For converting butter from a water-in-oil emulsion to an oil-in-water emulsion which can improve spreadability.

Butter Oil Production & Packaging Line	**1. Cream Separation** • **Raw Milk Reception:** Initially, raw milk is received and stored in silos, as previously described. • **Separation:** The milk is then processed through a separator to isolate cream from skim milk. The cream, which contains the fat, is what will be used for butter production. **2. Butter Making** • **Churning:** The cream is churned in a continuous butter churner to separate butterfat from buttermilk. The buttermilk is drained off. • **Butter Working:** The butter is then worked to remove remaining buttermilk and water, making it more concentrated in fat. **3. Butter Oil Production** **Traditional Method (Ghee Production):** • **Melting and Boiling:** Butter is melted and boiled in large vessels. During this process, water evaporates, milk solids separate, and the fat (ghee) clarifies. • **Settling:** The liquid butter is allowed to settle, where milk solids settle at the bottom, and clear butter oil (ghee) remains on top. **Modern Method (Anhydrous Milk Fat):** • **Heating:** Butter is heated gently to melt. • **Centrifugation:** The melted butter is passed through centrifuges or separators to remove water and solids. This step might be done under vacuum to minimize thermal degradation.	**1. Pre-Processing** • **Milk Separator:** To separate cream from skim milk. • **Clarifier:** To remove impurities from cream. **2. Butter Making** • **Continuous Butter Churner:** Churns cream into butter, separating buttermilk. • **Butter Worker:** For further processing to remove remaining buttermilk and water. **3. Butter Oil Production** **Traditional Method (Ghee Making):** • **Boiling Vats or Pans:** Large vessels where butter is heated to evaporate water and separate milk solids. • **Settling Tanks:** To allow impurities to settle out after boiling. **Modern Method:** • **Vacuum Evaporators:** To remove moisture under controlled conditions, preventing thermal degradation. • **Centrifuges:** For separating anhydrous milk fat from residual water and milk solids. **4. Filtration and Purification**

	• **Filtration:** The resulting butter oil might be filtered through microfilters or membrane filters to remove any residual solids.
	4. Quality Control
	• **Sampling:** Samples are taken for quality checks like moisture content, free fatty acids, color, and oxidative stability.
	• **Adjustment:** If necessary, further processing like deodorization might occur to remove off-flavors.
	5. Packaging Process
	• **Filling:**
	  ○ **Liquid Filling:** If the butter oil is still liquid, it's filled into containers using volumetric fillers or piston fillers for precise measurement.
	  ○ **Solidification:** For solid butter oil, it might be cooled in molds or directly in containers.
	• **Sealing:** Depending on the packaging:
	  ○ **Tins or Drums:** Sealed with lids, often with a foil seal for added protection.
	  ○ **Bottles or Jars:** Sealed with caps or lids.
	• **Labeling:** Labels are applied with batch numbers, expiration dates, and other required information.
	6. Cooling and Solidification (if applicable)
	• **Cooling Tunnels or Chambers:** If the product is to be solid at room temperature, it's passed through a cooling process to solidify.
		• **Microfilters or Membrane Filters:** To remove any remaining solids or impurities.
		5. Storage and Intermediate Holding
		• **Intermediate Storage Tanks:** For holding butter oil before packaging or further processing.
		6. Packaging Equipment
		• **Filling Machines:**
		  ○ **Volumetric Fillers:** For liquid or molten butter oil.
		  ○ **Piston Fillers:** For precise filling of viscous materials like butter oil.
		• **Capping Machines:** To seal containers such as tins or drums.
		• **Lidding Machines:** If using foil or plastic lids.
		• **Labeling Machines:** For applying product information and branding.
		7. Cooling and Solidification
		• **Cooling Tunnels or Chillers:** To solidify butter oil if it's packaged in a solid form.
		8. Quality Control and Inspection
		• **Metal Detectors:** For detecting metal contaminants.

	7. Inspection and Quality Assurance • **Metal Detection:** To ensure no metal contaminants are present. • **Checkweighers:** To verify that each package contains the correct weight. • **Vision Systems:** For checking seal integrity, label accuracy, and overall appearance.	• **X-ray Machines:** For thorough inspection, especially in solid or semi-solid forms. • **Checkweighers:** To ensure correct package weight. • **Vision Systems:** For checking packaging integrity and label accuracy.
Cheese Production & Packaging Line	• **Cheddar:** Emphasizes aging for flavor development, traditionally made from cow's milk, involves cheddaring. • **Mozzarella:** Known for its stretchability, can be from cow's or buffalo's milk, sometimes not aged. • **Cream Cheese:** Very high in fat, no aging, focuses on a smooth, spreadable texture, often used in recipes or as a spread. **1. Milk Preparation** • **Milk Reception:** All types start with milk collection and storage in silos. • **Standardization:** Milk is standardized for fat content which varies by cheese type: o **Cheddar:** Typically around 3.5% fat. o **Mozzarella:** Higher fat content, often 2-3% for low-moisture part-skim and up to 4% for whole milk varieties.	**1. Pre-Processing** • **Clarifier:** Removes impurities from milk. • **Standardizer:** Adjusts milk fat content for different cheese types. • **Pasteurizer:** For pasteurization (could be HTST for cheddar and mozzarella, ultra for cream cheese if desired). **2. Cheese Making Equipment** **Common for al 3 types:** • **Cheese Vats:** Large stainless-steel vats where milk is heated, cultured, and coagulated. • **Rennet Injector:** For adding rennet to coagulate milk.

	○ **Cream Cheese:** Very high fat content, up to 33% in some recipes. **2. Pasteurization** • **Cheddar, Mozzarella:** Typically pasteurized at high temperatures (HTST - High-Temperature Short-Time) to kill pathogens. • **Cream Cheese:** Often uses ultra-pasteurization for longer shelf life. **3. Culture Addition** • **Cheddar:** Starter cultures that favor lactic acid production. • **Mozzarella:** Uses thermophilic cultures to withstand higher cooking temperatures. • **Cream Cheese:** Mesophilic cultures, with sometimes additional cultures for specific flavors. **4. Coagulation** • **Rennet Addition:** ○ **Cheddar:** Rennet is added to coagulate the milk into a solid curd. ○ **Mozzarella:** Similar to cheddar but with adjustments for stretch and melt properties. ○ **Cream Cheese:** Acid coagulation might be used instead of or in addition to rennet. **5. Cutting and Cooking** • **Cheddar:** Curds are cut into small pieces and heated to around 39-40°C to expel whey.	• **Starter Culture Addition System:** For adding bacterial cultures. **Specific Adjustments:** • **Cheddar:** ○ **Stirrers and Cutters:** For cutting curd. ○ **Cheddaring Table:** For stacking and turning curds. ○ **Milling Machine:** For cutting cheddared curds into smaller pieces. ○ **Salting Device:** For salting curds. • **Mozzarella:** ○ **Stretching Machine:** For the pasta filata process. ○ **Brining Tank:** For storing fresh mozzarella in brine. • **Cream Cheese:** ○ **Ultrafiltration Unit:** For concentrating milk or cream. ○ **Cream Cheese Mixer:** For blending cream or concentrated milk with cultures or other ingredients. **3. Draining and Pressing** • **Drainers:** For whey removal.

	• **Mozzarella:** Curds are cut into larger pieces, cooked to higher temperatures (often 45-50°C) for stretching later. • **Cream Cheese:** No cutting; milk is simply acidified to destabilize the protein matrix. **6. Draining and Handling** • **Cheddar:** Curds are drained, cheddared (stacked and turned to knit), milled, salted, and pressed into forms. • **Mozzarella:** After draining, curds are stirred, often stretched in hot water (pasta filata), and then molded. • **Cream Cheese:** Cream or concentrated milk mixture is drained through filters, sometimes under pressure. **7. Ripening or Aging** • **Cheddar:** Aged for weeks to months or years, developing flavor through bacterial action and proteolysis. • **Mozzarella:** Fresh mozzarella might not be aged, while some versions are aged for a few days to develop a bit more flavor. • **Cream Cheese:** Typically not aged; consumed fresh or sometimes with minimal aging to develop a slight tang. **8. Packaging** • **Cheddar:** o Cut into blocks or shredded. o Vacuum sealed or wrapped in wax or foil for aging. o For retail, it might be vacuum-sealed or packed in gas-flushed packages.	• **Presses:** For pressing curds into forms (cheddar mainly but can be adjusted for other shapes). **4. Maturation (Aging)** • **Cheese Caves or Rooms:** For aging cheddar. • **Temperature and Humidity Controllers:** To maintain specific conditions during aging. **5. Post-Aging Processing** • **Block Forming Machines:** For cheddar and mozzarella. • **Slicers or Shredders:** Depending on final product form. **6. Packaging** **A. Multi-functional Packaging Machines** **i. Form-Fill-Seal Machines (FFS):** • Vertical FFS: Typically used for shredded cheddar or mozzarella. Can form the package, fill it with cheese, and then seal it. • Horizontal FFS: Used for flat packaging or for cream cheese in flat packs or individual servings. **ii. Flow Wrappers:**

	• **Mozzarella:**
	  o Formed into balls or blocks.
	  o For fresh versions, often packed in brine or vacuum-sealed.
	  o For low-moisture versions, vacuum-sealed or packed with gas-flush.
	• **Cream Cheese:**
	  o Usually packaged in tubs or foil-wrapped blocks.
	  o Sometimes includes additives like stabilizers or fruit for flavored varieties.
	9. Quality Control
	• **All Cheeses:** Inspected for texture, moisture content, flavor, and bacterial counts. Each type has specific standards for quality.
	Additional Equipment for Flexibility:
	• **Heat Exchangers:** For heating or cooling milk or curds at various stages.
	• **Pumps and Valves:** For transferring materials between equipment.
	• **Mixers:** For blending ingredients, especially relevant for cream cheese.
	• **Conveyors:** For moving materials through various stages of processing.
		• For wrapping individual portions of cheese or for cream cheese sticks/pucks. Wraps the product in plastic or foil.
		OR
		B. Filling Machines
		i. Volumetric Fillers:
		• For Cream Cheese: Precise filling of tubs or containers with cream cheese. These can handle the viscous nature of cream cheese.
		II. Net Weigh Fillers:
		• For Shredded or Cubed Cheese: Accurate weight filling for cheddar or mozzarella in bags or containers.
		iii. Piston Fillers:
		• Used for both cream cheese and sometimes for mozzarella or cheddar when high precision in weight or volume is required.
		C. Sealing Machines
		i. Vacuum Sealers:
		• For cheddar blocks or shredded cheese, creating an oxygen-free environment to extend shelf life.

	Notes: • **Flexibility:** Many pieces of equipment can be designed with adjustable parameters or modular attachments to accommodate different cheese types. For instance, vats might have different stirring mechanisms or heating elements. • **Shared Equipment:** Equipment like pasteurizers, silos, and packaging machines can often be shared with slight adjustments or settings changes for different cheese types. • **Customization:** While the core equipment might be similar, the specifics for each cheese type (like the stretching for mozzarella or cheddaring for cheddar) might require specialized or additional machinery.	**ii. Heat Sealers:** • Induction Sealers: For tamper-evident seals, often used for cream cheese tubs or jars. • Impulse Sealers: For sealing plastic bags or pouches used in FFS machines. **D. Lidding Machines:** • For Cream Cheese: Applies and seals lids or foil on tubs or containers. **7. Labeling and Coding** **A. Labeling Machines:** • Pressure-Sensitive Labelers: For self-adhesive labels on cheese packages. • Shrink Sleeve Labelers: Can provide a label that covers the entire container for a premium look. **B. Inkjet or Laser Coders:** • For printing batch codes, expiration dates, and other information directly on the packaging or labels. **8. Gas Flushing Equipment** **Modified Atmosphere Packaging (MAP) Machines:**

		• Used for cheddar or mozzarella to replace air with a protective gas mix (e.g., nitrogen, carbon dioxide) to extend shelf life. **9. Packaging Line Integration Equipment** **Conveyors:** • To move products from filling stations to sealing, labeling, and packing stations. **10. Quality Control** • **Metal Detectors:** To check for metal contaminants. • **Checkweighers:** To ensure correct weight. • **Vision Systems:** For inspecting packaging integrity and label accuracy.
Casein Production & Packaging Line	**1. Reception and Storage** • **Receiving Skim Milk and Buttermilk:** These are already separated from butter production and are stored in dedicated silos. **2. Pre-Processing** • **Standardization:** If necessary, skim milk or buttermilk might be adjusted for protein content or other parameters. • **Pasteurization:** To kill bacteria and extend shelf life, though this step might be skipped if the milk has already been pasteurized during butter processing.	**1. Reception and Pre-Processing** • **Milk Silos:** For storing received skim milk and buttermilk at refrigerated temperatures. • **Clarifiers:** Remove impurities from the milk. • **Standardizers:** Adjust the milk composition if necessary. **2. Processing** • **Pasteurizer:** To pasteurize the milk, potentially using ultra-pasteurization for

	3. Acidification
	• **Acid Addition:** Either liquid acids like hydrochloric acid or sulfuric acid, or food-grade lactic acid is added to the milk. This step lowers the pH, causing casein to precipitate.
	  o **HCl or H2SO4:** Often used for industrial production due to cost and efficiency.
	  o **Lactic or Acetic Acid:** Sometimes preferred for certain applications or for a milder flavor profile.
	4. Precipitation
	• **Stirring:** The mixture is stirred gently to ensure even acid distribution and to aid in the coagulation process.
	• **Settling:** Casein particles start to aggregate and settle out as the mixture reaches its isoelectric point (pH around 4.6 for casein).
	5. Separation
	• **Centrifugation or Filtration:** The curd (acid casein) is separated from the whey. Centrifuges are commonly used for industrial processes to efficiently separate solids from liquids.
	6. Washing
	• **Washing:** The separated casein curd is washed with water to remove lactose, minerals, and residual whey proteins. Multiple washing steps might be employed to achieve desired purity.
	7. Dewatering
	• **Pressing:** The washed curd is pressed to remove excess water. This can be done mechanically using screw presses or filter presses.
		longer shelf life or for enhancing the casein production process.
		• **Heat Exchangers:** For heating or cooling the milk as needed during processing.
		• **pH Meters and Acidification Systems:** For monitoring and adjusting pH levels for precipitation.
		3. Coagulation and Casein Recovery
		• **Acid Addition System:** Used to add food-grade acids like dilute hydrochloric acid or lactic acid to precipitate casein.
		• **Agitators:** For mixing the acid into the milk uniformly.
		• **Casein Vats:** Large tanks where the milk is acidified, allowing for the precipitation of casein.
		• **Centrifuges or Decanters:** To separate the casein curd from the whey.
		4. Washing and Concentration
		• **Washing Tanks:** For washing the casein curd to remove lactose, minerals, and whey proteins.
		• **Ultrafiltration Units:** To concentrate casein by removing water and some lactose. This also serves to further purify the casein.

	8. Drying • **Air Drying:** Casein might be spread out to dry naturally or in thin layers in a controlled environment. • **Spray Drying or Drum Drying:** For faster drying in industrial settings, where casein is turned into powder or granules. **9. Grinding and Sieving** • **Grinding:** The dried casein is ground to achieve the desired particle size. • **Sieving:** Screens or sieves ensure uniform particle size distribution. **10. Packaging Process:** • **Bagging or Bulk Packing:** o **Bag Filling Machines:** For filling into bags, often multiwall paper bags or plastic-lined bags for moisture protection. o **Weigh Fillers:** To ensure precise weights in each bag. • **Sealing:** o **Heat Sealing:** Bags are heat-sealed to prevent moisture ingress. • **Palletizing:** o **Robotic or Manual Paletizing:** Bags are arranged on pallets, often shrink-wrapped for stability in transport. **11. Quality Control:**	• **Dewatering Equipment:** Presses or centrifuges for removing excess water from the casein curd. **5. Drying** • **Dryers:** o **Spray Dryers:** Commonly used for casein, where the casein slurry is sprayed into a hot air stream drying it into fine powders. o **Roller Dryers:** Alternative method where the casein is dried on rollers. **6. Milling and Sieving** • **Milling Machines:** To grind dried casein into desired particle sizes. • **Sieves or Sifters:** For ensuring uniformity in particle size. **7. Packaging** • **Mixers:** For blending any additives or for ensuring uniformity before packaging. • **Weighing and Dosing Systems:** For precise filling of packages. • **Packaging Machines:** o **Vacuum Packers:** For sealing case

	• **Moisture Content:** Checked to ensure it meets specifications. • **pH Level:** Ensured to be within the appropriate range. • **Purity:** Samples might be tested for purity, including ash content, to verify the effectiveness of the washing process.	
Whey Production & Packaging Line	**1. Reception and Storage** • **Whey Reception:** Liquid whey from cheddar, mozzarella, and cream cheese production is received. This whey might vary slightly in composition depending on the process used for each cheese. • **Whey Silos:** Large tanks where the liquid whey is stored temporarily before processing. **2. Pre-Processing** • **Clarification:** o **Centrifuges or Decanters:** Used to remove any fat or large particulates from the whey. **3. Concentration** • **Ultrafiltration (UF):** o **Ultrafiltration Units:** The whey is passed through membranes with pore sizes that allow water, lactose, and minerals to pass through while retaining the larger protein molecules. This concentrates the whey protein and reduces the volume significantly. **4. Purification**	**1. Reception and Storage** • **Whey Storage Tanks:** Large tanks for temporarily storing liquid whey received from cheese production. **2. Pre-Processing** • **Clarifier:** Removes fat and large particulates from the whey. • **Centrifuge or Decanter:** For further clarification and removal of residual cheese fines. **3. Concentration and Purification** • **Ultrafiltration (UF) Units:** Membrane filtration systems that concentrate proteins by retaining them while allowing smaller molecules like lactose and minerals to pass through. • **Diafiltration (DF) Units:** Similar to UF but used to wash out lactose and salts while

	• **Diafiltration (DF):**
	  o Often follows ultrafiltration. Here, water or a buffer solution is added to the concentrated whey protein, and further filtration occurs. This step helps wash out lactose, salts, and non-protein components, enhancing the purity of the whey protein.
	5. Further Concentration
	• **Reverse Osmosis (RO):**
	  o Sometimes used to further concentrate the solution by removing more water before drying.
	6. Drying
	• **Drying:**
	  o **Spray Dryers:** The concentrated whey protein solution is sprayed into a hot air stream, rapidly drying it into a fine powder.
	  o **Fluid Bed Dryers:** Can be used post-spray drying to reduce moisture content further.
	7. Milling and Sieving
	• **Milling:** The dried whey protein might be milled to achieve a uniform particle size.
	• **Sieving:** Ensures the powder has the desired fineness by removing larger particles or clumps.
	8. Packaging
		retaining protein, increasing the purity of whey protein.
		4. Further Concentration
		• **Reverse Osmosis (RO) Systems:** Optional, used to concentrate the solution further by removing water.
		5. Drying
		• **Spray Dryers:** Converts the concentrated whey protein solution into a fine powder by spraying it into a hot drying chamber.
		• **Fluid Bed Dryers:** Sometimes used after spray drying to reduce residual moisture content.
		6. Post-Drying Processing
		• **Milling Equipment:** For grinding the dried whey protein to achieve uniform particle size.
		• **Sieving or Sifting Machines:** To ensure particle size consistency by removing any oversized particles or clumps.
		7. Quality Control
		• **Moisture Analyzers:** For checking the moisture content of the dried whey protein.
		• **Protein Analyzers:** To measure protein content.

	• **Weighing and Dosing Systems:** Precise filling of packaging materials.
	• **Packaging Machines:**
	  o **For Bulk:** Typically packed in drums, bags, or boxes.
	  o **For Retail:** Can be packed in smaller consumer-ready containers, often under vacuum or nitrogen flushing for extended shelf life.
	9. Quality Control
	• **Analytical Equipment:**
	  o **Protein Analyzers:** To check protein content.
	  o **Moisture Meters:** To ensure the product meets moisture specifications.
	  o **Ash Content Analysis:** For mineral content.
	  o **Microbiological Tests:** To ensure product safety.
		• **Ash Content Analyzers:** For determining mineral content.
		• **Microbiological Testing Equipment:** To ensure the product is safe from pathogens.
		8. Filling and Packaging Equipment:
		• **Dosing Systems:** For precise measurement of powder into packaging.
		• **Vacuum Packers or Gas Flushers:** To remove air or replace it with inert gas, extending shelf life by reducing oxidation.
		• **Bagging Machines:** For filling bulk powder into bags, often used for industrial or commercial supply.
		• **Cartoning Machines:** For placing bagged or canned whey protein into cartons.
		• **Sealing Machines:** For sealing bags, pouches, or containers.
		• **Labeling Machines:** Apply labels with batch information, nutritional facts, etc.
		• **Coding Machines:** Print expiration dates, batch codes, and other information directly on the packaging.

Boiler for Steam	The expanded facility shall use a **water-tube boiler system** where water circulates inside the tubes while hot combustion gases flow outside the	**Components of the Boiler System**

	tubes. This design allows for high steam pressures and is more responsive to load changes compared to fire-tube boilers. **1. Fuel and Combustion System** • **Burners:** Designed for the specific fuel being used. They ensure complete combustion while controlling emissions. • **Fuel System:** Includes storage, pumping, and delivery systems for the fuel, with controls for flame stability and efficiency. **2. Water Treatment** • **Water Softener:** Removes hardness minerals to prevent scale formation inside the tubes. • **Deaerator:** Removes dissolved gases like oxygen and carbon dioxide to prevent corrosion. • **Chemical Feed:** Injects chemicals for pH control, oxygen scavenging, and other treatments to maintain water quality. **3. Steam Distribution** • **Main Steam Pipes:** These carry high-pressure steam to different parts of the plant. Insulation is crucial to minimize heat loss. • **Steam Traps:** Installed to remove condensate, ensuring only steam reaches the process equipment. • **Pressure Reducing Valves:** For adjusting steam pressure according to the requirement of different processes. **4. Control and Safety Systems** • **PLC or DCS:** Controls boiler operations, including fuel feed, water level, pressure, and temperature.	1. **Furnace:** Where fuel (gas, oil, biogas, or biomass) is burned. It's designed to maximize combustion efficiency and heat transfer. 2. **Tubes:** Multiple tubes where water is heated and turned into steam. The arrangement can be vertical, horizontal, or a combination, depending on the design. 3. **Steam Drum:** Located at the top, it separates water from steam. Water, after being heated in the tubes, rises to the drum where steam is released, and the water, now with less steam content, returns to the tubes. 4. **Mud Drum:** At the bottom, it collects sediments and sludge, which are periodically blown down to maintain efficiency. 5. **Superheater (if required):** To further heat the steam above boiling point, reducing moisture content and increasing efficiency for certain processes requiring dry steam. 6. **Economizer:** Preheats feedwater using the exhaust gases before they escape, increasing efficiency.

	• **Safety Valves:** Critical for overpressure protection, preventing boiler explosions. • **Low Water Cut-Off:** Shuts down the boiler if water levels drop too low to prevent overheating and damage. • **Flame Safeguards:** Ensures the flame is stable and extinguishes it if unstable conditions are detected. **5. Environmental and Efficiency Considerations** • **Emission Controls:** Equipped with systems to control NOx, SOx, and particulate matter if burning fossil fuels. • **Energy Recovery:** Heat recovery systems might be in place to utilize waste heat from the flue gases. **6. Maintenance** • **Regular Inspections:** Includes checking for tube wear, leaks, and ensuring that safety devices are operational. • **Blowdown:** Regular removal of sediments from the mud drum to maintain efficiency.	
Laboratory	**1. Raw Material Testing** • **Reception and Sampling:** Upon arrival, raw milk is sampled for initial testing. • **Microbiological Analysis:** Testing for pathogens like Salmonella, E. coli, Listeria, and total bacterial count to ensure safety. • **Chemical Analysis:** Checking for components like fat, protein, lactose, and solids-not-fat (SNF) using methods like infrared analysis or traditional wet chemistry.	**1. Raw Material Testing** • **Laboratory Glassware:** o Beakers, flasks, pipettes, graduated cylinders, test tubes. • **Microbiological Equipment:** o Autoclave for sterilization. o Incubators for bacterial growth.

	• **Sensory Evaluation:** Basic organoleptic tests for taste, smell, and appearance. **2. Standardization and Adjustment** • **Fat Standardization:** Adjusting the fat content to meet product specifications by adding cream or skim milk. • **pH Measurement:** Regular monitoring to prevent spoilage and ensure process efficiency. **3. Processing Monitoring** • **Pasteurization:** Ensuring the milk is heated to the correct temperature for the right duration, which varies by product (e.g., high-temperature short-time (HTST) for butter production). • **Separation:** For producing butter and butter oil, cream separation is critical. The lab would test the efficiency of centrifugal separators. • **Culturing:** For some butter types, starter cultures might be added. The lab would monitor culture activity and growth. **4. Product Specific Activities** • **Spreadable Butter:** o **Texture Analysis:** Using tools like texture analyzers to ensure spreadability. o **Emulsion Stability:** Checking the stability of water-in-fat emulsions. • **Butter Oil:**	o Microscopes for visual examination. o Petri dishes, culture media, and inoculating loops. • **Chemical Analysis Equipment:** o Milk analyzers (e.g., infrared milk analyzer for fat, protein, lactose). o Lactometers for specific gravity. o pH meters. • **Sensory Evaluation:** o Sensory booths or rooms with controlled conditions for flavor and texture assessment. **2. Standardization and Adjustment** • **pH Meters:** For precise measurement during standardization. • **Balances:** For weighing ingredients to adjust fat content. **3. Processing Monitoring** • **Pasteurization:** o Thermometers or digital temperature probes. o Data loggers for time-temperature profiles.

	○ **Anhydrous Milk Fat (AMF) Production:** Testing for moisture content, ensuring it's below 0.1% for butter oil. ○ **Oxidative Stability:** Testing for rancidity through peroxide values or anisidine values. • **Casein:** ○ **Precipitation and Washing:** Monitoring pH and salt concentration during casein precipitation. ○ **Purity and Quality:** Checking for residual lactose, ash, and moisture. • **Whey Protein:** ○ **Filtration and Concentration:** Ensuring correct membrane filtration processes (e.g., ultrafiltration). ○ **Protein Content:** Using methods like Kjeldahl or Dumas for protein quantification. ○ **Denaturation Levels:** Assessing protein functionality post-processing. **5. Quality Control** • **End Product Testing:** ○ **Nutritional Content:** Confirming labeled claims for fats, proteins, etc. ○ **Shelf-Life Studies:** Conducting accelerated shelf-life testing to predict product stability. ○ **Packaging Integrity:** Testing for leaks, seal integrity, and material compatibility.	• **Separation:** ○ Microscope for fat globule size analysis after separation. **4. Product Specific Activities** • **Spreadable Butter:** ○ Texture Analyzers (e.g., TA.XTplus, Brookfield Texture Analyzer) for spreadability tests. ○ Emulsification Testing Kits. • **Butter Oil:** ○ Moisture Analyzers (e.g., Karl Fischer titrator for water content). ○ Gas Chromatography (GC) for fatty acid profiles and oxidative stability. • **Casein:** ○ Centrifuges for separating casein from whey. ○ Filtration equipment for washing casein. • **Whey Protein:** ○ Ultrafiltration units or other membrane filtration systems. ○ Spectrophotometers or ELISA for protein quantification.

	• **Regulatory Compliance:**
	  o Ensuring all products meet local and international standards (e.g., FDA, EU regulations).
	  o Documentation for traceability and certification.
	6. Research and Development
	• **New Product Development:** Experimenting with formulations, ingredients, or processes to develop new dairy products or improve existing ones.
	• **Optimization:** Continuously improving processes for cost, yield, or quality.
	7. Environmental Monitoring
	• **Cleanliness:** Regular swabbing for microbial contaminants in the lab and production areas.
	• **Waste Management:** Analyzing waste streams for potential recovery of valuable components or compliance with environmental regulations.
	8. Instrument Calibration and Maintenance
	• **Calibration:** Regular calibration of analytical instruments like spectrophotometers, pH meters, and moisture analyzers.
	• **Validation:** Ensuring all testing methods are validated according to standards like AOAC or ISO.
	9. Training and Education
	• **Staff Training:** Continuously educating lab and production staff on new testing methods, quality standards, and safety protocols.
		5. Quality Control
		• **General Lab Equipment:**
		  o Freezers and refrigerators for sample storage.
		  o Ovens for drying samples or accelerated shelf-life testing.
		  o Vacuum packing machines for shelf-life studies.
		• **Packaging Integrity:**
		  o Leak testers, seal strength testers.
		6. Research and Development
		• **Rheometers:** For analyzing the flow characteristics of dairy products.
		• **High-Pressure Liquid Chromatography (HPLC):** For detailed component analysis.
		• **Gel Electrophoresis Units:** For protein profile analysis in R&D.
		7. Environmental Monitoring
		• **ATP Luminometers:** For rapid hygiene monitoring.
		• **Air Samplers:** To check for airborne contaminants.
		8. Instrument Calibration and Maintenance

		• **Calibration Standards:** pH buffers, known solutions for analyzers.
		• **Maintenance Kits:** For various instruments like pipettes, spectrophotometers.
		9. General Lab Safety and Utility
		• **Safety Equipment:**
		  ○ Protective clothing, gloves, goggles, lab coats.
		  ○ Biohazard disposal containers.
		• **Fume Hoods:** For handling chemicals safely.
		• **Distilled/Deionized Water Systems:** For preparing solutions.

Waste Management	The expanded facility shall use a wastewater management system that combines **Dissolved Air Flotation (DAF) for pre-treatment and an anaerobic system like Up-flow Anaerobic Sludge Blanket (UASB).** This provides a good balance of efficiency, cost, and environmental compliance for dairy processing plants, especially when energy recovery from biogas can offset operational costs. This combined system reduces the environmental footprint by minimizing waste, recovering energy, and potentially reusing treated water.
	1. Dissolved Air Flotation (DAF) as Pre-Treatment
	• **Function:** DAF is used before anaerobic treatment to remove suspended solids, fats, oils, and greases (FOG) which can inhibit
		Anaerobic Treatment System (ATS) Components:
		1. Anaerobic Digester:
		  ○ **Type:** Can be Upflow Anaerobic Sludge Blanket (UASB), Continuous Stirred Tank Reactor (CSTR), or Fixed-Film Reactors.
		  ○ **Size:** Determined by wastewater volume, typically in cubic meters.
		2. Biogas Collection System:

	or reduce the efficiency of anaerobic processes if not adequately controlled.
	• **Process:**
	  ○ **Coagulation/Flocculation:** Chemicals might be added to the wastewater to aggregate small particles into larger flocs.
	  ○ **Aeration:** Air is dissolved into a portion of the treated water under pressure, then released at atmospheric pressure, creating microbubbles that adhere to the flocs.
	  ○ **Separation:** The air-filled flocs rise to the surface, forming a floating layer which is skimmed off, leaving cleaner water to proceed to the anaerobic treatment.
	• **Benefits:**
	  ○ **Efficient Pre-Treatment:** Removes a significant portion of FOG and solids, which could otherwise clog or reduce the efficiency of anaerobic reactors.
	  ○ **Reduced Load:** By removing a considerable amount of contaminants, it ensures the anaerobic system operates at optimal efficiency, reducing operational costs and increasing system longevity.
	2. Anaerobic Treatment System
	• **Function:** Anaerobic treatment involves the biological decomposition of organic matter by microorganisms in the absence of oxygen, converting organic pollutants into biogas (mainly methane and carbon dioxide) and sludge.
		○ **Gas Holder:** To store biogas produced, often using a floating or fixed dome.
		○ **Gas Piping:** For transporting biogas to points of use or storage.
		3. Biogas Utilization:
		○ **Combined Heat and Power (CHP) Unit:** Converts biogas into electricity and heat.
		○ **Flare System:** For safely burning off excess or unusable biogas.
		4. Sludge Handling:
		○ **Sludge Thickening:** Prevents excessive water content in the digesters.
		○ **Sludge Dewatering Equipment:** Like centrifuges or filter presses for further reduction of moisture.
		5. Control and Monitoring:
		○ **PLC (Programmable Logic Controller) System:** For automated control of digestion temperature, mixing, pH, and biogas production.
		○ **Sensors:** For monitoring pH, temperature, flow, and gas composition.

	• **Setup:** For dairy wastewater, which is high in organic content (BOD, COD), a system like an Upflow Anaerobic Sludge Blanket (UASB) reactor could be used. Here, wastewater flows upwards through a dense blanket of anaerobic sludge where organic matter is broken down.
	• **Benefits:**
	  ○ **High Organic Load Handling:** Ideal for dairy wastewater with its high BOD and COD.
	  ○ **Biogas Production:** The biogas produced can be used for on-site energy generation, reducing dependency on external energy sources.
	  ○ **Sludge Reduction:** Anaerobic processes produce less sludge compared to aerobic ones, reducing the volume of waste for disposal or further treatment.
	3. Integration and Optimization
	• **Flow Management:** The DAF effluent, now significantly cleaner, flows into the anaerobic system. Here, any remaining organic matter is further broken down, producing biogas.
	• **Energy Recovery:** Biogas can be captured and used to generate electricity, potentially meeting part of the plant's energy needs or being sold to the grid.
	• **Post-Treatment:** After anaerobic treatment, the wastewater might still require further treatment (like aerobic processes) or polishing before discharge or reuse, depending on local regulations.
		Dissolved Air Flotation (DAF) System Components:
		1. DAF Tank:
		  ○ **Material:** Corrosion-resistant like stainless steel or coated steel.
		  ○ **Design:** Includes an inlet zone, flocculation zone, contact zone, clarification zone, and skimming zone.
		2. Air Dissolution System:
		  ○ **Air Compressor:** To pressurize air.
		  ○ **Saturation Tank or Air Drum:** Where air is dissolved into water under pressure.
		  ○ **Air Release Mechanism:** Valves or nozzles for controlled bubble formation.
		3. Recycle Pump:
		  ○ **Function:** Recycles part of the treated water to mix with pressurized air for bubble formation.
		4. Chemical Dosing System:

	• **System Control:** Modern systems integrate PLCs or similar systems for monitoring and controlling the entire treatment process, optimizing pH, temperature, and organic loading rates for anaerobic digestion.	○ **Coagulants/Flocculants:** Dosing equipment for chemicals like ferric chloride or polymers. ○ **pH Control:** With chemical feeders for acid or base to maintain optimal pH. **5. Skimming and Sludge Removal:** ○ **Skimmer:** To remove floated solids (sludge). ○ **Sludge Pump/Scraper:** For removing settled solids at the bottom. **6. Automation and Control:** ○ **Control Panel:** With PLC or HMI for operational control, monitoring water levels, pressure, and chemical dosing. ○ **Sensors:** For TSS, pH, flow rate, and level detection. **Additional Facilities for Integration:** **1. Pre-Treatment:** Screens, grit chambers for removing larger particles before DAF or anaerobic treatment.

		2. **Equalization Tank:** To balance flow rates and pollutant loads before treatment. 3. **Post-Treatment:** Possibly additional aerobic treatment or filtration if water is to be reused or discharged according to stricter standards. 4. **Waste Handling:** Equipment for safe disposal or further treatment of residuals like dewatered sludge, which might be composted or incinerated. 5. **Safety Systems:** Including gas detectors, emergency shutdowns for biogas systems, and overpressure devices for boilers or digesters. 6. **Maintenance and Storage:** Areas for storing chemicals, spare parts, and maintenance tools.
Butter, Cheese, and Butter Oil Cold Storage	1. **Temperature Control** • **Butter (Spreadable):** Should be stored at 35-40°F (1.7-4.4°C). This temperature range helps keep butter spreadable while preventing spoilage. • **Cheddar and Mozzarella:** These cheeses require a slightly lower temperature, ideally around 35-40°F (1.7-4.4°C) to prevent mold growth and preserve texture and flavor.	1. **Refrigeration Units** • **Walk-In Refrigerator:** Large enough to accommodate bulk storage, with multiple shelves or racks for organization. • **Reach-In Refrigerators:** For smaller quantities or specific product types needing slightly different conditions.

	• **Cream Cheese:** Needs to be kept at 40°F (4.4°C) or below due to its high moisture content, which makes it more susceptible to bacterial growth if not refrigerated properly. • **Butter Oil:** Given its high-fat content and lack of water, it's less perishable but still benefits from storage around 35-40°F (1.7-4.4°C) to maintain quality. **2. Humidity** • **General Dairy Products:** An integrated storage area should have controlled humidity, ideally between 60-85% for cheeses like cheddar and mozzarella to prevent them from drying out or becoming too moist, which could lead to mold. **3. Light Exposure** • **All Products:** Minimize exposure to light, especially UV light, which can degrade the quality of fats in butter and cheese, leading to off flavors. Use opaque packaging or store in dark, enclosed areas. **4. Air Exposure** • **Packaging:** Use vacuum-sealed or airtight containers to prevent oxidation which can degrade fats and lead to rancidity, particularly in butter and butter oil. **5. Odor Control** • **Isolation:** Dairy products can absorb odors from other foods. Thus, they should be stored in areas isolated from strong-smelling items like onions or garlic. Using sealed containers or wrapping materials can also help.	• **Freezers:** If freezing some products like butter for long-term storage, though this is less common for most cheeses. **2. Climate Control Equipment** • **Temperature Controllers:** Digital controllers with alerts for temperature changes outside the set range. • **Humidity Controllers:** To maintain appropriate moisture levels, especially important for cheeses. **3. Monitoring and Logging Systems** • **Temperature Data Loggers:** Devices like iButton or similar data loggers that record temperatures over time. • **Humidity Sensors:** Integrated with data loggers or standalone devices for monitoring humidity. • **Alarm Systems:** To notify staff of any deviations from set conditions (e.g., temperature rise). **4. Shelving and Storage Solutions** • **Adjustable Shelving:** Allows customization for different product sizes.

	6. Rotation and Stock Management • **FIFO (First In, First Out):** Implement a system where older stock is used before newer stock to ensure freshness and reduce waste. **7. Hygiene and Safety** • **Cleanliness:** Regular cleaning and sanitizing of the storage area to prevent cross-contamination. • **Temperature Checks:** Regularly monitor temperatures with digital thermometers or integrated systems to ensure the environment remains within safe limits. **8. Specific Storage Techniques** • **Butter:** For spreadable butter, consider using butter dishes with lids in the refrigerator if not used frequently. For long-term storage, freezing is an option, but it should be used within a reasonable time to maintain texture. • **Cheeses:** Store cheeses like cheddar and mozzarella in their original packaging or wrap them in wax or parchment paper before placing in the fridge. Avoid plastic wrap for long-term storage as it can cause moisture buildup. • **Cream Cheese:** Always keep in its original packaging or tightly wrapped to prevent absorption of fridge odors and to maintain moisture. **9. Defrosting and Handling** • **Frozen Products:** If any items like butter or cheese are frozen, they should be defrosted in the refrigerator to prevent bacterial growth during thawing.	• **Racks and Bins:** Specifically designed for dairy products, possibly with ventilation to prevent condensation. • **Sliding or Rotating Shelves:** For easier access and to follow FIFO (First In, First Out) principles. **5. Packaging and Preservation Tools** • **Vacuum Sealers:** For sealing products to reduce air exposure and extend shelf life. • **Cheese Paper or Wax Paper:** For wrapping cheeses to maintain moisture while allowing some breathability. • **Airtight Containers:** For butter and cream cheese to prevent odor absorption and microbial growth. **6. Lighting** • **LED Lighting:** Energy-efficient with minimal heat output, which helps maintain cooler temperatures. Preferably with UV filters to protect products from light degradation. **7. Safety and Hygiene Equipment** • **Hand Washing Stations:** Located near storage areas to ensure hygiene.

	10. Monitoring and Maintenance • **Equipment:** Use of integrated storage systems with automated temperature and humidity controls. Regular calibration of these systems ensures they function as intended.	• **Cleaning Supplies:** Sanitizers, brushes, and tools specifically for food storage areas. **8. Inventory Management** • **Barcode Scanners and Inventory Software:** For tracking product batches, expiration dates, and stock levels. • **Label Printers:** For creating labels with batch numbers, expiry dates, etc. **9. Air Circulation** • **Ventilation Systems:** To maintain air quality and prevent condensation, equipped with HEPA filters if necessary to ensure clean air circulation. **10. Doors and Insulation** • **Insulated Doors:** Including strip curtains or air curtains for frequent entry points to minimize temperature fluctuations. • **Seals:** Around doors and windows to prevent cold loss and external contamination. **11. Backup Systems** • **Backup Generators:** Essential for keeping refrigeration units running during power outages.

		• **Battery Backup for Monitoring Systems:** Ensures data logging and alarms continue to function during power failures. **12. Security** • **Access Control Systems:** To ensure only authorized personnel can enter the storage area. • **CCTV:** For monitoring activity and ensuring food safety practices are followed.
Casein & Whey Powder Storage	**1. Temperature Control** • **Casein:** Should be stored at a temperature range of 10-20°C (50-68°F). Casein, being relatively shelf-stable due to its low moisture content, doesn't need to be refrigerated but benefits from a cool, dry environment. • **Whey Protein:** Typically stored at room temperature or slightly below, around 20-25°C (68-77°F). However, if it's in liquid or high-moisture forms like whey protein concentrate (WPC), it might require cooler conditions, similar to casein, to prevent microbial growth. **2. Humidity** • **Controlled Humidity:** Both casein and whey, especially in powder form, are sensitive to moisture. The ideal relative humidity should be kept below 60% to avoid clumping or caking due to moisture absorption.	**1. Climate-Controlled Storage Rooms:** Equipped with HVAC systems capable of maintaining specific temperature and humidity levels. **2. Sealed Containers:** For storing powders, ensuring no moisture ingress. Silica gel packets or other desiccants can be used within these containers. **3. Automated Systems:** Consider automated storage and retrieval systems (ASRS) for large-scale operations to reduce manual handling and contamination risks. **4. Integrated Monitoring Systems:** With sensors for temperature, humidity, and potentially for gas composition if using nitrogen or other inert gases for packaging.

	3. Light Exposure • **Minimized:** Both products should be stored away from direct light, especially UV light, which can degrade proteins. Use packaging that blocks out light or store in dark conditions. **4. Air Exposure** • **Airtight Storage:** Use vacuum-sealed packaging or nitrogen-flushed containers to prevent oxidation, which can degrade proteins and change their functional properties. **5. Odor Control** • **Isolation:** Casein and whey proteins can absorb odors from other substances, potentially affecting their flavor profile. They should be stored separately from strong-smelling products. **6. Pest Control** • **Protective Measures:** Implement pest control strategies, as powders are particularly vulnerable to insect contamination. **7. Stock Rotation** • **FIFO System:** Employ a First In, First Out (FIFO) system to ensure older stock is used before newer stock, reducing waste. **8. Specific Storage Equipment** • **Shelving and Bins:** Use moisture-resistant shelving materials, and bins or boxes that can be sealed to protect against environmental factors. **9. Monitoring and Maintenance**	**5. Backup Power:** To ensure conditions remain stable during power outages.

	• **Environmental Monitoring:** Use data loggers for temperature and humidity to ensure conditions are maintained. Alarms should be set to alert staff to any deviations. **10. Cleaning and Hygiene** • **Sanitation:** Regular cleaning of the storage area to prevent contamination. Focus on dust and moisture control since powders can clump or become contaminated easily. **11. Safety Measures** • **Fire Safety:** Ensure fire suppression systems are appropriate for areas storing powders, as standard water sprinklers might not be ideal due to the risk of product damage with moisture. **12. Access Control** • **Security:** Control access to maintain hygiene standards and protect the integrity of the stored products.	
Butter, Cheese, and Butter Oil Transportation to Market	**1. Pre-Transport Preparation** • **Packaging:** Ensure products are appropriately packaged. Use insulated packaging or thermal blankets for temperature-sensitive items like butter and cheeses. Vacuum-sealing or using airtight containers can prevent oxidation and microbial growth. • **Labeling:** Apply clear labels indicating handling instructions, storage temperatures, and expiration dates. For international shipments, include all necessary documentation like health certificates, import permits, etc.	**1. Refrigerated Trucks or Vans:** These vehicles (reefers) are equipped with refrigeration units to maintain the required temperature throughout the journey. For shorter distances, insulated vans may suffice if ambient temperatures are not too high. **2. Temperature Control:** Ensure the transport vehicle has functioning temperature control systems. Use digital

	• **Inspection:** Conduct a final inspection to confirm the quality and integrity of the packaging before transport. **2. Temperature Conditions** • **Spreadable Butter:** Keep at 35-40°F (1.7-4.4°C). • **Butter Oil:** Though less perishable, maintaining 35-40°F (1.7-4.4°C) is ideal for quality preservation. • **Cheddar and Mozzarella:** Should be transported at around 35-40°F (1.7-4.4°C) to prevent spoilage and maintain texture. • **Cream Cheese:** Requires even colder conditions, ideally at or below 40°F (4.4°C) due to its high moisture content. **3. Handling During Transport** • **Gentle Handling:** Dairy products can be sensitive to rough handling. Use shock-absorbent materials or packaging to minimize physical damage. • **Segregation:** If transporting with other goods, ensure dairy products are segregated to avoid contamination or damage from odors or physical impacts. **4. Monitoring and Compliance** • **Data Loggers:** Install temperature and humidity data loggers to record the conditions throughout the transport. This data can be used for quality control and compliance purposes. • **Regulatory Compliance:** Adhere to local, national, and international food safety regulations like HACCP (Hazard Analysis and Critical Control Points), ensuring all transport conditions meet legal standards.	thermometers or data loggers to monitor temperatures continuously. **3. Insulation:** Vehicles should have adequate insulation to prevent temperature fluctuations from external conditions.

	5. Delivery • **Final Temperature Check:** Upon arrival, check the product temperature before unloading to ensure it's within acceptable limits. • **Quick Unloading:** Unload goods quickly into storage or display units that can maintain required temperatures to avoid temperature spikes. **6. Emergency Procedures** • **Plan for Failures:** Have protocols in place for refrigeration unit failures, including emergency contact numbers for repair services or alternate transport solutions. **7. Post-Transport Handling** • **Immediate Storage:** Products should be moved into appropriate storage conditions immediately upon arrival at the market or retail location. • **Inspection:** Conduct a post-transport inspection for any signs of spoilage or damage. **8. Documentation and Traceability** • **Track and Trace:** Keep meticulous records of the transport journey, including temperature logs, for traceability in case of a quality issue or recall.	
Casein & Whey Powder Transportation to Market	**1. Pre-Transport Preparation**	**1. Climate-Controlled Vehicles:** While casein and whey protein powders are less temperature-sensitive than liquid dairy

	• **Packaging:** Use moisture-proof, airtight containers or packaging that prevents air and moisture ingress. Vacuum-sealing or nitrogen flushing can be employed to minimize oxidation. • **Labeling:** Apply labels with handling instructions, storage conditions, and expiration dates. For international shipments, ensure all necessary documentation is prepared, including health certificates and import permits. • **Quality Check:** Conduct final quality checks and ensure all packaging is sealed properly before transport. **2. Temperature and Humidity Conditions** • **Temperature:** Aim to keep these powders at room temperature or slightly below, around 15-25°C (59-77°F). However, they are more tolerant of temperature variations compared to other dairy products but should be kept away from extreme heat or cold. • **Humidity:** Control relative humidity below 60% to prevent moisture absorption, which could lead to caking or clumping of the powders. **3. Handling During Transport** • **Avoid Humidity and Moisture:** Ensure the transport environment is dry. Use desiccants or moisture-absorbing materials within the packaging if necessary. • **Physical Handling:** These powders can be sensitive to physical shock, which might compact or damage the product. Handle pallets with care, using cushioning if necessary. • **Segregation:** Segregate from odorous or strongly flavored products to prevent cross-contamination.	products, they benefit from controlled environments. Use trucks or containers with HVAC systems capable of maintaining a stable environment, especially if transporting through varied climates. **2. Insulation:** If full climate control isn't necessary, use insulated trucks or containers with minimal temperature control, which can still help maintain cooler temperatures during transport.

	4. Monitoring and Compliance • **Data Loggers:** Deploy humidity and temperature data loggers for monitoring. This data is crucial for quality assurance and compliance with regulations. • **HACCP and FSMA Compliance:** Follow food safety standards like Hazard Analysis and Critical Control Points (HACCP) or the Food Safety Modernization Act (FSMA), ensuring transportation meets all regulatory requirements. **5. Route Planning** • **Optimal Routes:** Choose routes that minimize exposure to extreme weather conditions. Plan routes to reduce transit time, especially if temperature control is minimal. • **Avoiding Delays:** Plan to avoid transport during peak traffic or times likely to cause delays, which could expose the product to unfavorable conditions longer. **6. Delivery** • **Immediate Storage:** Upon arrival, move the powders into storage conditions that match transport conditions as quickly as possible to maintain consistency in environment. • **Inspection:** Check for any signs of moisture ingress or physical damage to packaging during transport.	
Equipment for an Integrated, Optimized, Processing Plant	**1. Raw Material Reception:** • Milk Tanker Unloading Dock • Raw Milk Storage Silos	

	• Raw Milk Cooling System
	• Milk Quality Testing Equipment
	
	2. Pre-Processing:
	• Milk Standardization Equipment:
	  o Milk Separators for fat standardization
	• Pasteurization Equipment:
	  o High-Temperature Short-Time (HTST) Pasteurizers
	
	3. Processing Sections:
	Cheese Production (Cheddar & Mozzarella):
	• Cheese Vats
	• Cheese Cutting Knives
	• Cooking and Stirring Equipment
	• Cheddar Specific:
	  o Cheddaring Tables
	  o Cheese Presses
	  o Curing Rooms with Climate Control
	• Mozzarella Specific:
	  o Stretching Machines
	  o Cooling Tanks

	○ Brining Tanks **Cream Cheese Production:** • Cream Separator • Cream Pasteurizer • Cream Cheese Culturing Vats • Cream Cheese Processing Line (including homogenizers and mixers) **Butter and Butter Oil Production:** • Butter Churns • Butter Workers • Butter Packaging Machines • Butter Oil Clarification Equipment **Whey Processing:** • Whey Storage Tanks • Ultrafiltration Units • Reverse Osmosis Equipment (if needed for further concentration) • Spray Dryers for Whey Protein Powder **Casein Production:** • Acidification Tanks • Precipitation Equipment • Centrifuges for Acid Casein • Spray Dryers for Casein Powder

	4. Utilities and Support: **Boiler System:** • Industrial Boiler • Heat Exchangers for Heat Recovery **Wastewater Treatment:** • Anaerobic Digesters • Dissolved Air Flotation (DAF) System • Aerobic Treatment Tanks • Sludge Dewatering Equipment **5. Packaging:** • Vacuum Packers for Cheese • Butter and Cream Cheese Filling and Sealing Machines • Powder Packaging Machines for Whey Protein and Casein **6. Quality Control:** • **Laboratory Equipment:** o Microbiological Testing Kits o Chemical Analyzers (for protein, fat, lactose content) o pH Meters

- Refractometers

7. Cleaning-In-Place (CIP):

- Central CIP Unit
- Pumps and Pipes for CIP
- Heat Exchangers for Cleaning Solutions

8. Sustainability Features:

- **Energy Recovery Systems:**
  - Heat Recovery Units
- **Water Treatment Systems:**
  - RO Systems for water reuse

9. Logistics:

- Cold Rooms and Freezers
- Refrigerated Conveyor Systems
- Loading Docks with Automated Pallet Jacks

Additional Considerations:

- Automated Control Systems: PLCs (Programmable Logic Controllers) for managing machinery and process automation.
- Conveyor Systems: For moving products between processing stages.

	• Weighing Scales: At various stages for precise measurements. • Storage Solutions: For raw materials, intermediate products, and finished goods.

14. CORPORATE GOVERNANCE STRUCTURE

14.1. Board of Directors

The Company's Board is currently Chaired by the Managing Director and majority shareholder.

14.2. Labour Requirement & Cost

Table 10: Projected Labour Requirement & Associated Annual Cost

15. KEY RISKS FACING THE BUSINESS

Table 11: Overview of Risk Facing the Expansion Project

CATEGORY OF RISK	PARTICULAR RISK	DESCRIPTION OF RISK	PROPOSED MITIGATION MEASURES
Supply Chain Risks	Raw Material Supply	Fluctuations in milk supply due to seasonal changes, disease outbreaks among cattle, or economic factors affecting dairy farms.	Sourcing for raw milk through aggregators whose business is to collect milk from all regions in the country.
	Logistics	Delays or disruptions in transportation, whether it's getting raw milk and other productions inputs to the facility or distributing finished products.	Maintaining Company-owned trucks to ensure that logistics timelines are met.
Production Risks	Equipment Failure	Machinery breakdowns can halt production. For example, a malfunction in pasteurization or packaging equipment could lead to significant downtime	Sourcing for equipment from reputable manufacturers like Tetra Pak and maintaining relationships with their servicing departments. The Company also hires its own certified maintenance engineers.
	Quality Control Issues	Contamination or failure to meet quality standards can result in product recalls, like discovering listeria in cheese or butter.	Ensuring implementation standards of production processes and environment.
	Technology Obsolescence	Rapid advancements in technology might make current equipment outdated, necessitating	Staying informed about any advancements in production technology and analysing their effects on the Company's operations.

		investment in new technologies to remain competitive.	
	Labor Issues	Workforce shortages, strikes, or high turnover can impact production. Skilled labor is crucial for maintaining quality and efficiency.	The Company uses local labour wherever it can. The Company also makes sure to pay competitive wages and provides other benefits like lunch and transport.
	Health and Safety	Ensuring workplace safety to avoid accidents or health issues among employees.	Ensuring implementation standards of production processes and environment.
Market Risks	Price Volatility	Dairy commodity prices can fluctuate widely due to supply and demand imbalances. For instance, a surplus in butter production might lead to price drops.	Product diversification to limit the effects of changes in prices for any one product.
	Consumer Preferences	Shifts towards plant-based alternatives or health trends might reduce demand for traditional dairy products.	Market diversification to limit the effects of changes in consumer preference in any one country/region.
Financial Risks	Credit Risk	Delays in payments from distributors or retailers can strain cash flow.	Implementing working capital management techniques like matching credit periods from suppliers to credit periods from customers. Also, utilising overdraft facilities from the Company's banking partners.
	Currency Risk	For processors involved in international trade, currency fluctuations can affect profitability.	Ensuring the development of both local and foreign markets. The Company may also use different financial products like currency swaps and forward

			exchange contracts to limit the effect of unfavourable changes in the exchange rate.
Regulatory and Compliance Risks	Food Safety Regulations	Changes in regulations or non-compliance can lead to fines or shutdowns. For example, new standards for pasteurization or labeling laws.	Ensuring implementation standards of production processes and environment.
	Trade Policies	Tariffs or trade bans can affect import/export of dairy products, impacting market access. This is especially true for Kenya and Tanzania. Kenya has sought to limit imports of UHT milk and milk powder from Uganda based on allegations of poor quality and that Uganda is re-exporting milk imported from outside the East African Community, but more likely, to protect its local dairy industry. Tanzania also limits the issuance of import permits for milk to protect its local industry.	The Company shall look to partner with licensed importers of dairy products in its target foreign markets. In addition, the diversification of its product portfolio is expected to provide a wider option of tradeable products to its partners in markets that limit importation of locally produced dairy products like UHT milk, yoghurt, and powdered milk.
Reputational Risk	Brand Damage	Public health scares or ethical lapses (like staff welfare concerns) can damage brand reputation, affecting long-term consumer trust.	In addition to ensuring implementation standards of production processes and environment and maintaining mutually beneficial relationships with its staff, the Company shall also invest in a public relations and marketing campaign to bolster its image in the market.

16. TIMELINE TO LAUNCH OF BUSINESS EXPANSION ACTIVITIES

This expansion Project shall be launched as soon as the requisite funds are made available to the Company. The Company estimates a period of 6 – 9 months for the completion of all civil works, setting up and installation of all necessary equipment, and hiring of the necessary labour, both skilled and unskilled.

17. FINANCIAL PLAN

17.1. Assumptions Used

Some of the assumptions used in the development of the financial projections presented in this section are presented in the figure below. These assumptions relate to the drivers of projected revenue of the Company. Assumptions relating to the costs are presented in the Appendix.