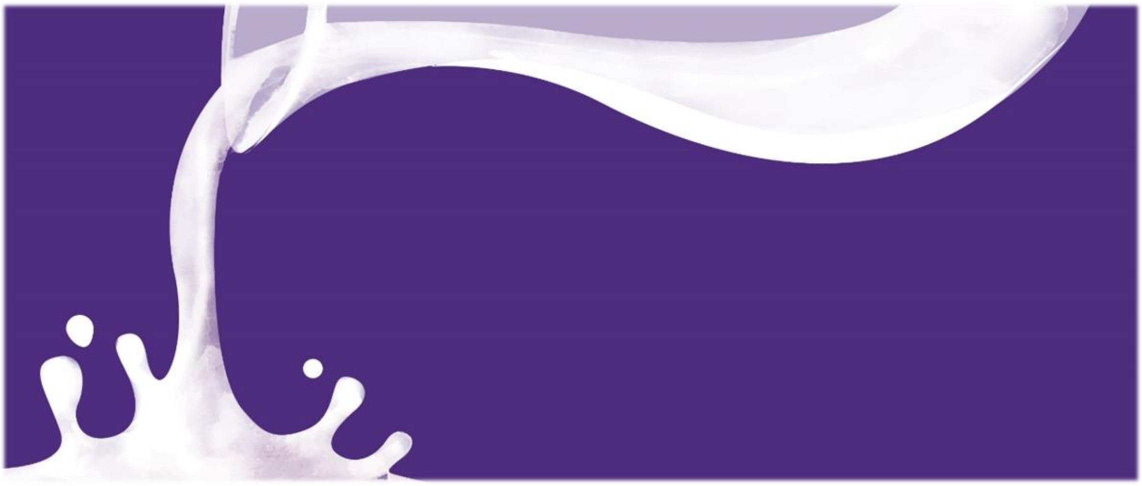
RAJASTHAN AGRICULTURAL COMPETITIVENESS PROJECT

Study Report of Innovative Technology based Business Model

Goat Milk & Value added Products



Prepared by:

Grant Thornton

An instinct for growth™

AGRI BUSINESS PROMOTION FACILITY

Contents

List of Tables

List of Figures

Executive Summary

The development objective of Rajasthan Agriculture Competitiveness Project (RACP) is to sustainably increase agriculture productivity and farmers' incomes in several selected locations of Rajasthan. As a part of this approach, several Farmer Producer Companies (FPCs) have been developed and supported under the project. Each of these companies will have primary and/or secondary (value adding) processing infrastructure. Broadly, these companies will aggregate goat milk & value add and directly sell it in B2B or B2C network. This, in turn, will enable farmers to realize higher and better remuneration for their produce. In a nutshell, the envisaged project will have micro or small scale processing and packaging units to facilitate services to the Goat milk producers in the cluster & allied areas.

Naturally, existing and upcoming agro and food processing units in the state play a highly important role in the scheme of things, i.e. forward linkages in agriculture. Evidently, higher investments in such agribusinesses will foster development and sustainability of FPCs and farmers thereto. In line with the approach, RACP, through its Agri-Business Promotion Facility (ABPF), aims at:

- Promoting agribusiness investments in the state
- And providing incubation facilities to foster innovation & entrepreneurship

The objective of this report is "scouting of technologies and suitable replicable models" in Goat milk processing. Broadly, the report aims to provide some insights, to prospective entrepreneurs and existing unit holders in the state - on technological gaps identified in existing units, on several technological advances in the industry, on benchmarking technology and efficiency vis-à-vis industry bests in other parts of the country and providing suitable replicable models for medium scale investors.

Notably, milk production and demand has increased dramatically during the last decade due to evidence supporting the benefits of milk in the diet, as well as diverse uses of Value added product. However, there are unique challenges that accompany goat milk production, processing, Value addition, Marketing & Distribution. The present report provides some important suggestions on the adoption of new technologies to overcome such challenges.

The report also outlines two project profiles, that could be referred by entrepreneurs to select their most suitable option. Chapter 4 showcase the financial feasibility of the project.

Chapter 1- Introduction

For humans, milk and dairy products make a significant contribution by meeting our body needs for calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid (vitamin B5) and therefore play a vital role in our development.

By 2050 the global population is expected to reach 9.1 billion, 34 % higher than today. Most of this increase is likely to occur in developing countries like Brazil, China and India, where more and more people are choosing to live in urban areas with higher incomes. Total food production must therefore increase to meet the projected demands of this growing population. The FAO considers milk of such importance in human nutrition that it recommends 2-3 servings of milk or other dairy products every day.

A common food allergy for children under three years is noticed by consumption of Cow's milk. Side effects include vomiting, diarrhea, and skin rashes and severe effects can be as serious as anaphylactic shock. Needless to say it is a serious condition. The allergic reaction can be blamed on a protein allergen known as Alpha s1 Casein found in high levels in Cow's milk. The levels of Alpha s1 Casein in goat's milk are about 89% less than Cow's milk providing a far less allergenic food. In fact, recent studies of infants allergic to Cow's milk found that nearly 93% could drink goat's milk with virtually no side effects.

Goat's milk has smaller fat globules as well as higher levels of medium chain fatty acids. This means that during digestion, each fat globule and individual fatty acid will have a larger surface-to-volume ratio resulting in a quicker and easier digestion process. Also, when the proteins found in milk denature (clump up) in the stomach, they form a much softer bolus (curd) than Cow's milk. This allows the body to digest the protein more smoothly and completely as compared to Cow's milk.

All milk contains certain levels of lactose which is also known as 'milk sugar.' A relatively large portion of the population suffers from a deficiency (not an absence) of an enzyme known as lactase which is used to digest lactose. This deficiency results in a condition known as lactose intolerance which is a fairly common ailment. (Lactose intolerance and Cow's milk allergy (CMA) are two distinct conditions. CMA is due to a protein allergen, while lactose intolerance is due to a carbohydrate sensitivity). Goat's milk contains less lactose than Cow's milk and therefore is easier to digest for those suffering from lactose intolerance.

1.1. Global Scenario

In the goat milk segment: The world goat milk production was 15.2 million tons (FAOSTAT, 2016). India leads the global goat milk production at 5.6 million tons accounting for about 25% of the total production. A wide variety of products are manufactured from goat milk such as different cheeses, butter, yogurt, fluid beverages etc. Goat milk has therapeutic and beneficial effects on the people who have allergy from Cow milk. However, the greater portion of goat milk is still not widely traded, but is consumed locally.

Figure 1:Table 1:Evolution of goat milk production (tons) in the World during the period 1990 – 2012 (Faostat, 2013)

Particulars	Year			Change	Contribution %
	1990	**2000**	**2012**	**2000-2012**	**2012**
Asia	5,485,692	6,948,745	10,410,137	49.81	58.35
Africa	2,055,653	2,777,245	4,308,399	55.13	24.14
Australia	25	28	48	71.43	0.00002
Europe	2,161,678	2,587,928	2,536,773	-1.98	14.2
E.U. (28)	1,725,329	1,982,607	1,927,712	-2.77	10.8
Americas	467,190	505,342	509,761	0.87	3.31
World	**9,980,102**	**12,819,288**	**17,846,118**	**39.21**	**100**

Source: http://www.lrrd.org/lrrd28/11/skap28200.htmlc

Among the continents, Asia is constantly the largest producer of goat milk (contribution 58.35%), followed by Africa (contribution 24.14%), Europe (contribution14.21%) and Americas (contribution 3.31%). Australia had a significant increase of goat milk production during the period 2000-2012 (+71.43), followed by Africa (55.13%), Asia (49.81%) and America (0.87%). In Europe and also in E.U., on the contrary, during the same period the goat milk production decreased by (- 1.98 and -2.77, respectively). Greece observed the largest decrease of goat milk production by (-21.80%), because of reduction of total goat number and also the decrease of goat farms number. Meanwhile, Greece takes the first place in Europe for goat milk production per inhabitant and per year (43.52 kg, Faostat 2013).

In Asia, the larger producers of goat milk are India, Bangladesh, Pakistan and Turkey. China, which possess the greatest number of goats in the world has limited production of goat milk, because the larger number of goats in this country are farmed for meat production. The African countries with the larger amount of milk are Sudan, Mali, Somalia, Kenya and Algeria. In the American continent the leader countries in goat milk production are Jamaica, Mexico and Brazil, while in Europe the larger producers are France, Spain and Greece. Netherlands observed a significant upward tendency for this product (Faostat 2013). On the other hand, Netherlands is the leader in terms of annual milk production per goat. The annually milk production per goat in Netherlands amounts to (798.4 Ltrs), followed by France (686.6 Ltrs), Spain (352.1 Ltrs) and Israeli (304.8 Ltrs).

1.2. Indian Scenario

Goat sector contributes 8.45 % of India's Livestock GDP[1]. India currently possesses the second-largest goat population in the world. In the prevailing socio-economic conditions in the country, where per capita land holding is hardly 0.2 Ha, goat rearing becomes an inseparable component of mixed farming system. Goat farming has been recommended as the best choice for the rural people in developing countries because of the low investment, wide adaptability, high fertility and fecundity, low feed and management needs, high feed conversion efficiency, quick pay-off and low risk involved. Goats play an important role in income generation, capital storage, employment generation and improving household nutrition.

Goat rearing is the backbone of the economy of small and landless farmers in India. It is an insurance against crop failure and provides alternate source of livelihood to the farmers all year round. Goats provide dependable source of income to 40% of the rural population who are below the poverty line. Several states are now encouraging goat husbandry.

As per data from 19th Livestock Census; 37.28% were cattle, 21.23% buffaloes, 12.71% sheep, 26.40% goats and 2.01% pigs.

The goat milk production estimate in India was 5180.18 thousand metric tonnes during 2014-15. The total milk production in India was 146313.55 thousand metric tonnes during 2014-15. Thus, the percentage share of goat milk production estimate in total milk production estimate in India was 3.54 % during 2014-15. The top 5 states in terms of the goat milk production estimate in India were: Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat and Maharashtra during 2014-15. The goat milk production estimate in Rajasthan was 1822.82 thousand metric tonnes during 2014-15. The total milk production in Rajasthan was 16934.31 thousand metric tonnes during 2014-15. Thus, the percentage share of goat milk production estimate in total milk production estimate in Rajasthan was 10.76 % during 2014-15. The goat milk production estimate in Uttar Pradesh was 1287.84 thousand metric tonnes during 2014-15. The total milk production in Uttar Pradesh was 25198.36 thousand metric tonnes during 2014-15. Thus, the percentage share of goat milk production estimate in total milk production estimate in Uttar Pradesh was 5.11 % during 2014-15. The goat milk production estimate in Madhya Pradesh was 556.75 thousand metric tonnes during 2014-15. The total milk production in Madhya Pradesh was 10779.07 thousand metric tonnes during 2014-15. Thus, the percentage share of goat milk production estimate in total milk production estimate in Madhya Pradesh was 5.17 % during 2014-15. The goat milk production estimate in Gujarat was 267.3 thousand metric tonnes during 2014-15. The total milk production in Gujarat was 11690.57 thousand metric tonnes during 2014-15. Thus, the percentage share of goat milk production estimate in total milk production estimate in Gujarat was 2.29 % during 2014-15. The goat milk production estimate in Maharashtra was 247.43 thousand metric tonnes during 2014-15. The total milk production in Maharashtra was 9542.29 thousand metric tonnes during 2014-15. Thus, the percentage share of goat milk production estimate in total milk production estimate in Maharashtra was 2.59 % during 2014-15.

We have seen a growth of 3.82% in Production of Goat milk during 2015-16 over 2014-15. We have seen a growth of 2.61% in Production of Goat milk from 5048 thousand tonnes during 2013-14 to 5180 thousand tonne during 2014-15. The top 10 States/UTs in terms of Production of Goat milk during 2015-16 were: Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Bihar, West Bengal, Kerala, Jharkhand and Karnataka.

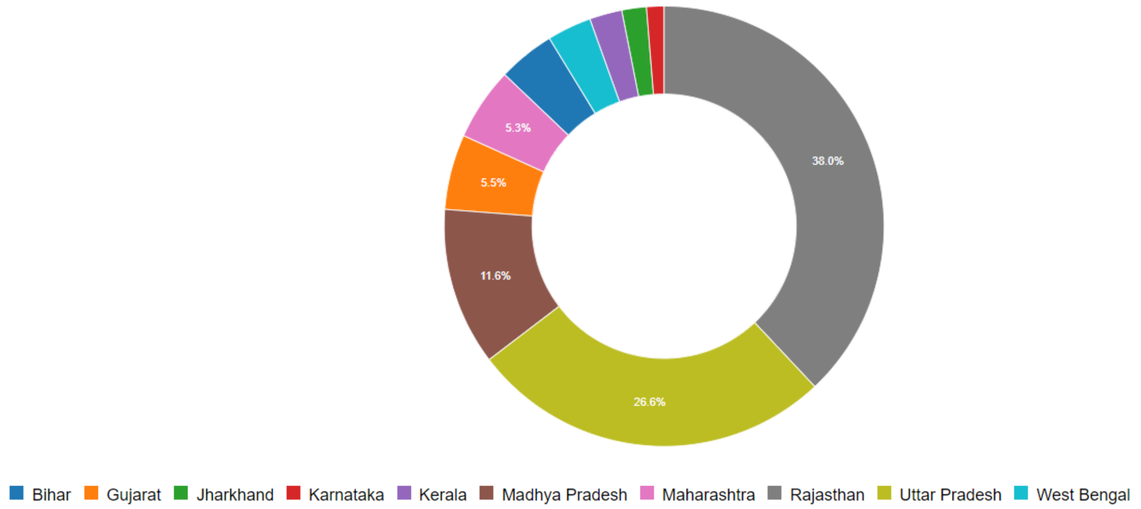
Production of Goat milk in Rajasthan was 1933 thousand tonnes during 2015-16, which accounted 35.94% of total Goat milk produced in India during the year. In Rajasthan, there was growth of 2.42% and 6.03% in Goat milk production during 2014-15 and 2015-16 respectively over the previous year. Production of Goat milk in Uttar Pradesh was 1279 thousand tonnes during 2015-16, which accounted 23.78% of total Goat milk produced in India during the year. In Uttar Pradesh, there was growth of 3.21% and -0.7% in Goat milk production during 2014-15 and 2015-16 respectively over the previous year. Production of Goat milk in Madhya Pradesh was 609 thousand tonnes during 2015-16, which accounted 11.32% of total Goat milk produced in India during the year. In Madhya Pradesh, there was growth of 2.58% and 9.34% in Goat milk production during 2014-15 and 2015-16 respectively over the previous year.

Production of Goat milk in Gujarat was 289 thousand tonnes during 2015-16, which accounted 5.37% of total Goat milk produced in India during the year. In Gujarat, there was growth of 3.09% and 8.24% in Goat milk production during 2014-15 and 2015-16 respectively over the previous year. Production of Goat milk in Maharashtra was 258 thousand tonnes during 2015-16, which accounted 4.8% of total Goat milk produced in India during the year. In Maharashtra, there was growth of -1.2% and 4.45% in Goat milk production during 2014-15 and 2015-16 respectively over the previous year.

These top 5 states accounted for 81.22% of the total Goat milk produced in India as a whole during 2015-16. 198 thousand tonne Goat milk produced in Bihar during 2015-16. It accounted 3.68% of the total Goat milk produced in India during the year. 130 thousand tonne Goat milk produced in West Bengal during 2015-16. It accounted 2.42% of the total Goat milk produced in India during the year. 129 thousand tonne Goat milk produced in Kerala during 2015-16. It accounted 2.4% of the total Goat milk produced in India during the year. 102 thousand tonne Goat milk produced in Jharkhand during 2015-16. It accounted 1.9% of the total Goat milk produced in India during the year. 78 thousand tonne Goat milk produced in Karnataka during 2015-16. It accounted 1.45% of the total Goat milk produced in India during the year.

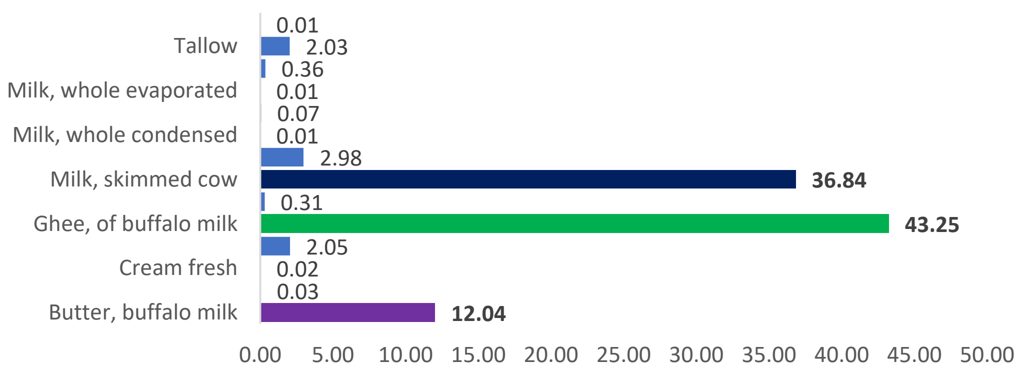
The below mentioned top 10 states accounted for 93.06% of the total Goat milk produced in India as a whole during 2015-16.

Figure 2:Top 10 States/UTs in terms of Production of Goat Milk in India during 2015-16



Source: Community.Data.gov.in

Figure 3:% Production Share of various milk based value added products: (Average 2012 - 2014: India)



Source: GT Analysis based on FAOSTAT Data

1.3. State Scenario: Rajasthan

55% of total area of Rajasthan is desert and hence livestock is the main source of livelihood. As per the distribution of livestock in the Rajasthan, Goat has the largest share among animal population in Rajasthan i.e. 37.35% . The Share of other domesticized animals is: Cattle 23.08%, Buffalo 22.48%, Sheep 15.73% and other 1.19%. Rajasthan is having 3 well known breeds of goats, viz, Jakharana, Sirohi, and Marwari. In Rajasthan, Barmer has the largest goat population i.e. 2,896,620, followed by Jodhpur with 1,681,913, Jaisalmer with 1,513,386, Nagaour with 1,485,051 and Udaipur with 1,106,814.

Table 1:Goat Population Distribution in Rajasthan

S. No.	District	Goat Population
1	Barmer	2896620
2	Jodhpur	1681913
3	Jaisalmer	1513386
4	Nagaour	1485051
5	Udaipur	1106814

Source: 19th livestock census 2012

The table below shows the distribution of the livestock with respect to the population of goats where the comparison is done for three terms of five years each year's i.e. 2003, 2007 and 2012. Overall, there has been increase in the population of goats in Rajasthan since 2003.

Table 2:Livestock Distribution according to Sex for three consecutive livestock census years

Particulars	2003	2007	2012	% Change from 2007 to 2012
Male	2550	4067	4260	4.74
Female	14258	17435	17405	-0.17
Total Goat	**16809**	**21503**	**21665**	**0.76**

Source: 19th livestock census 2012

1.4. District and Cluster scenario

Within RACP Clusters, Goat rearing is a value chain component for 12 clusters as stated in Table below. Goats are not part of value chain intervention in Bonli, Sangod, Z Distributary, Phoolasar and Pratapgarh clusters. Goats are also reared by substantial no. of households in the below mentioned clusters under RACP and these households are primarily small holders with limited resources. The Livestock Profile of various clusters shows high population of the goats, indigenous cattle with low milk yield. The small holders of the clusters prefer to keep animals with low resource requirements. So there is scope of popularising goat farming with suitable interventions for improving milk and meat productivity. Project intervention is also supporting small holder's in Goat rearing and market linkage.

Table 3:Cluster wise data for Goats in RACP Clusters

Sn	Cluster	No of Goat MTGs	No of households having goats	No of goats	Average Goat population per family	No of males	District Goat population
1	Bari	71	580	4274	7	1117	89,652
2	Bansur	80	1472	5638	4	1934	379,776
3	Mokhampura	40	3013	12053	4	3616	837,094
4	Palayatha	40	3467	9227	3	2214	183,499
5	Dooni	60	4119	15174	4	5170	375,827

Sn	Cluster	No of Goat MTGs	No of households having goats	No of goats	Average Goat population per family	No of males	District Goat population
6	Manoharthana	35	4039	12562	3	3454	313,475
7	Gudha	150	9081	45289	5	8288	329,366
8	Kheruwala	20	1209	18572	15	4861	961,907
9	Ladnun	20	4542	17553	4	6122	1,485,051
10	Pisangan	90	6342	44397	7	7968	730,758
11	Kushalgarh	20	3531	11094	3	3516	504,758
12	Orai-bassi	125	9567	31587	3	6778	474,799
	Total	**751**	**50962**	**227420**	4	**55038**	**6665962**

Source: RACP, CACP

1.4.1. Goat Milk production potential in RACP Clusters

Cow/Buffalo, milk channel is very well developed around most part of Rajasthan and the Rajasthan Cooperative Dairy Federation has an outreach to most of the clusters. Apart from these, the launching of various other large and small dairies like Payas, Amul, Reliance have increased the access of Cow/Buffalo milk producers to the market. However, due to smaller per capita production of milk from goat (mostly due to non-descript animals), smaller volumes per production cluster, lack of availability of separate handling facilities like chilling, transportation, pasteurization and packaging facilities and thus high cost of operation, none of the large and successful players in the general milk sector have ventured into the Goat milk sector. The Goat milk production profile for RACP clusters is discussed below.

Bari: The estimated milk yield would be around 1847 L per day at an estimated average 1.5 L/day/animal. Out of this, around 50% i.e. 923 L would be marketable surplus.

Bansur: The estimated milk yield would be around 2903 L per day at an estimated average yield of 1.5 L/day per animal. The marketable surplus would be around 1451 L per day. However, there are few areas around the cluster (surrounding of Aravali hills) where the Goat population is very high and thus the area has great potential for collection and further processing of Goat milk. The villages around the Aravali hills have large number of Goat Herders (Rewars) who rear 30-50 goats and are large source of goat milk. Bansur cluster also has a great potential for work in goat milk value chain due to its proximity to major potential market like National Capital region.

Dooni: The cluster has a total of around 15174 goats out of which 34% are milking animals. The estimated milk yield would be around 7755 L per day at an average milk yield of around 1.5 L/day as most of the animals are non-descript. The marketable surplus would be around 3878 L/day.

Gudha: The cluster has a total of around 45,289 goats out of which 30% are milking animals. The nearest milk union in Kota collected an average of 91,000 L milk per day in 2016-17. The estimated milk yield would be around 20589 L per day (at an estimated average yield of 1.5 L/day/animal) is the potential for collection as on date and 10259 L/day is the estimated marketable surplus if maximum potential is achieved by developing a separate remunerative value chain for Goat milk. This suggests Goat milk has a future in the area. Apart from this, it has a good catchment area for milk as other parts of the district and nearby RACP cluster in Dooni have good number of goat population and good volume of Goat milk could be collected there.

Kheruwala: The cluster has a total of around 18572 goats out of which 26% are milking animals. The estimated milk yield would be around 7292 L per day and marketable surplus would be around 3646 L/day. This suggests Goat milk has a future in the area. However, it is not advised to work on Goat milk in this area due to scattered population and logistic issues.

Kushalgarh: The dairy cooperative network is not so strong in the district. The district mil union collects around 7000 L of milk per day. The cluster has a total of around 11094 goats out of which 31% are milking animals. The estimated milk yield would be around 5277 L per day and marketable surplus is estimated at around 2637 L/day. Because of the long distance from markets, and fragmented collection areas, milk value chain is not suggested in the cluster.

Ladnun: Dairy cooperative network is not much developed in the district. The district milk union collected around 13000 L of milk per day in FY 16-17. The cluster has a total of around 17753 goats out of which 34% are milking animals. The estimated milk yield would be around 6846 L per day is the potential for collection as on date and 3423 L/day is estimated marketable surplus that might be available if separate remunerative milk collection system is established in the cluster. The nearest markets could be Ajmer and Jaipur.

Manohar Thana: The cluster has a total of around 12562 goats out of which 28% are milking animals. The estimated milk yield would be around 5181 L per day and marketable surplus is estimated to be 2591 L/day at an average surplus of 0.75 L/day per milking animal.

Mokhampura: The cluster has a total of around 12053 goats out of which 30% are milking animals. The estimated milk yield would be around 5423 L/day and estimated surplus milk would be 2711 L/day. This suggests Goat milk has a future in the area.

Palayatha: The cluster has a total of around 9227 goats out of which 29% are milking animals. The estimated milk yield would be around 4034 L per day and marketable surplus would be 2017 L/day. It is suggested to club this area with Bundi for future milk processing activities as Bundi district has a large number of goat population and the cluster is hardly 45 km from the cluster in Bundi.

Pisangan: The cluster has a total of around 44397 goats out of which 34% are milking animals. The estimated milk yield would be around 26423 L per day out of which, the marketable surplus would be 13217 L/day. However, the cluster is spread across a large area and three key centres i.e. Nand, Kadel and Nooriawas (having a coverage of 14 villages) have maximum concentration of Goat farmers and have potential to collect a marketable surplus of 6000 L per day.

Orai-bassi: The cluster has a total of around 31587 goats out of which 31% are milking animals. The district milk union collected an average of 100,000 L milk per day in 2016-17. The estimated milk yield would be around 14666 L per day and marketable surplus would be around 7333 L/day. However, the area is quite scattered and goat milk collection can be kept in mind for future expansions of the project.

Chapter 2- Technological advances in milk processing & Valued added products

The dairy industry in many countries is a major contributor to the manufacturing capacity of the food sector. Already dairy operations range from the straightforward handling of liquid milk through to the production of highly sophisticated consumer items, and it is of note that all this activity is based on a raw material that is readily perishable at ambient temperatures. This competitive, commercial position, together with the fact that the general public has a high regard for dairy products, is an indication of the extent to which milk producers and processors have combined to ensure that products are both nutritious and hygienically acceptable. Achievement of these aims, and at reasonable cost, has depended in large measure on the advances that have been made in the handling of large volumes of milk. Thus, factories designed to handle millions of litres of milk per week are now commonplace, and it is the plant and equipment involved that provides the factual background. In view of the same this chapters gives a detailed analysis on recent advancement in the technological aspects pertaining to the goat milk processing.

2.1. Key Advances in each step and process of milk processing

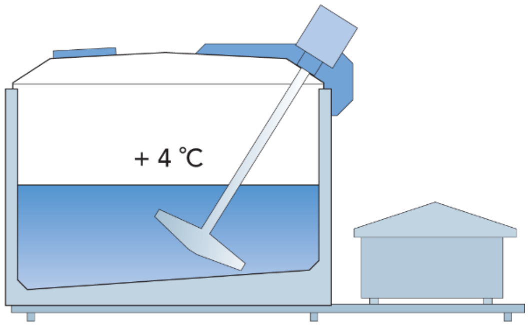
2.1.1. Milk Collection

The milk is brought from the collection centre to the dairy for processing. All kinds of receptacles have been used, and are still in use, throughout the world, from 2 – 3 litre calabashes and pottery to modern bulk-cooling farm tanks for thousands of liters of milk.

Keeping the milk cool: The milk should be chilled to + 4 °C immediately after milking and be kept at this temperature all the way to the dairy. If the cold chain is broken somewhere along the way, e.g. during transportation, the microorganisms in the milk will start to multiply. This will result in the development of various metabolic products and enzymes. Subsequent chilling will arrest this development, but the damage will already be done. The bacteria count is higher and the milk contains substances that will affect the quality of the end product.

Design of Farm Dairy Premises: The first steps in preserving the quality of milk must be taken at the farm. Milking conditions must be as hygienic as possible; the milking system designed to avoid aeration, the cooling equipment correctly dimensioned. To meet the hygienic requirements, dairy farms have special rooms for refrigerated storage. Bulk cooling tanks are also becoming more common. These tanks (Figure:4, with a capacity of 300 to 30 000 liters, are fitted with an agitator and cooling equipment to meet certain stipulations – for example that all the milk in the tank should be chilled to +4 °C within two hours after milking. Larger farms, producing large quantities of milk, often install separate plate coolers for chilling the milk before it enters the tank (Figure:5). This saves mixing warm milk from the Goat with the already chilled contents of the tank. The milk room should also contain equipment for cleaning and disinfecting the utensils, pipe system and bulk cooling tank.

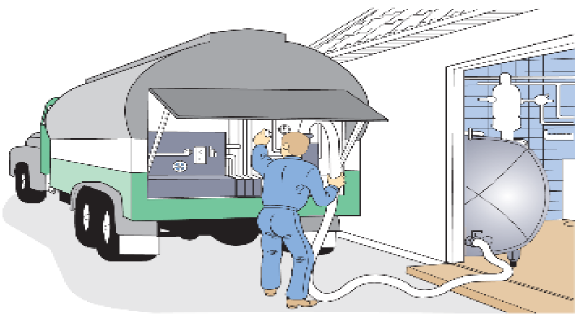
Figure 4:Bulk cooling tank with agitator & chilling unit



Delivery to the Dairy: The raw milk arrives at the dairy in insulated road tankers. The milk must be kept well chilled, free from air and treated as gently as possible. For example, tanks should be well filled to prevent the milk from sloshing around in the container.

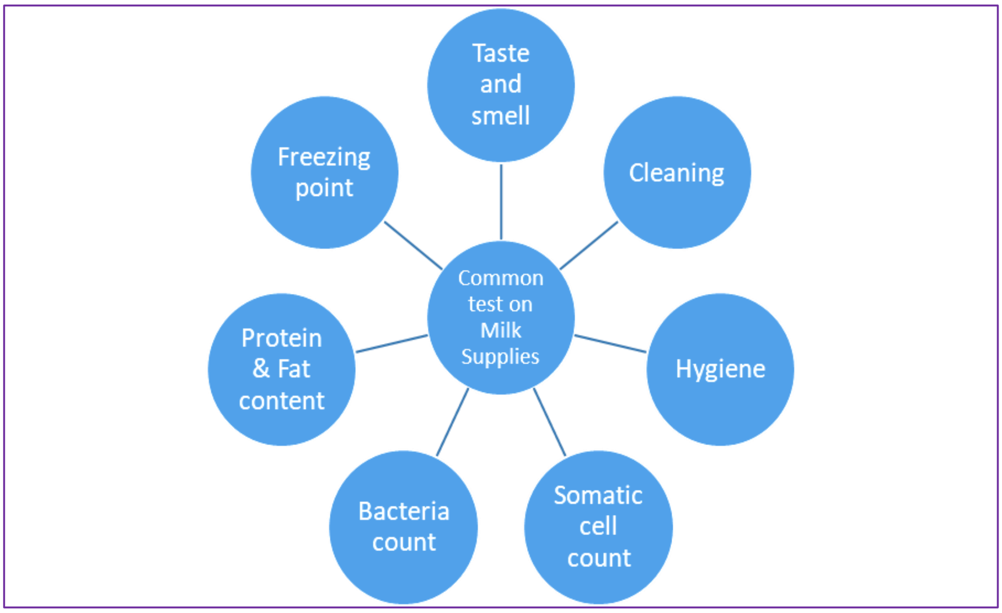
Bulk Collection: When milk is collected by the tanker, it must be possible to drive all the way to the farm milk room. The loading hose from the tanker is connected to the outlet valve on the farm cooling tank (Fig:6). The tanker is usually fitted with a flow meter and pump so that the volume is automatically recorded. Otherwise, the volume is measured by recording the level difference which, for the size of the tank in question, represents a certain volume. In many cases, the tanker is equipped with an air-eliminator. Pumping is stopped as soon as the cooling tank has been emptied. This prevents air from being mixed into the milk. The tank of the bulk collection vehicle is divided into a number of compartments to prevent the milk from sloshing around during transportation. Each compartment is filled in turn, and when the tanker has completed its scheduled round, it delivers the milk to the dairy.

Figure 5:Farm cooling Tank



Testing milk for quality: Milk from sick animals and milk which contains antibiotics or sediment must not be accepted by the dairy. Even traces of antibiotics in milk can render it unsuitable for the manufacture of products which are acidified by the addition of bacteria cultures, e.g. yoghurt and cheese. Normally, only a general assessment of the milk quality is made at the farm. The composition and hygienic quality is usually determined in a number of tests on arrival at the dairy. The outcome of some of these tests has a direct bearing on the compensation to the farmer. The most common tests carried out on milk supplies are detailed below.

Figure 6:Common Test on Milk Supplies



Taste & smell: In the case of bulk collection, the driver takes a sample of the milk at the farm for testing at the dairy. Milk that deviates in taste and smell from normal milk receives a lower quality rating. This affects the payment to the farmer. Milk with significant deviations in taste and smell should be rejected by the dairy.

Hygiene or Resazurin Tests: The bacteria content of the milk is a measure of its hygienic quality. The Resazurin Tests are used frequently. Resazurin is a blue dye which becomes colorless when it is chemically reduced by the removal of oxygen. When it is added to the milk sample, the metabolic activity of the bacteria present has the effect of changing the colour of the dye at a rate which bears a direct relationship to the number of bacteria in the sample. Two hygiene tests use this principle. One is a quick-screening test, which may form the basis for the rejection of a bad churn supply. If the sample starts to change shade immediately, the consignment is considered unfit for human consumption. The other test is a routine test and involves storage of the sample in a refrigerator overnight, before a Resazurin solution is added. The sample is then incubated in a water bath and held at 37,5 °C for two hours.

Bacteria count: A simplified form of bacteria count can also be used to assess the bacteria content. In this, the Leesment method, the bacteria are cultivated at 30 °C for 72 hours in a 0.001 ml milk sample with a nutritive substrate. The bacteria count is determined with a special screen.

Protein Content: Many dairies pay farmers according to the protein content of the milk. This is analyzed by means of instruments operating with infrared rays. Up to 300 analyses per hour can be performed.

Fat Content: Various methods can be used to determine the butterfat content. The Gerber test is the most widely used method for whole milk.

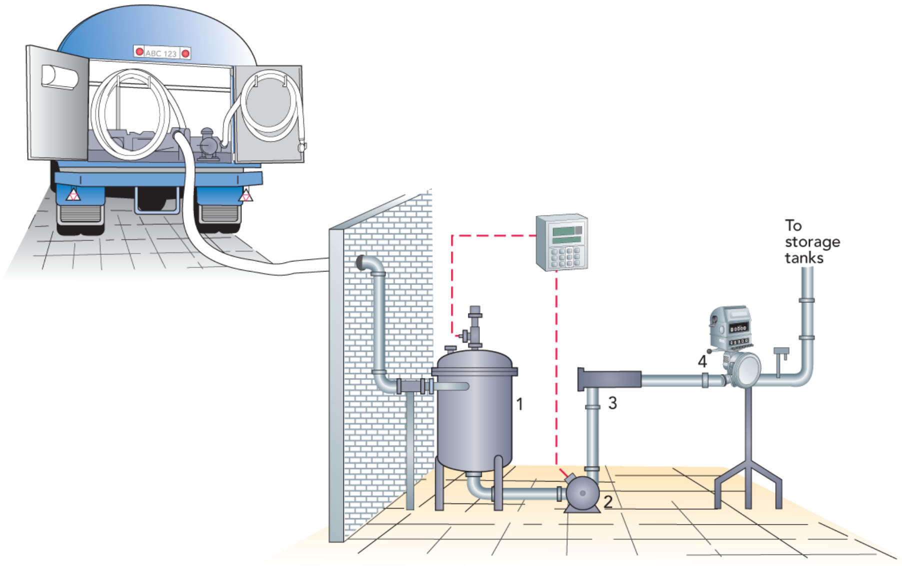
Freezing Point: Many dairies check the freezing point of the milk to determine whether or not it has been diluted with water. Milk of normal composition has a freezing point of -0.54 to -0.59 °C. The freezing point will rise if water is added to the milk. Special instruments are used for this check.

2.2. Milk Reception

Dairies have special reception departments to handle the milk brought in from the farms. The first thing done at reception is to determine the quantity of the milk. The quantity is recorded and entered into the weighing system that the dairy uses to weigh the intake and compare it with the output. The quantity of the intake can be measured by volume or by weight.

Tanker Reception: Tankers arriving at the dairy drive straight into a reception hall, often large enough to accommodate several vehicles. The milk is measured either by volume or by weight.

Figure 7:Measurement by Volume

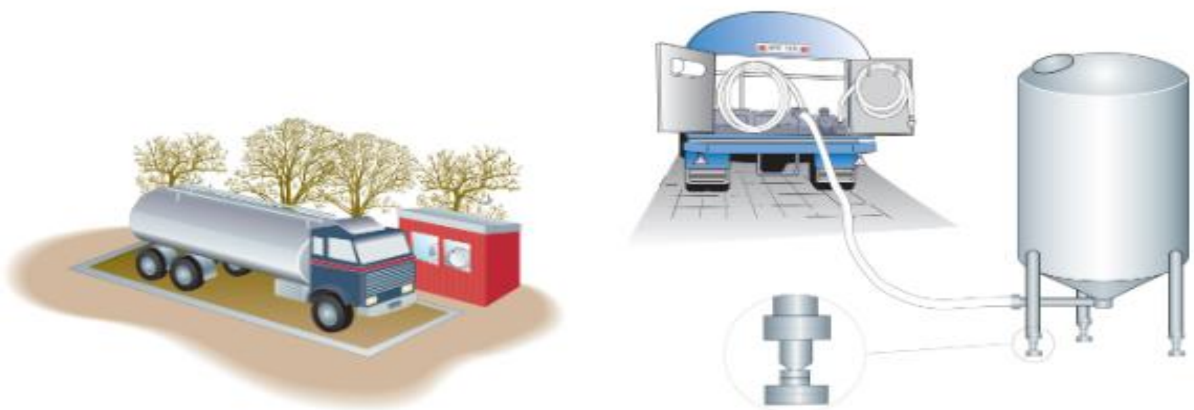


1: Air Eliminator, 2: Pump, 3: Filter, 4: Metering device

Measuring by weight: Bulk-collected milk can be measured in in two ways:

1. Weighing the tanker before and after unloading and then subtracting one value from the above (Figure 8).
2. Using special weighing tanks with load cells in the feet (Figure 9). In the first alternative, the tanker is driven onto a weighbridge at the dairy.

Figure 8:Tanker on a weighbridge



Operation may be manual or automatic. If manual, the operator records the weight against the driver's code number. Where operation is automatic, the necessary data are recorded when the driver places a card in a card scanner. Before being weighed the tanker normally passes a vehicle washing station. This is of special importance when the weather is bad.

When the gross weight of the tanker has been recorded, the milk is delivered into the dairy. This may take place in line with a de-aerator but not a flowmeter. When empty, the tanker is weighed again and the tare weight is deducted from the previously recorded gross weight.

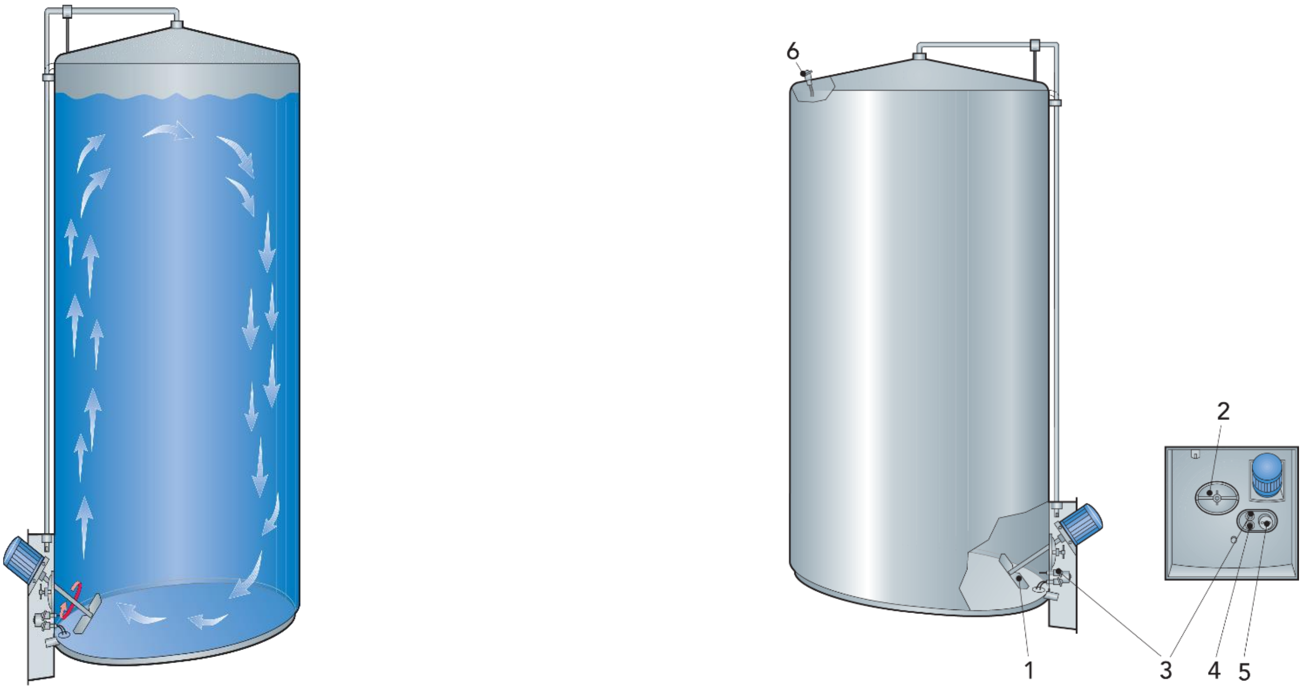
When the weighing-tank method is used, the milk is pumped from the tanker into a special tank with load cells built into the feet. The cells supply an electric signal that is always proportional to the weight of the tank. The strength of the signal increases with the weight of the tank as the milk enters the tank. The weight of the contents in the tank can be recorded when all the milk has been delivered. After this the milk is pumped to a silo tank.

Tanker cleaning: Tankers are cleaned every day, as a rule at the end of a collection round. If the tanker makes several rounds a day, cleaning should take place after each round. Cleaning can be carried out by connecting the tanker to a cleaning system while in the reception area, or by driving it to a special cleaning station. Many dairies also clean the outside of their tankers every day so that they always look clean when they are on the road. In more and more countries new rules are introduced about disinfection of tankers to avoid spreading animal diseases.

Raw milk storage: The untreated raw milk – whole milk – is stored in large vertical tanks – silo tanks – which have capacities from about 100,000 liters up to 500,000 liters. Smaller silo tanks are often located indoors while the larger tanks are placed outdoors to reduce building costs. Outdoor silo tanks are of double-wall construction, with insulation between the walls. The inner tank is of stainless steel, polished on the inside, and the outer wall is usually of welded sheet metal.

Agitation in Silo Tanks: These large tanks must have some form of agitation arrangement to prevent cream separation by gravity. The agitation must be very smooth. Extreme agitation causes aeration of the milk and fat globule disintegration. This exposes the fat to attack from the lipase enzymes in the milk. Gentle agitation is therefore a basic rule in the treatment of milk. The tank in Figure 10 has a propeller agitator, often used with good results in silo tanks. In very high tanks it may be necessary to fit two agitators at different levels to obtain the required effect. Outdoor silo tanks have a panel for ancillary equipment. The panels on the tanks all face inwards towards a covered central control station.

Figure 9:Silo tank with Propeller Agitator



1: Agitator, 2; Manhole, 3: Temperature Indicator,4: Low Level indicator,
5: Pneumatic level indicator, 6: High-level electrode

Tank Temperature Indication: The temperature in the tank is indicated on the tank control panel. Usually, an ordinary thermometer is used, but it is becoming more common to use an electric transmitter, which transmits signals to a central monitoring station.

Level Indication: There are various methods available for measuring the milk level in a tank. The pneumatic level indicator measures the static pressure represented by the head of liquid in the tank. The higher the pressure, the higher the level in the tank. The indicator transmits readings to an instrument.

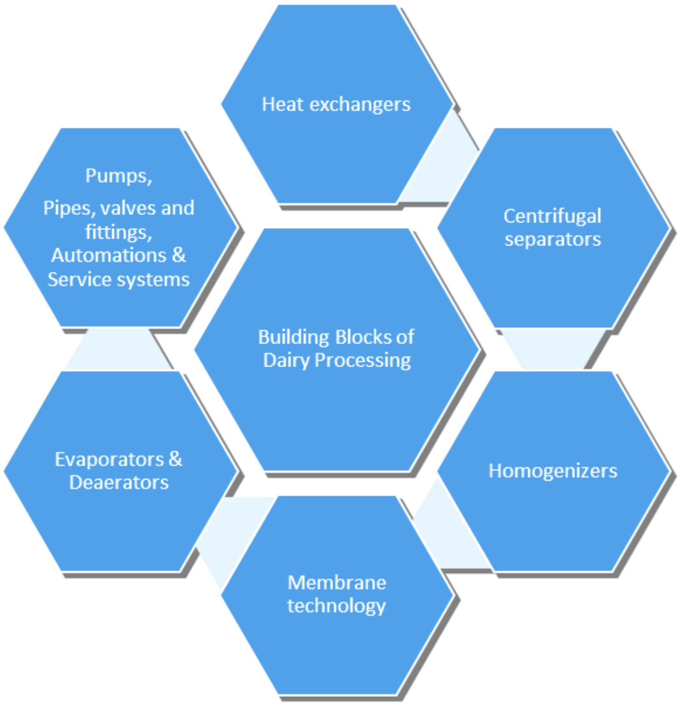
Low-Level Protection: All agitation of milk must be gentle. The agitator must therefore not be started before it is covered with milk. An electrode is often fitted in the tank wall at the level required for starting the agitator. The agitator stops if the level in the tank drops below the electrode. This electrode is known as the low-level indicator.

Overflow Protection: A high-level electrode (HL) is fitted at the top of the tank to prevent overfilling. This electrode closes the inlet valve when the tank is full, and the milk supply is switched to the next tank.

Empty Tank Indication: During an emptying operation, it is important to know when the tank is completely empty. Otherwise, any milk remaining when the outlet valve has closed will be rinsed out and lost during the subsequent cleaning procedure. The other risk is that air will be sucked into the line if emptying continues after the tank is dry. This will interfere with later treatment. Consequently, an electrode, lowest low level, (LLL) is often located in the drainage line to indicate when the last of the milk has left the tank. The signal from this electrode is used to switch to another tank or to stop emptying.

2.3. Building blocks of dairy processing

Figure 10:: Different blocks of dairy processing



Heat Treatment Purpose: Fortunately, all common pathogenic organisms likely to occur in milk are killed by relatively mild heat treatment, which has only a very slight effect on the physical and chemical properties of milk. The most resistant organism is the tubercle bacillus (T.B.), which is considered to be killed by heating milk to 63 °C for 10 minutes. Complete safety can be assured by heating milk to 63 °C for 30 minutes. T.B. is therefore regarded as the index organism for pasteurization: any heat treatment that destroys T.B. can be relied upon to destroy all other pathogens in milk.

Apart from pathogenic microorganisms, milk also contains other substances and microorganisms that may spoil the taste and shorten the shelf life of various dairy products. Hence, a secondary purpose of heat treatment is used to destroy as many as possible of these other organisms and enzymatic systems. This requires more intense heat treatment than is needed to kill the pathogens.

This secondary purpose of heat treatment has become more and more important as dairies have become larger and less numerous. Longer intervals between deliveries mean that, despite modern cooling techniques, microorganisms have more time to multiply and to develop enzymatic systems. In addition, the constituents of the milk are degraded, the pH drops, etc. To overcome these problems, heat treatment must be applied as quickly as possible after the milk has arrived at the dairy.

Table 4:Main categories of heat treatment in dairy industries

Process	Temperature, °C	Time
LTLT pasteurization of milk	63	30 min
HTST pasteurization of milk	72 – 75	15 – 20 s
HTST pasteurization of cream, etc.	> 80	1 – 5 s
Ultra pasteurization	125 – 138	2 – 4 s

UHT (flow sterilization) normally	135 – 140	a few seconds
Sterilization in container	115 – 120	20 – 30 min

LTLT Pasteurization: The original type of heat treatment was a batch process in which milk was heated to 63 °C in open vats and held at that temperature for 30 minutes. This method is called the holder method or low temperature, long time (LTLT) method. Nowadays milk is almost always heat treated in continuous processes like thermization, HTST pasteurization or UHT treatment.

HTST pasteurization: HTST is the abbreviation of High Temperature Short Time. The actual time/temperature combination varies according to the quality of the raw milk, the type of product treated, and the required storage properties.

The HTST process for milk involves heating it to 72 – 75 °C with a hold of 15 – 20 seconds before it is cooled. The phosphatase enzyme is destroyed by this time/temperature combination. The phosphatase test is therefore used to check that milk has been properly pasteurized. The test result must be negative; there must be no detectable phosphatase activity.

Cream & Cultured Products: Phosphatase tests should not be used for products with fat contents above 8%, as some reactivation of the enzyme takes place a fairly short time after pasteurization. The heat treatment must also be stronger, as fat is a poor heat conductor.

Peroxidase, another enzyme, is therefore used for checking the pasteurization results for cream (Peroxidase test according to Storch). The product is heated to a temperature above 80 °C, with a holding time of about five seconds. This more intense heat treatment is sufficient to inactivate peroxidase. The test must be negative – there must be no detectable peroxidase activity in the product.

As the phosphatase test cannot be used for acidified products either, heating control is based on the peroxidase enzyme. Milk intended for cultured milk production is normally subjected to intense heating to coagulate whey proteins and increase its water-binding properties, i.e. prevent formation of whey.

ULTRA Pasteurization: Ultra pasteurization can be utilized when a particular shelf life is required. For some manufacturers, two extra days are enough, whereas others aim for a further 30 – 40 days on top of the 2 – 16 days that are traditionally associated with pasteurized products. The fundamental principle is to reduce the main causes of reinfection of the product during processing and packaging, so as to extend the shelf life of the product. This requires extremely high levels of production hygiene and a distribution temperature of no more than 7 °C; the lower the temperature, the longer the shelf life.

Heating milk to 125 – 138 °C for 2 – 4 seconds and cooling it to < 7 °C is the basis of extended shelf life. ESL, Extended Shelf Life, is a general term for heat-treated products that have been given improved keeping qualities by one means or another. Nevertheless, ESL products must still be kept refrigerated during distribution and in retail stores.

UHT Treatment: UHT is the abbreviation for Ultra High Temperature. UHT treatment is a technique for preserving liquid food products by exposing them to brief, intense heating, normally to temperatures in the range of 135 – 140 °C. This kills microorganisms that would otherwise destroy the products.

UHT treatment is a continuous process that takes place in a closed system that prevents the product from being contaminated by airborne microorganisms. The product passes through heating and cooling stages in quick succession. Aseptic filling, to avoid reinfection of the product, is an integral part of the process.

Two alternative methods of UHT treatment are used:

- Indirect heating and cooling in heat exchangers,
- Direct heating by steam injection or infusion of milk into steam and cooling by expansion under vacuum.

Sterilization: The original form of sterilization, which is still in use, is in-container sterilization, usually at 115 – 120 °C for some 20 – 30 minutes.

After fat standardization, homogenization and heating to about 80 °C, the milk is packed in clean containers; usually glass or plastic bottles for milk, and cans for evaporated milk. The product, still hot, is transferred to autoclaves in batch production or to a hydrostatic tower in continuous production.

Calculation of holding time: The appropriate tube length for the required holding time can be calculated when the hourly capacity and the inner diameter of the holding tube are known. As the velocity profile in the holding tube is not uniform, some milk molecules will move faster than the average. To ensure that even the fastest molecule is sufficiently pasteurized, an efficiency factor must be used. This factor depends on the design of the holding tube, but is often in the range of 0.8 – 0.9 if the flow is turbulent. For more viscous fluids, the flow might be laminar and then the efficiency factor is lower.

Data required for calculation:

Q = flow rate at pasteurization, l/h

HT = holding time in seconds

L = length of holding tube in dm, corresponding to Q and HT

D = inner diameter of holding tube in dm, to be known or adapted to the other pipework

V = volume of milk in l or dm3 corresponding to Q and HT

η = efficiency factor

Figure 11:Zig- Zag Holding Tube

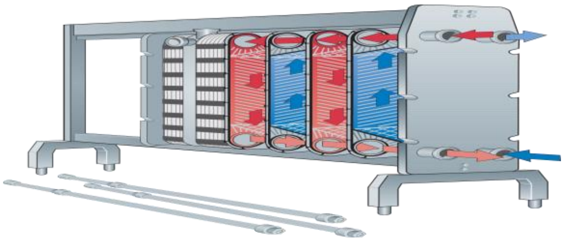
Different types of Heat Exchangers:

- Plate heat exchanger
- Tubular heat exchanger
- Scraped-surface heat exchanger

Plate heat Exchanger: Most heat treatment of dairy products is carried out in plate heat exchangers. The plate heat exchanger (often abbreviated PHE) consists of a pack of stainless steel plates clamped in a frame. The frame may contain several separate plate packs – sections – in which different stages of treatment, such as pre-heating, final heating and cooling take place. The heating medium is hot water, and the cooling medium cold water, ice-water or propyl glycol, depending on the required product outlet temperature.

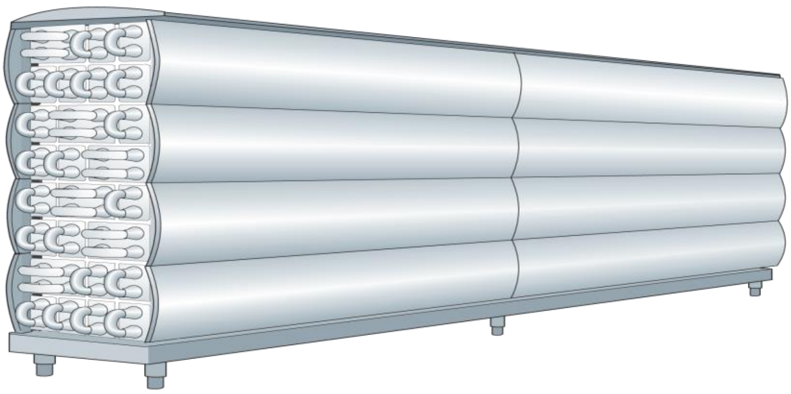
The plates are corrugated in a pattern designed for optimum heat transfer. The plate pack is compressed in the frame. Supporting points on the corrugations hold the plates apart, so that thin channels are formed between them. The liquids enter and leave the channels through holes in the corners of the plates. Varying patterns of open and blind holes route the liquids from one channel to the next. Gaskets around the edges of the plates and around the holes form the boundaries of the channels and prevent external leakage and internal mixing.

Figure 12:Principles of flow and heat transfer in a plate heat exchanger



Tubular Heat Exchanger: Tubular heat exchangers (THE) are in some cases used for pasteurization and UHT treatment of dairy products. The tubular heat exchanger (Figure:14), unlike plate heat exchangers, has no contact points in the product channel and can thus handle products with particles up to a certain size. The maximum particle size depends on the diameter of the tube. The tubular heat exchanger can also run longer between cleanings than the plate heat exchanger in UHT treatment. Compared to a plate heat exchanger, a higher flow velocity is needed to create efficient heat transfer in a tubular heat exchanger. Tubular heat exchangers are available in two fundamentally different types; multi/mono tube and concentric tube.

Figure 13:The tubular heat exchanger tubes are assembled in a compact unit.

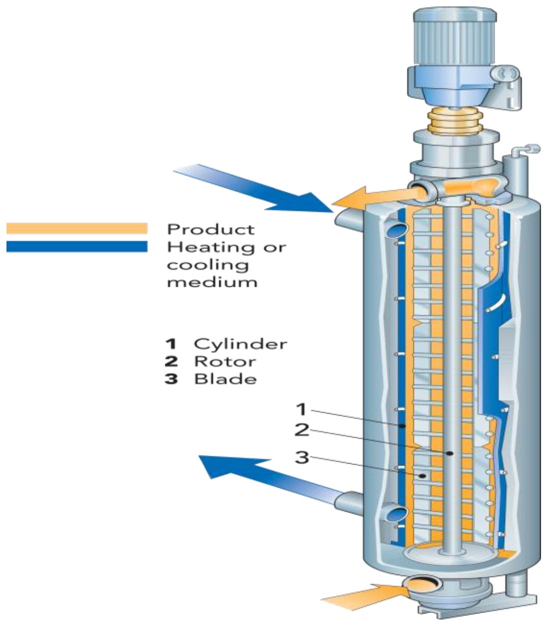


Scraped Surface Heat Exchanger: The scraped-surface heat exchanger (Figure 15), is designed for heating and cooling of viscous, sticky and lumpy products and for crystallization of products. All products that can be pumped can also be treated. A scraped surface heat exchanger consists of a cylinder (1) through which the product is pumped in counter current flow to the service medium in the surrounding jacket. Exchangeable rotors (2) of various diameters, and varying pin/blade (3) configurations allow adaptation to different applications. Smaller diameter rotors allow larger particles to pass through the cylinder, while larger diameter rotors result in shorter residence time and improved thermal performance.

The product enters the vertical cylinder through the lower port and continuously flows upwards through the cylinder. At process start-up, all the air is completely purged ahead of the product, allowing complete and uniform product coverage of the heating or cooling surface. The rotating blades continually remove the product from the cylinder wall to ensure uniform heat transfer to the product. In addition, the surface is kept free from deposits.

The product exits the cylinder via the upper port. Product flow and rotor speed are varied to suit the properties of the product flowing through the cylinder. At shut-down, thanks to the vertical design, the product can be displaced by water with minimum intermixing, which helps assure product recovery at the end of every run. Following this, complete drainage facilitates CIP and product changeover. As mentioned above, rotor and blades are exchangeable, an operation that is possible due to the automatic hydraulic lift that facilitates raising and lowering the rotor/blade assembly.

Figure 14:Vertical type of scraped-surface heat exchanger



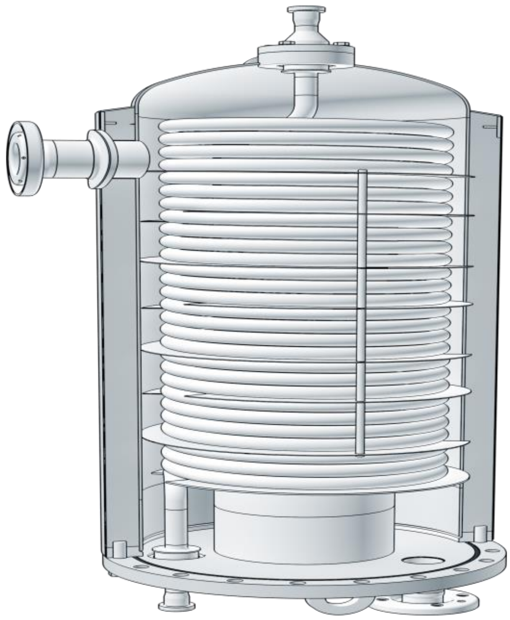
Typical products treated in the scraped-surface heat exchanger are jams, sweets, dressings, chocolate and peanut butter. It is also used for fats and oils for crystallization of margarine and shortenings, etc. The scraped-surface heat exchanger is also available in versions designed for aseptic processing. Two or more vertical-type scraped-surface heat exchangers can be linked in series or parallel to give a greater heat transfer surface depending on the processing capacity required.

Coiled Heat Exchanger: In a coiled tubular heat exchanger, the product flows through a coil-shaped tube and media flows around the product tube to heat or cool the product. A unique feature of the coiled design is that it creates a secondary flow pattern at high velocity, which significantly increases the heat transfer efficiency. This secondary flow pattern is called the Dean effect. With laminar flow in straight tubes the heat transfer to the fluid is maintained purely by heat conduction in the fluid. Therefore, the heat transfer efficiency is lower than in turbulent flow where an intensive mixing takes place thus greatly increasing the heat transfer.

In coiled tubes the Dean vortices will act as 'internal mixers' transporting fluid elements from the tube wall into the tube centre and vice versa. The mixing procedure will greatly reduce the time needed for the desired heat transfer to take place thus reducing the length and the necessary heating surface of the heat exchanger. In addition, the residence time and hence the product volumes will be decreased. The magnitude of the heat transfer enhancement is dependent on the design of the coil, of the velocity of the fluid and of the physical properties of the fluid. The enhancement is based on the Dean number, which has to exceed 100 to give any significant effect. High Dean numbers are usually reached by high product velocities in combination with a tightly coiled tube.

The coiled mono-tube unit— between 30 and 100 metres long — has only one inlet and one outlet connection. This enables gentle mechanical treatment and ensures excellent particle integrity for particles of up to 25 mm in diameter. The unit is designed for high hygiene and easy maintenance with floating ends through the top and bottom flanges. The coiled product tube is placed in a vertical chamber where the heating or cooling media flows. The bottom and top product tube connections are sealed by O-rings to create a system that allows movement between the product tube and the media shell. This design absorbs the effects of thermal expansion and prevents the tube from cracking. The unit is supplied with insulation to minimize heat losses and ensure operator safety. The heat exchanger dimension is selected based on each specific application – the number of units depends on desired capacity and required heat transfer area. Typical products treated in the coiled heat exchanger are dairy based dessert puddings, tomato paste, ketchup, fruit purées and products with particles.

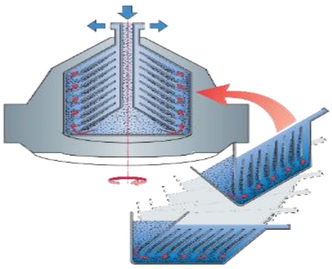
Figure 15:Coiled heat exchanger



Centrifugal Separators and milk standardization: Below figure shows a centrifuge bowl for continuous separation of solid particles from a liquid. This operation is called clarification. Imagine the sedimentation vessel in turned 90 ° and spun round the axis of rotation. The result is a sectional view of a centrifugal separator.

Separation channels: The centrifuge bowl has baffle inserts in the form of conical discs. This increases the area available for sedimentation. The disc's rest on each other and form a unit known as the disc stack. Radial strips called caulks are welded to the discs and keep them the correct distance apart. This forms the separation channels. The thickness of the caulks determines the width.

Figure 16: Centrifugal Bowl



The baffled vessel can be turned 90° and rotated, creating a centrifuge bowl for continuous separation of solid particles from a liquid. Figure 20 shows how the liquid enters the channel at the outer edge (radius r1), leaves at the inner edge (radius r2) and continues to the outlet. During passage through the channel, the particles settle outward towards the disc, which forms the upper boundary of the channel.

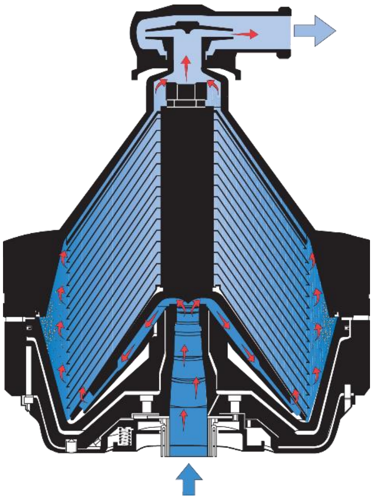
The velocity w of the liquid is not the same in all parts of the channel. It varies from almost zero, closest to the discs, to a maximum value in the centre of the channel. The centrifugal force acts on all particles, forcing them towards the periphery of the separator at a sedimentation velocity, v. A particle consequently moves simultaneously at velocity w with the liquid, and at sedimentation velocity, v radially towards the periphery.

The resulting velocity, vp, is the sum of these two motions. The particle moves in the direction indicated by vector arrow vp. For the sake of simplicity, it is assumed that the particle moves in a straight path as shown by the broken line in the figure.

In order to be separated, the particle must settle on the upper plate before reaching point B', i.e. at a radius equal to or greater than r2. Once the particle has settled, the liquid velocity at the surface of the disc is so small that the particle is no longer carried along with the liquid. It therefore slides outwards along the underside of the disc under the influence of the centrifugal force, is thrown off the outer edge at B and deposited on the peripheral wall of the centrifuge bowl.

Continuous centrifugal separation of milk: In a centrifugal clarifier, the milk is introduced into the separation channels at the outer edge of the disc stack, flows radially inwards through the channels towards the axis of rotation and leaves through the outlet at the top as illustrated in Figure. On the way through the disc stack, the solid impurities are separated and thrown back along the undersides of the discs to the periphery of the clarifier bowl. There they are collected in the sediment space. As the milk passes along the full radial width of the discs, the time of passage also allows very small particles to be separated. The most typical difference between a centrifugal clarifier and a separator is the design of the disk stack. A clarifier has no distribution holes or open holes at the periphery. The number of outlets also differs – a clarifier has one and a separator has two.

Figure 17:centrifugal clarifier bowl



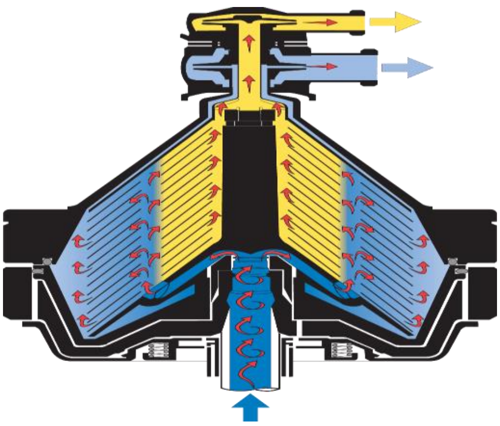
In a centrifugal clarifier bowl, the milk enters the disc stackat the periphery and flows inwards through the channels.

Separation: In a centrifugal separator, the disc stack is equipped with vertically-aligned distribution holes. Figure below shows schematically how fat globules are separated from the milk in the disc stack of a centrifugal separator. The milk is introduced through vertically-aligned distribution holes in the discs at a certain distance from the edge of the disc stack. Under the influence of centrifugal force, the sediment and fat globules in the milk begin to settle radially outwards or inwards in the separation channels, according to their density relative to that of the continuous medium (skim milk).

As in the clarifier, the high-density solid impurities in the milk will quickly settle outwards towards the periphery of the separator and collect in the sediment space. Sedimentation of solids is assisted by the fact that the skim milk in the channels in this case moves outwards towards the periphery of the disc stack.

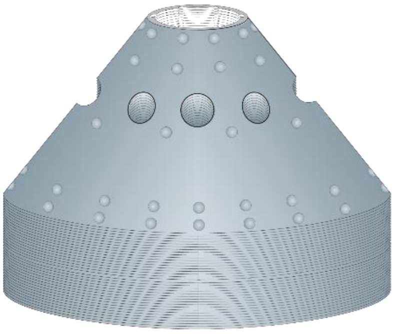
The cream, i.e. the fat globules, has a lower density than the skim milk and therefore moves inwards in the channels, towards the axis of rotation. The cream continues to an axial outlet. The skim milk moves outwards to the space outside the disc stack and from there through a channel between the top of the disc stack and the conical hood of the separator bowl to a concentric skim milk outlet.

Figure 18:centrifugal separator bowl



In a centrifugal separator bowl, the milk enters the disc stack through the distribution holes. Skimming efficiency: The amount of fat that can be separated from milk depends on the design of the separator, the rate at which the milk flows through it, and the size distribution of the fat globules.

The smallest fat globules, normally < 1 µm, do not have time to rise at the specified flow rate but are carried out of the separator with the skim milk. The remaining fat content in the skim milk normally lies between 0.04 and 0.07 %, and the skimming ability of the machine is then said to be 0.04 – 0.07. The flow velocity through the separation channels will be reduced if the flow rate through the machine is reduced. This gives the fat globules more time to rise and be discharged through the cream outlet. The skimming efficiency of a separator consequently increases with reduced throughput and vice versa.



Fat content of Milk: The whole milk supplied to the separator is discharged as two flows, skim milk and cream, of which the cream normally represents about 10 % of the total throughput. The proportion discharged as cream determines the fat content of the cream. If the whole milk contains 4 % fat and the throughput is 20 000 l/h, the total amount of fat passing through the separator will be:

$$\frac{4 \times 20\,000}{100} = 800 \text{ l/h}$$

Assume that cream with a fat content of 40 % is required. This amount of fat must be diluted with a certain amount of skim milk. The total amount of liquid discharged as 40 % cream will then be:

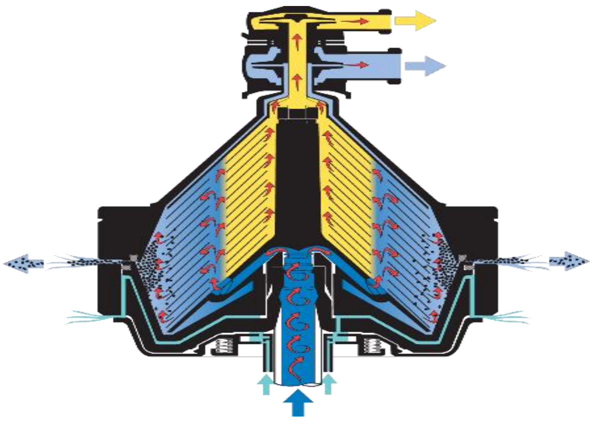
$$\frac{800 \times 100}{40} = 2000 \text{ l/h}$$

800 l/h is pure fat, and the remaining 1 200 l/h is skim milk. Installation of throttling valves in the cream and skim milk outlets makes it possible to adjust the relative volumes of the two flows to obtain the required fat content in the cream. The size of fat globules varies during the Goat's lactation period, i.e. from parturition to going dry. Large globules tend to predominate just after parturition, while the number of small globules increases towards the end of the lactation period:

a) The solids that collect in the sediment space of the separator bowl consist of straw and hairs, udder cells, white blood corpuscles (leucocytes), red blood corpuscles, bacteria, etc. The total amount of sediment in milk varies but may be about 1 kg/10 000 litre. The sediment space volume varies depending on the size of the separator, typically 10 – 20 litres. In milk separators of the solids-retaining type it is necessary to dismantle the bowl manually and clean the sediment space at relatively frequent intervals. This involves a great deal of manual labour.

b) Self-cleaning or solids-ejecting separator bowls are equipped for automatic ejection of accumulated sediment at pre-set intervals. This eliminates the need for manual cleaning. The system for solids discharge is described at the end of this chapter under "The discharge system". Solids ejection is normally carried out at 30 to 60 minute intervals during milk separation.

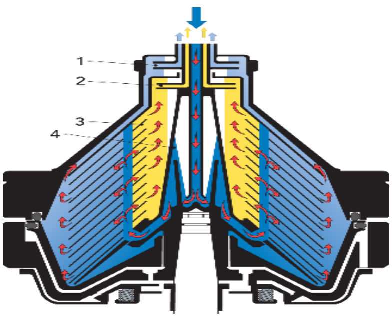
Figure 19:Solids ejection by short opening of the sedimentation space at the periphery of the bowl



Basic design of the centrifugal separator: Consists of two major parts, the body and the hood. They are held together by a threaded lock ring. The disc stack is clamped between the hood and the distributor at the centre of the bowl. There are two types of modern separators: semi-open and hermetic.

Semi-Open design: Centrifugal separators with paring discs at the outlet are known as semi-open types (as opposed to the older open models with overflow discharge). In the semi-open separator, the milk is supplied to the separator bowl from an inlet, normally in the top, through a stationary axial inlet tube. When the milk enters the ribbed distributor (4), it is accelerated to the speed of rotation of the bowl, before it continues into the separation channels in the disc stack (3). The centrifugal force throws the milk outwards to form a ring with a cylindrical inner surface. This is in contact with air at atmospheric pressure, which means that the pressure of the milk at the surface is also atmospheric. The pressure increases progressively, with increasing distance from the axis of rotation, to a maximum at the periphery of the bowl. The heavier solid particles settle outwards and are deposited in the sediment space. Cream moves inwards towards the axis of rotation and passes through channels to the cream paring chamber (2). The skim milk leaves the disc stack at the outer edge and passes between the top disc and the bowl hood to the skim milk paring chamber (1).

Figure 20:Semi-open (paring disc) self-cleaning separator



1. **Skim milk paring chamber**
2. **Cream paring chamber**

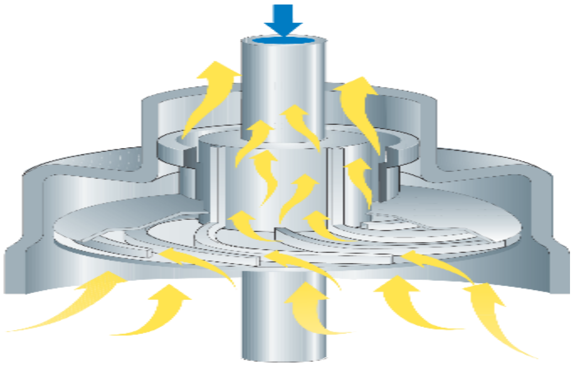
3. **Disc stack**

4. **Distributor**

In the semi-open separator, the cream and skim milk outlets have special outlet devices – paring discs, – one of which is shown in Figure below. Because of this outlet design, the semi-open separators are usually called – paring-discs – separators.

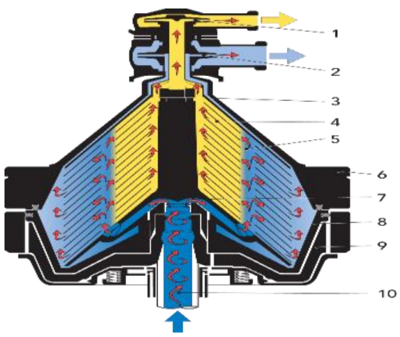
The rims of the stationary paring discs' dip into the rotating columns of liquid, continuously paring out a certain amount. The kinetic energy of the rotating liquid is converted into pressure in the paring disc, and the pressure is always equal to the pressure drop in the downstream line. An increase in downstream pressure means that the liquid level in the bowl moves inwards. In this way, the effects of throttling at the outlets are automatically counteracted. In order to prevent aeration of the product, it is important that the paring discs are sufficiently covered with liquid.

Figure 21:The paring disc outlet at the top of the semi-open bowl



Hermetic design: In the hermetic separator, the milk is supplied to the bowl through the bowl spindle. It is accelerated to the same speed of rotation as the bowl and then continues through the distribution holes in the disc stack. The bowl of a hermetic separator is completely filled with milk during operation. There is no air in the centre. The hermetic separator can therefore be regarded as part of a closed piping system. The pressure generated by the external product pump is sufficient to overcome the flow resistance through the separator to the discharge pump at the outlets for cream and skim milk. The diameter of the pump impellers can be engineered to suit the outlet pressure requirements.

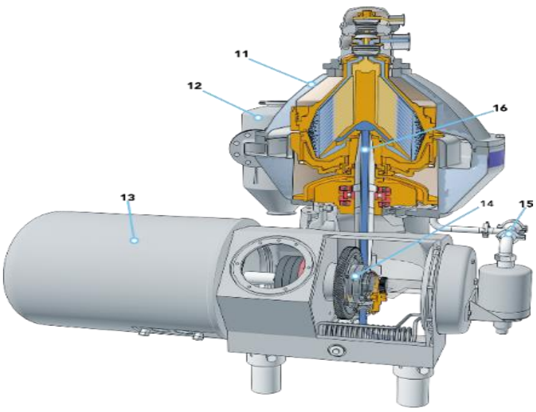
Figure 22:Section through the bowl with outlets of a hermetic separator



1. Outlet pump cream
2. Outlet pump skim milk
3. Bowl hood

4. Disc stack
5. Distribution hole
6. Lock ring
7. Distributor
8. Sliding bowl bottom
9. Bowl body
10. Hollow bowl spindle
11. Frame hood
12. Sediment cyclone
13. Motor
14. Gear
15. Operating water system
16. Hollow bowl spindle

Figure 23:Sectional view of a hermetic separator

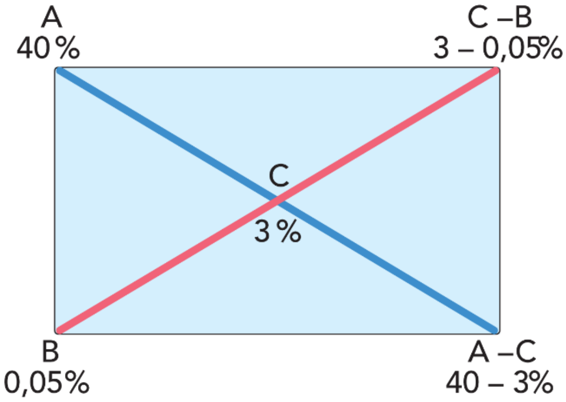


Standardization of fat & protein:

Standardization involves adjustment of the fat content of milk, or a milk product, by addition of cream or skim milk as appropriate to obtain a given fat content. Various methods exist for calculating the quantities of products with different fat contents that must be blended to obtain a given final fat content. These cover mixtures of whole milk with skim milk, cream with whole milk, cream with skim milk and skim milk with anhydrous milk fat (AMF).

One of these methods, frequently used, is taken from the Dictionary of Dairying by J.G. Davis and is illustrated by the following example:
How many kilograms of cream of A % fat must be blended with skim milk of B % fat to make a mixture containing C % fat? The answer is obtained from a rectangle (Figure 6.2.31) where the given figures for fat contents are placed.

A Cream fat content, %	40
B Skim milk fat content, %	0.05
C Fat content of the end product, %	3



Calculation of the fat content in product C.

Subtract the fat content values on the diagonals to give C – B = 2.95 and A – C = 37.

The mixture is then 2.95 kg of 40 % cream and 37 kg of 0.05 % skim milk to obtain 39.95 kg of a standardized product containing 3 % fat.

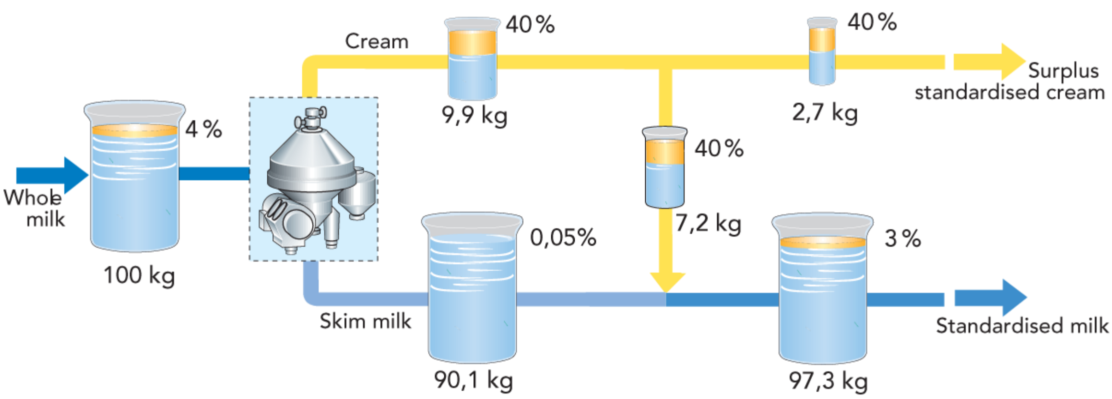
From the equations below, it is then possible to calculate the amounts of A and B needed to obtain the desired quantity (X) of C.

1) $\frac{X \times (C - B)}{(C - B) + (A - C)}$ kg of A and 2) $\frac{X \times (A - C)}{(C - B) + (A - C)}$ kg of B

[also (X - equation 1)]

Principle of Standardization: The cream and skim milk leaving a separator have constant fat contents, if all other relevant parameters remain constant. The principle of standardization – regardless of whether control is manual or automated – is illustrated in Figure 6.2.32. The figures in the illustration are based on treatment of 100 kg whole milk with 4 % fat. The requirement is to produce an optimal amount of 3% standardized milk and surplus cream containing 40 % fat. Separation of 100 kg of whole milk yields 90.35 kg of skim milk with 0.05 % fat and 9.65 kg of cream with 40 % fat. The amount of 40 % cream that must be added to the skim milk is 7.2 kg. This gives a total of 97.55 kg of 3 % market milk, leaving 9.65 – 7.2 = 2.45 kg surplus 40 % cream.

Figure 24: Principle Of Fat Standardization



Direct- In Line Standardization: In modern milk processing plants with a diversified product range, direct in-line standardization is usually combined with separation. Previously, standardization was done manually, but, along with increased volumes to process, the need for fast, accurate standardization methods, independent of seasonal fluctuations of the raw milk fat content, has increased. Control valves, flow and density meters and a computerized control loop are used to adjust the fat content of milk and cream to desired values. This equipment is usually assembled in units (Figure 6.2.33). The pressure in the skim milk outlet must be kept constant in order to enable accurate standardization. This pressure must be maintained, regardless of variations in flow or pressure drop caused by the equipment after separation, and this is done with a constant-pressure valve located close to the skim milk outlet.

In modern milk processing plants with a diversified product range, direct in-line standardization is usually combined with separation. Previously, standardization was done manually, but, along with increased volumes to process, the need for fast, accurate standardization methods, independent of seasonal fluctuations of the raw milk fat content, has increased. Control valves, flow and density meters and a computerized control loop are used to adjust the fat content of milk and cream to desired values. This equipment is usually assembled in units.

The pressure in the skim milk outlet must be kept constant in order to enable accurate standardization. This pressure must be maintained, regardless of variations in flow or pressure drop caused by the equipment after separation, and this is done with a constant-pressure valve located close to the skim milk outlet.

For precision in the process, it is necessary to measure variable parameters such as:

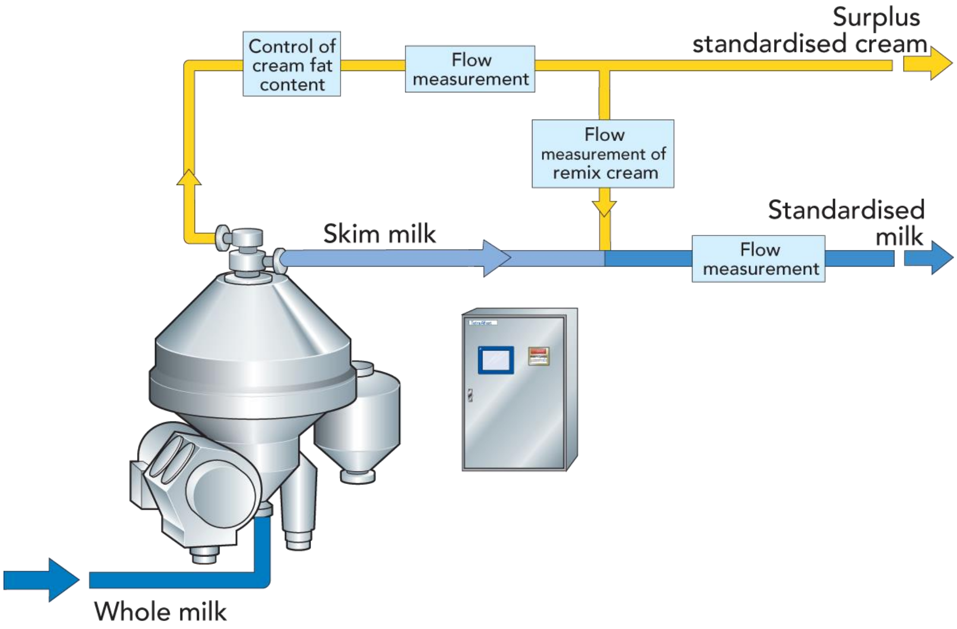
- Fluctuations in the fat content of the incoming milk
- Fluctuations in throughput
- Fluctuations in pre-heating temperature

Most of the variables are interdependent; any deviation in one stage of the process often results in deviations in all stages. The cream fat content can be regulated to any value within the performance range of the separator, with a standard deviation based on repeatability of 0.15 % fat. For standardized milk, the standard deviation based on repeatability should be less than 0.02 %. Usually, whole milk is heated to 55 – 65 °C in the pasteurizer before being separated. Following separation, the cream is standardized to a pre-set fat content. To achieve this, the calculated amount of cream intended for standardization is routed and remixed with an adequate amount of skim milk. The surplus cream is directed to the cream pasteurizer. The course of events is illustrated in Figure below.

Under certain circumstances, it is also possible to apply an in-line standardization system to a cold milk centrifugal separator. However, it is then very important that all fat fractions of the milk fat are given enough time at the low temperature (10 – 12 hours) for complete crystallization. The reason is that the density will vary with the degree of crystallization and will thus affect the measuring accuracy of the density transmitter, which is always calibrated after installation.

Figure 25:Direct in-line standardization systems are preassembled as a process unit.

Figure 26:Principle for direct in-line standardization of cream and milk

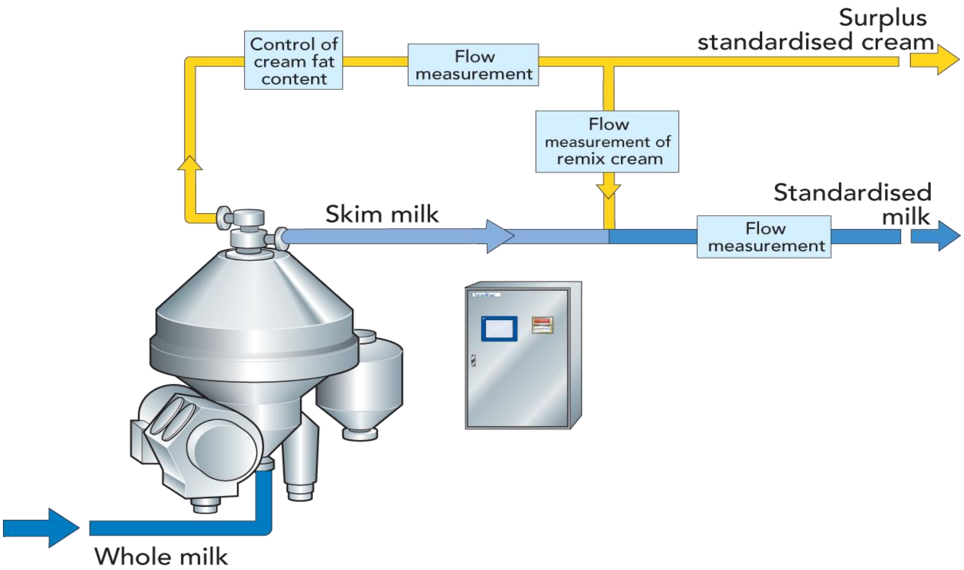


Cream Fat Control System: The fat content of the cream in the outlet from the separator is determined by the cream flow rate. The cream fat content is inversely proportional to the flow rate. Some standardization systems therefore use flow meters to control the fat content. This is the quickest method and – as long as the temperature and fat content in the whole milk before separation are constant – also an accurate method. The fat content will be wrong if these parameters change.

Various types of instruments can be used for continuous measurement of the fat content in cream. The signal from the instrument adjusts the cream flow so that the correct fat content is obtained. This method is accurate and sensitive to variations in the temperature and fat content of the milk. However, the control is slow and it takes a long time for the system to return to the correct fat content when a disturbance has occurred. There are two transmitters in Figure 6.2.35 measuring the flow of standardized cream and skim milk respectively. With these two flow data, the control system (4) calculates the flow of whole milk to the separator. A density transmitter (1) measures the cream density and converts this value into fat content. Combining fat content and flow rate data, the control system activates the modulating valve (3), to obtain the required cream fat content. Control loop for keeping a constant cream fat content.

1. Density transmitter
2. Flow transmitter
3. Control valve
4. Control panel
5. Constant-pressure valve

Figure 27:Cascade Control



A combination of accurate measurement of the fat content and rapid flow metering, known as cascade control, offers great advantages, as illustrated in Figure above.

When disturbances occur, caused for example by the recurrent partial discharges of the self-cleaning centrifuges or changes in the temperature of the cream or the fat content of the incoming milk, the diagram shows that

The flow control system alone reacts fairly quickly, but the fat content of the cream deviates from the pre-set value after stability is restored The density measurement system alone reacts slowly, but the fat content of the cream returns to the pre-set value

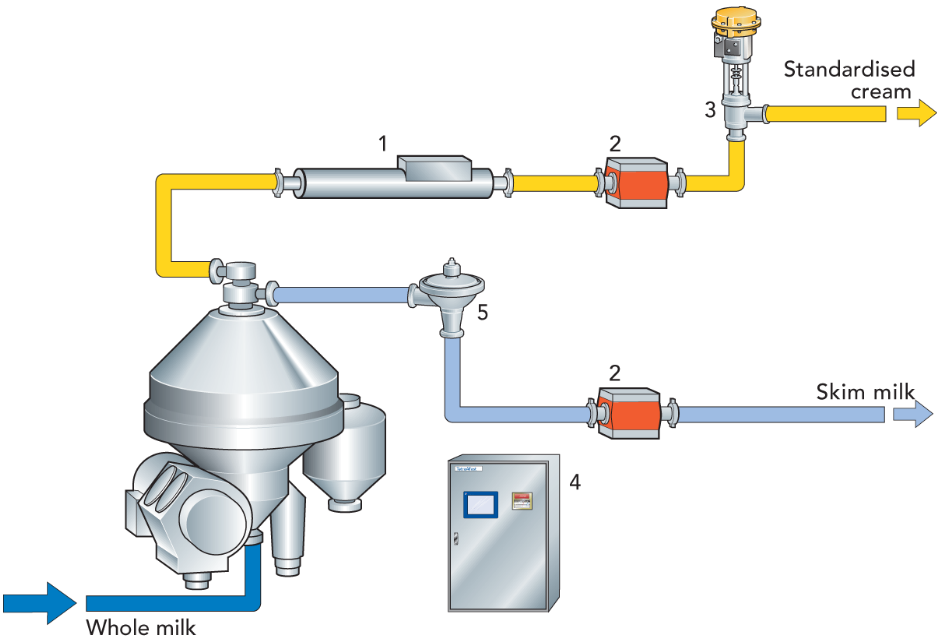
When the two systems are combined in cascade control, a rapid return to the pre-set value is achieved The cascade control system thus results in fewer product losses and a more accurate result. The computer monitors the fat content of the cream, the flow rate of the cream and the setting of the cream regulating valve.

The density transmitter in the circuit measures the density of the cream continuously (mass per unit of volume, e.g. kg/m3), which is inversely proportional to the fat content as the fat in cream has a lower density than the milk serum. The density transmitter transmits continuous density readings to the computer in the form of an electric signal. The strength of the signal is proportional to the density of the cream. Increasing density means that there is less fat in the cream and the signal will increase.

Any change in density modifies the signal from the density transmitter to the computer; the measured value will then deviate from the set point value which is programmed into the computer. The computer responds by changing the output signal to the regulating valve by an amount corresponding to the deviation between measured and set-point values. The position of the regulating valve changes and restores the density (fat content) to the correct value.

In Figure given below the flow transmitter (2) in the control circuit measures the flow in the cream line continuously and transmits a signal to the computer. The transmitters in the control circuit measure the flow and density in the cream line continuously and transmit a signal to the computer.

Cascade control is used to make necessary corrections due to variations in the fat content in the incoming whole milk. Cascade control works by comparing:



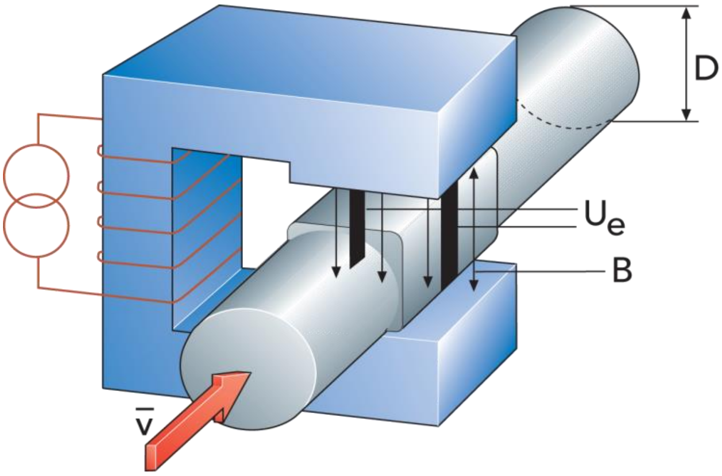
The flow through the flow transmitter, which is proportional to the cream fat content, and The density measured by the density transmitter, which is revised according to the cream fat content. The computer in the control panel (4) then calculates the actual whole milk fat content and alters the control valves to make the necessary adjustments. The standardized milk fat content is recorded continuously.

Fat control by Density Measurement: Measurement of the cream fat content is based on the fixed relationship which exists between fat content and density. The fat content varies inversely with density because the fat in cream is lighter than the milk serum. In this context, it is important to remember that the density of cream is also affected by temperature and gas content. Much of the gas, which is the lightest phase in the milk, will follow the cream phase, reducing the density of the cream. It is therefore important that the amount of gas in the milk is kept at a constant level. Milk can contain varying levels of air and gases, but 6 % can be taken as an average figure. More air than that can cause problems such as inaccuracy in volumetric measurement of milk, increased fouling of equipment during heating, etc. More about air in milk is mentioned in Chapter 6.6, Deaerators. The simplest and most common way of doing this is to let the raw milk stand for at least one hour in a tank (silo) before it is processed. Otherwise, a deaerator should be integrated into the plant, ahead of the separator. The density of the cream is reduced if the separation temperature is increased, and vice versa. To bridge moderate variation of the separation temperature, the density transmitter is also provided with a temperature sensor (Pt 100) for signalling the pre-sent temperature to the control module.

The density transmitter continuously measures the density and temperature of the liquid. Its operating principle can be likened to that of a tuning fork. As the density of product being measured changes, it in turn changes the vibrating mass and thus the resonant frequency. The density value signals are transmitted to a control module. The density transmitter consists of a single straight tube through which the liquid flows. The tube is vibrated by excitation coils on the outside, which are connected to the instrument casing and thus to the pipeline system, via bellows.

The density transmitter is installed as part of the pipeline system and is light enough to require no special structural support.

Flow Transmitter: Various types of meters are used for flow control. Electromagnetic meters have no moving parts that wear. They are often used, as they require no service and maintenance. There is no difference in accuracy between the meters. The meter head consists of a metering pipe with two magnetic coils. A magnetic field is produced, at right angles to the metering pipe, when a current is applied to the coils. An electric voltage is induced and measured by two electrodes mounted in the metering pipe, when a conductive liquid flows through the pipe. This voltage is proportional to the average velocity of the product in the pipe and therefore to the volumetric flow. The flow transmitter contains a microprocessor, which controls the current transformer that maintains a constant magnetic field. The voltage of the measuring electrodes is transmitted, via an amplifier and signal converter, to the computer in the control panel.



Flow transmitter.

Ue = K x B x v x D

where

Ue = Electrode voltage

K = Instrument constant

B = Strength of magnetic field

v = Average velocity

D = Pipe diameter

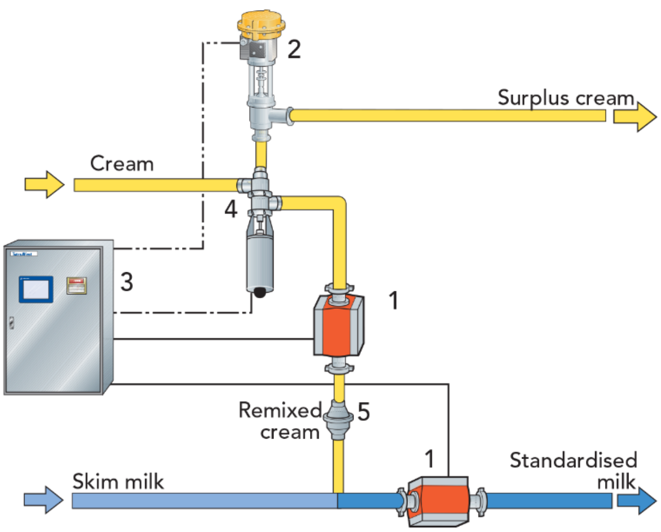
Flow Control Valves for Cream and Skim Milk: The computer compares the measured value signal from the density transmitter with a pre-set reference signal. If the measured value deviates from the pre-set value, the computer modifies the output signal to the control valve in the line after the density transmitter. This resets the valve to a position which alters the cream flow from the separator to correct the fat content.

Control Circuit for Remixing of Cream: *The control circuit controls the amount of cream to be continuously remixed into the skim milk to obtain the required fat content in the standardized milk. It contains two flow transmitters (2). One is located in the line for the cream to be remixed, and the other in the line for standardized milk, downstream of the remixing point. The signals from the flow transmitters are conveyed to the computer, which generates a ratio between the two signals. The computer compares the measured value of the ratio with a pre-set reference value and transmits a signal to a regulating valve in the cream line.*

Too low fat content in the standardized milk means that too little cream is being remixed. The ratio between the signals from the flow transmitters will therefore be lower than the reference ratio, and the output signal from the computer to the control valve changes. The valve closes, creating a higher pressure drop and a higher pressure which forces more cream through the remixing line. This affects the signal to the computer; the adjustment proceeds continuously and ensures that the correct quantity of cream is remixed. The electric output signal from the computer is converted into a pneumatic signal for the pneumatically-controlled valve.

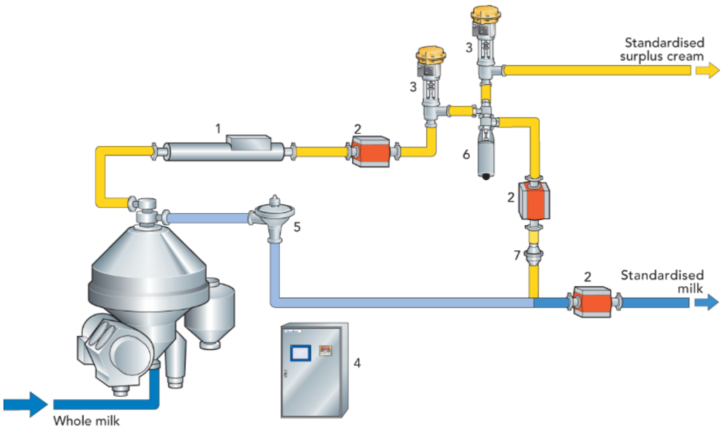
Remixing is based on known constant values of the fat content in the cream and skim milk. The fat content is normally regulated to a constant value between 35 and 40 % and the fat content of the skim milk is determined by the skimming efficiency of the separator. Accurate density control, combined with constant pressure control at the skim milk outlet, ensures that the necessary conditions for remixing control are satisfied. Cream and skim milk will be mixed in the exact proportions to give the pre-set fat content in the standardized milk, even if the flow rate through the separator changes, or if the fat content of the incoming whole milk varies. The flow transmitter and the regulating valve in the cream remixing circuit are of the same types as those in the circuit for control of the fat content.

Figure 28:Control circuit for remixing cream into skim milk



1. Flow transmitter
2. Control valve
3. Control panel
4. Change-over valve
5. Check valve

The Complete Direct Standardization Line: The pressure control system at the skim milk outlet (5) maintains a constant pressure, regardless of fluctuations in the pressure drop over downstream equipment. The cream-regulating system maintains a constant fat content in the cream discharged from the separator, by adjusting the flow of cream discharged. This adjustment is independent of variations in the throughput or in the fat content of the incoming whole milk. Finally, the ratio controller mixes cream of constant fat content with skim milk in the necessary proportions to give standardized milk of a specified fat content. The standard deviation, based on repeatability, should be less than 0.02 % for milk and 0.15 % for cream.



1. Density transmitter
2. Flow transmitter
3. Control valve
4. Control panel
5. Constant-pressure valve
6. Shut-off valve
7. Check valve

Tanks: Tanks in a dairy factory are used for a number of purposes. The sizes range from 150 000 litres for the silo tanks in the reception department down to approximately 100 litres for the smallest tanks. Tanks can generally be divided into two main categories according to function:

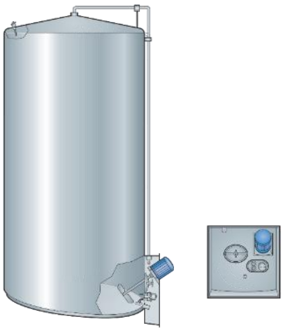
Storage tanks: Silos Tank

Silo tanks for milk reception belong to the storage category and have been described in Chapter 5, Collection and reception of milk. They vary in size from 25 000 to about 150 000 litres and the wetted surfaces are made of stainless steel. They are often placed outdoors to save on building costs.

In these cases, the tanks are insulated. They have a double shell with a minimum of 70 mm mineral wool insulation in between. The outer shell can be of stainless steel, but for economic reasons, it is usually made of mild steel and coated with anti-corrosion paint. To make complete drainage easy, the bottom of the tank slopes downwards with an inclination of about 6 % towards the outlet. This is a statutory requirement in some countries.

Silo tanks are fitted with various types of agitators and monitoring and control equipment. The number and size of the silo tanks are determined by such factors as the milk intake per day, the number of days per working week, the number of hours per working day (one, two or three shifts), the number of different products to be manufactured, and the quantities involved.

Figure 29:Silo tank alcove with manhole and motor for propeller agitator

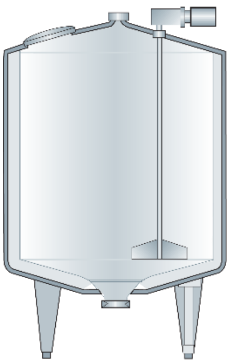


Intermediate Storage Tank: These tanks are used to store a product for a short time before it continues along the line. They are used for buffer storage, to level out variations in flow. After heat treatment and cooling, the milk is pumped to a buffer tank, and from there to filling. If filling is interrupted, the processed milk is buffered in the tank, until operation can be resumed. Similarly, milk from this tank can be used during a temporary processing stoppage.

In storage tanks, with a capacity of 1 000 to 50 000 litres the inner shell is made of stainless steel. The tank is insulated to maintain a constant product temperature. In this case, the outer shell is also of stainless steel, and there is a layer of mineral wool between the shells.

The storage tank has an agitator and can be fitted with various components and systems for cleaning and for control of level and temperature. This equipment is basically the same as previously described for silo tanks.

A good general assumption is that the process requires a buffer capacity corresponding to a maximum of 1.5 hour normal operation, i.e. 1.5 x 20 000 = 30 000 litres.



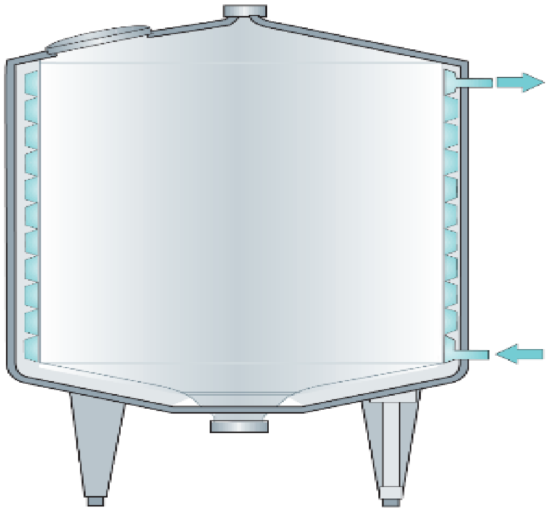
A typical storage tank has a capacity of 1 000 litres up to about 50 000 litres

Mixing Tanks:

As the name implies, these tanks are used for mixing different products and for the admixture of ingredients to the product. The tanks may be of the insulated type or have a single stainless steel shell. Equipment for temperature control may also be fitted. Insulated tanks, with mineral wool between the inner and outer shells, have a jacket outside the inner shell through which a heating/cooling medium is pumped. The jacket consists of welded-on channels.

Agitators for mixing tanks are designed to suit the specific application.

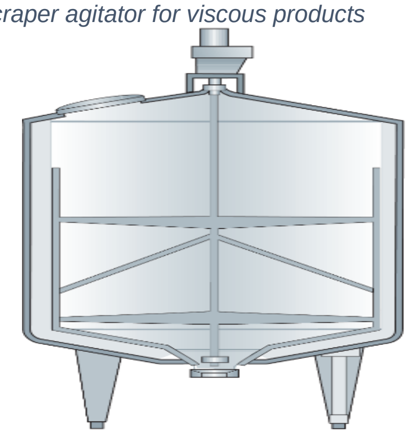
Figure 30:Mixing tank with welded-on heating/cooling channels



.

Process tanks: In these tanks, the product is treated for the purpose of changing its properties. They are widely used in dairies, e.g. ripening tanks for butter cream and for cultured products such as yoghurt, crystallization tanks for whipping cream, and tanks for preparing starter cultures. There are many different types of process tanks. The application determines the design. Common features are some form of agitator and temperature control. They have stainless steel shells, with or without insulation. Monitoring and control equipment may also be fitted.

Figure 31:An insulated process tank with scraper agitator for viscous products



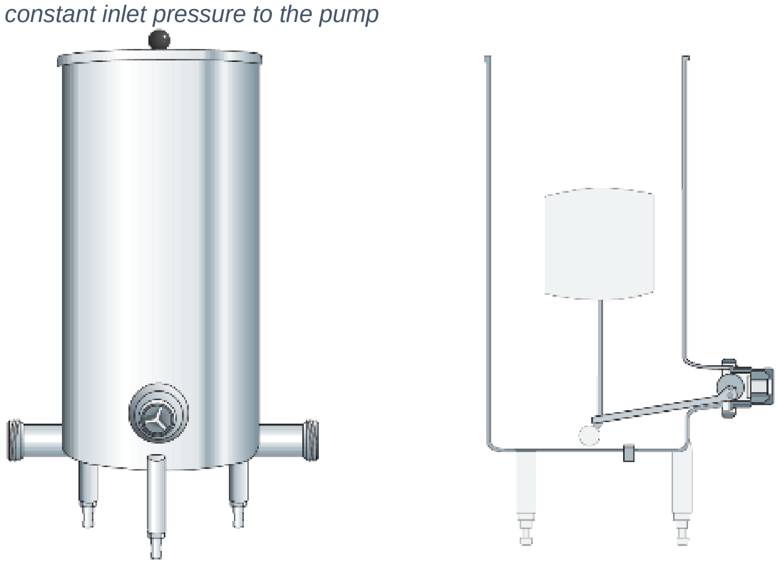
Balance Tank: There are a number of problems associated with the transport of the product through the line:

- The product handled must be free from air or other gases if a centrifugal pump is to function properly.
- To avoid cavitation, the pressure at all points in the pump inlet must be higher than the vapour pressure of the liquid.
- A valve must be actuated to redirect the untreated liquid, should the temperature of a heat-treated product drop below the required value.
- The pressure on the suction side of the pump must be kept constant to ensure a uniform flow in the line.

These problems, as well as some others dealt with here, are often resolved by fitting a balance tank in the line on the suction side of the pump. The balance tank keeps the product at a constant level above the pump inlet. In other words, the head on the suction side is kept constant. The tank in Figure:33 contains a float connected by a lever to an eccentrically-pivoted roller that operates the inlet valve on the tank. As the float moves downwards or upwards with the liquid level, the valve is opened and closed respectively. If the pump draws more from the tank than flows in at the inlet, the level drops and the float with it. The valve opens and lets in more liquid. In this way, the liquid in the tank is kept at a constant level. Today the same functionality is usually achieved with level sensors that control a regulating valve. The inlet is located at the bottom of the tank so that the liquid enters below the surface. Consequently, there is no splashing and, above all, no aeration. Any air already present in the product on entry will rise in the tank. Some deaerating takes place. This has a favourable effect on the operation of the pump, and the product is treated more gently.

The balance tank is often included in a recirculating system where liquid is returned for recycling, e.g. as a result of insufficient heat treatment. In this case, a temperature indicator actuates a flow diversion valve, which directs the product back to the balance tank. This causes a quick increase in the liquid level and an equally quick movement of the float mechanism to close the inlet valve. The product then circulates until the fault has been repaired or the plant is shut down for adjustment. A similar procedure is employed for circulating cleaning solution when the line is cleaned.

Figure 32:Balance tank for constant inlet pressure to the pump



Chapter 3: Appropriate technology options: Milk Procurement, Manufacturing process & Calculation Data

3.1. Milk Procurement System:

Figure 33:Milk Procurement System at Village Level

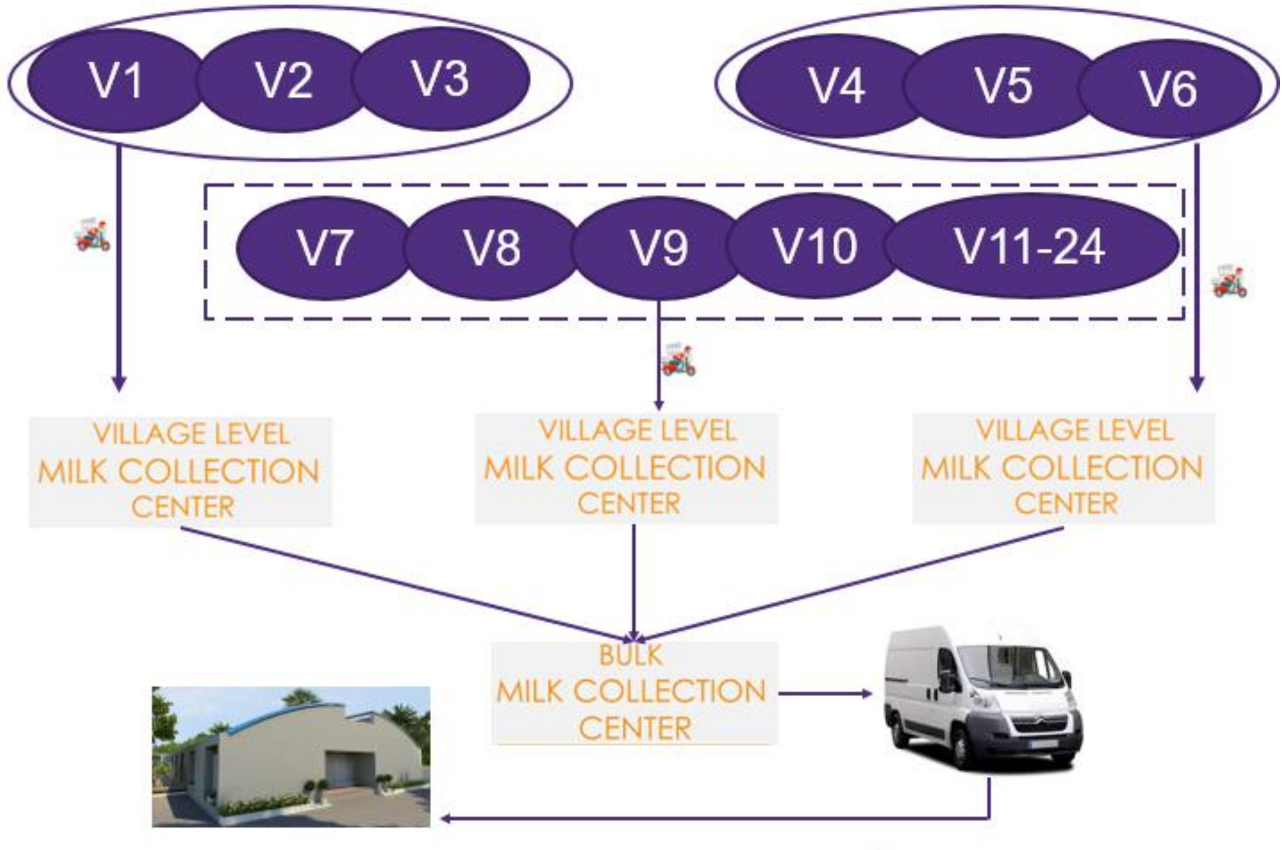


Figure 34:Village Level Milk Collection Centre: Process Flow

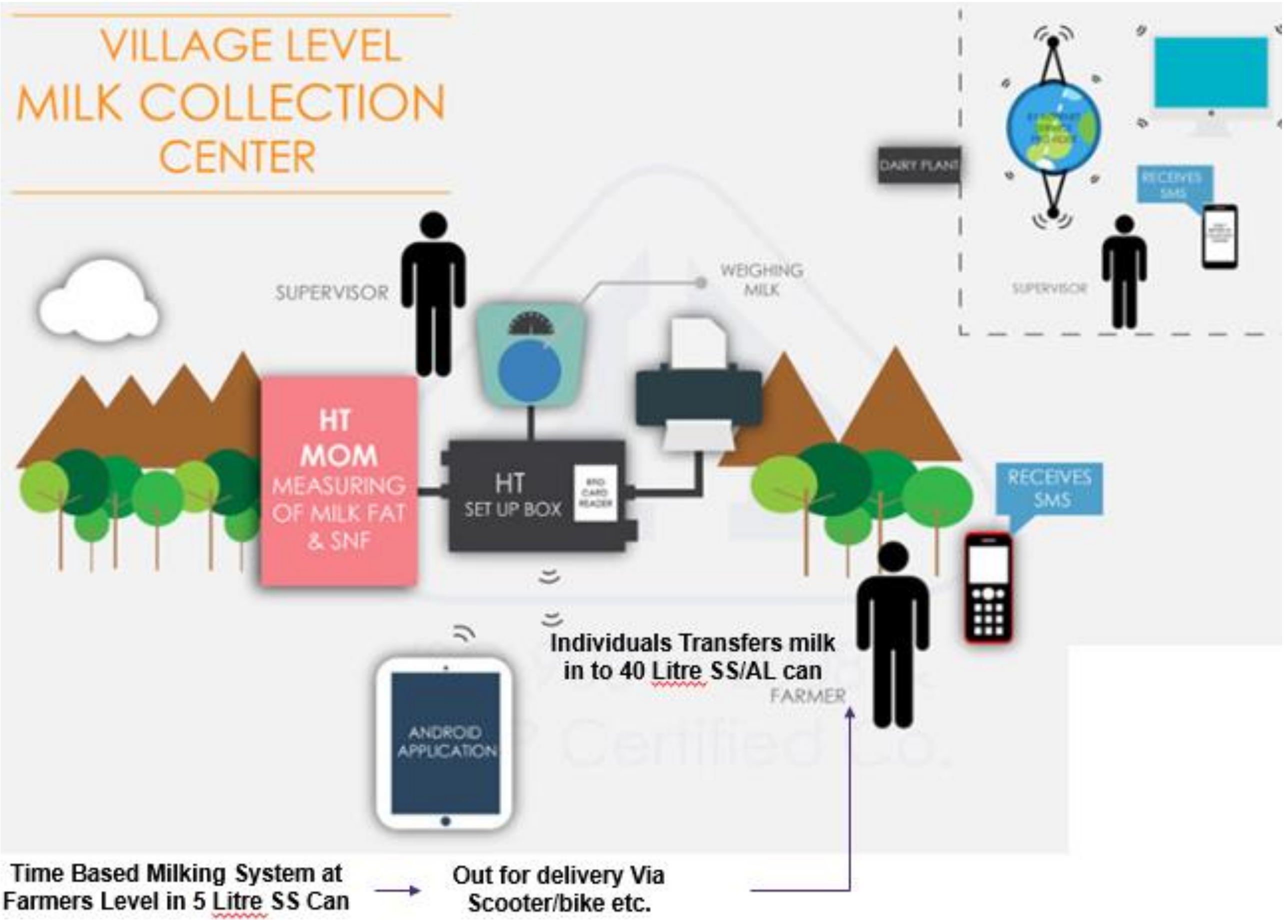


Figure 35:Milk Collection Process :From Village to VLCC

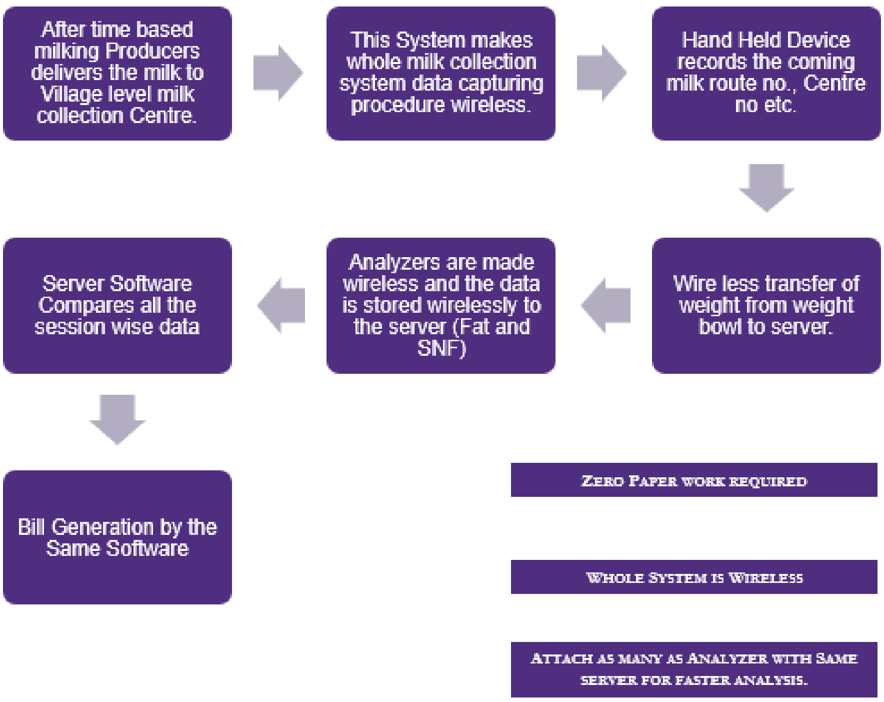


Figure 36:Milk Collection strategy at BMCC:

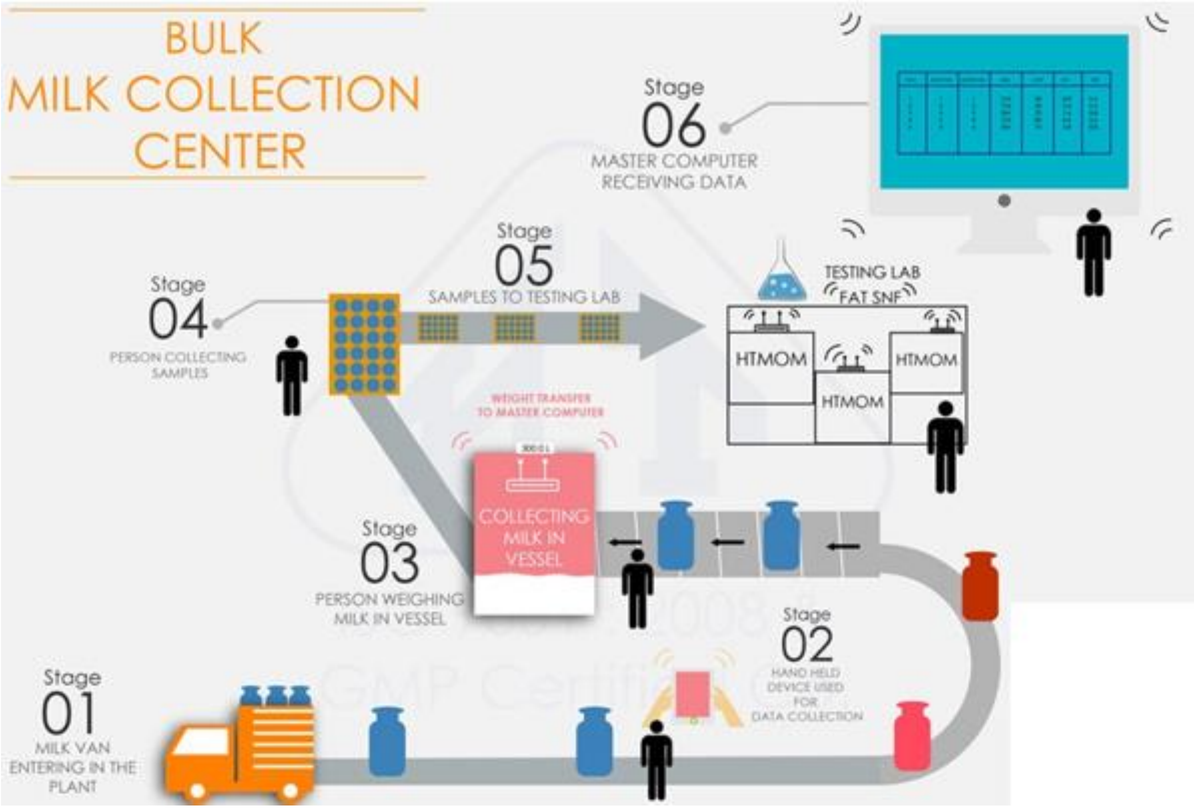


Figure 37:Process Flow Chart For the BMCC

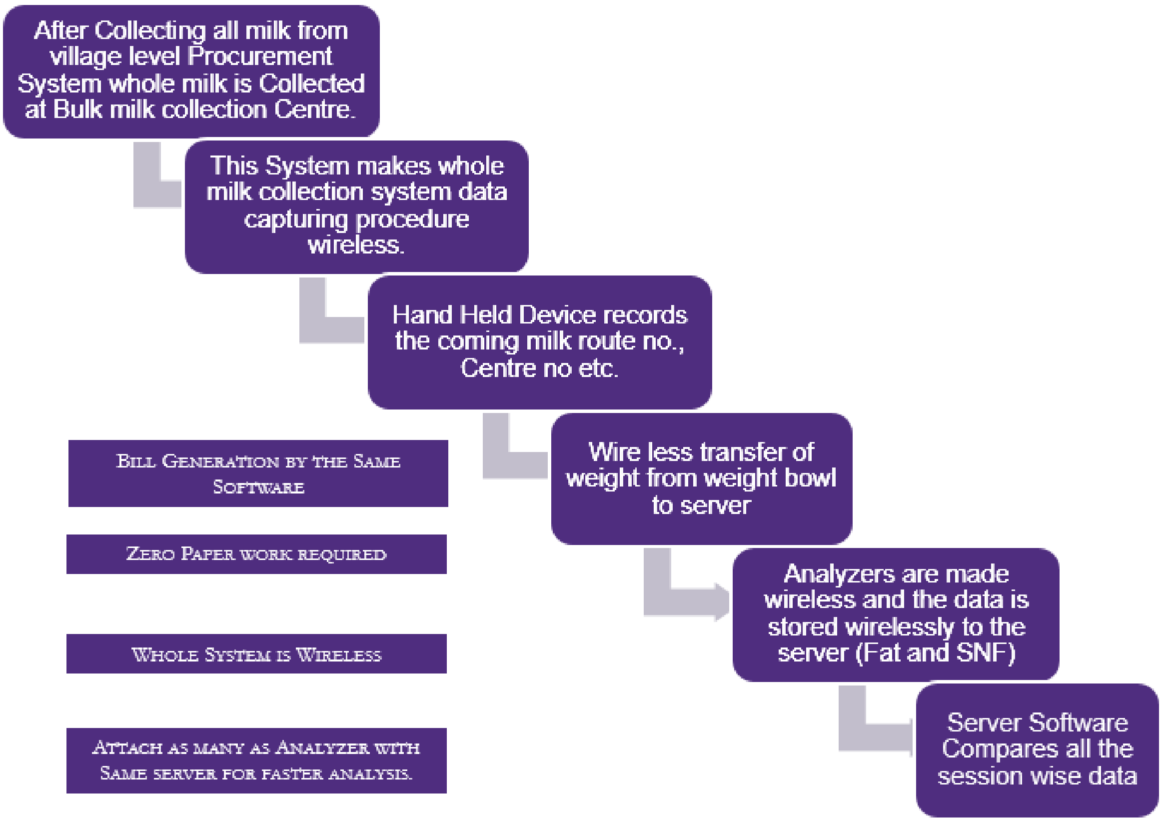
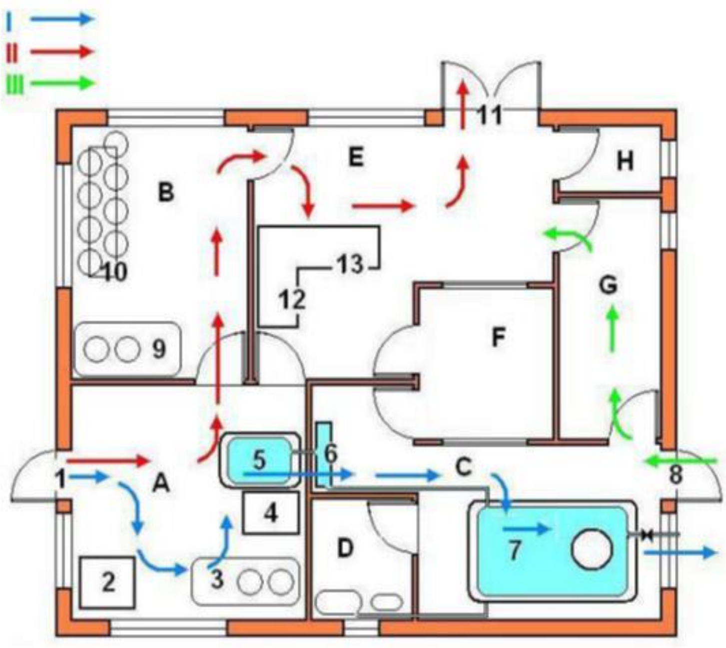


Figure 38:General Layout Description for the BMCC



A – Reception room;
B – cans washing rooms;
C – tank room;
D – space for cooling installation;
E – store and desk for registering the delivered milk;
F - center manager's desk;
G - space for storing the goods sold in the store

1 - Entry for the farmers that bring the milk in plastic cans;
2 – place for milk samples;
3 – place for milk tests;
4 - scale;
5 – temporary milk tank;
6 – unit of milk pre-cooling;
7 – tank for milk cooling and storing;
8- access door for the hoses of tank trucks which retrieve the milk and for supplying the farmer's store with necessary goods;
9- room for washing the cans;
10 – rack for draining and drying the washed cans;
11 - exit door;
12 – shelves for supplying the farmers;
13 – registers containing records the quality and quantity the milk delivered to the Centre

Figure 39:Critical Control Points at the Dairy Processing Centre

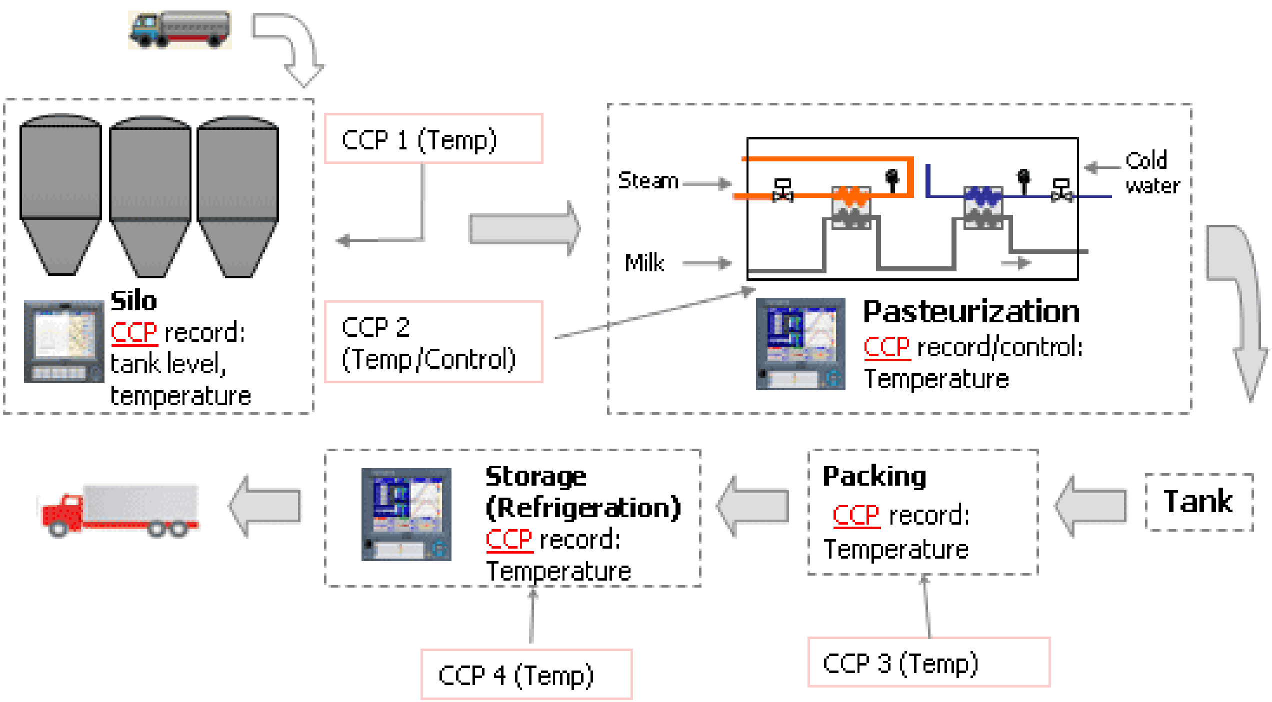


Figure 40:Whole Session Report System (Automation)

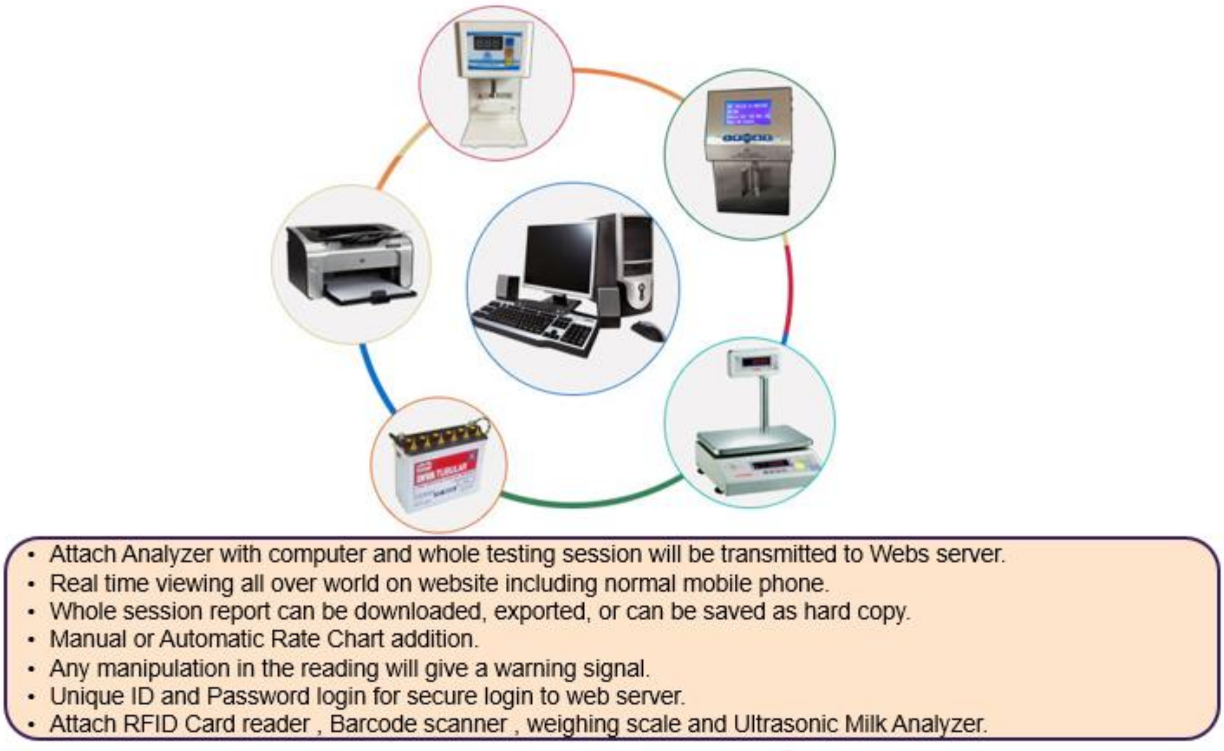
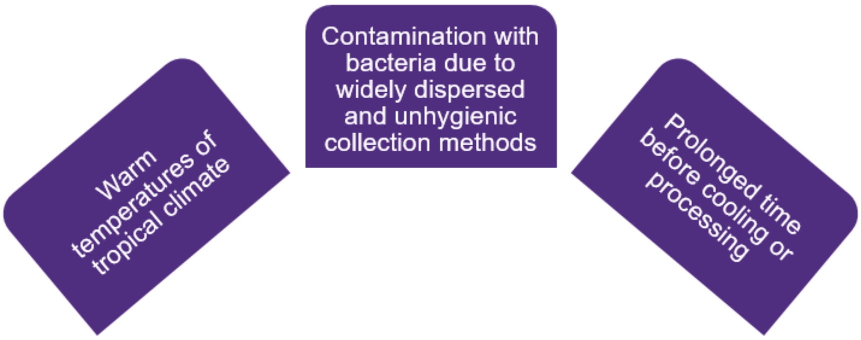
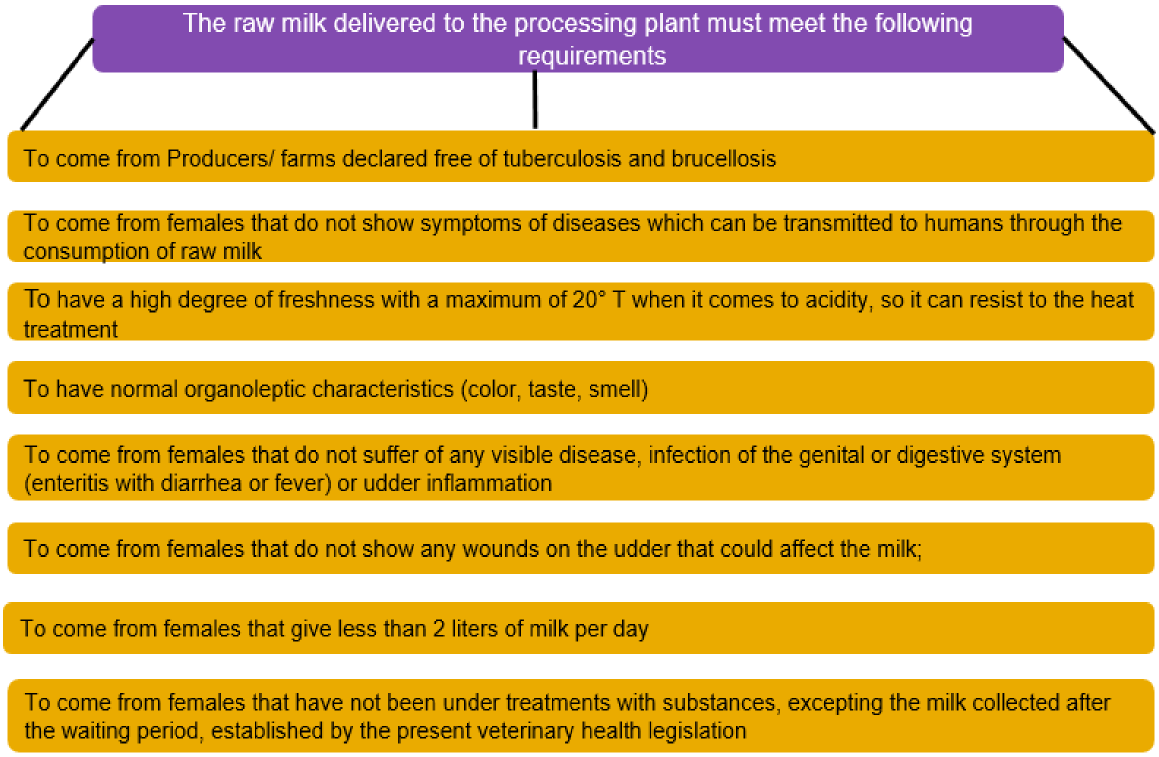


Figure 41: Bacterial Contamination

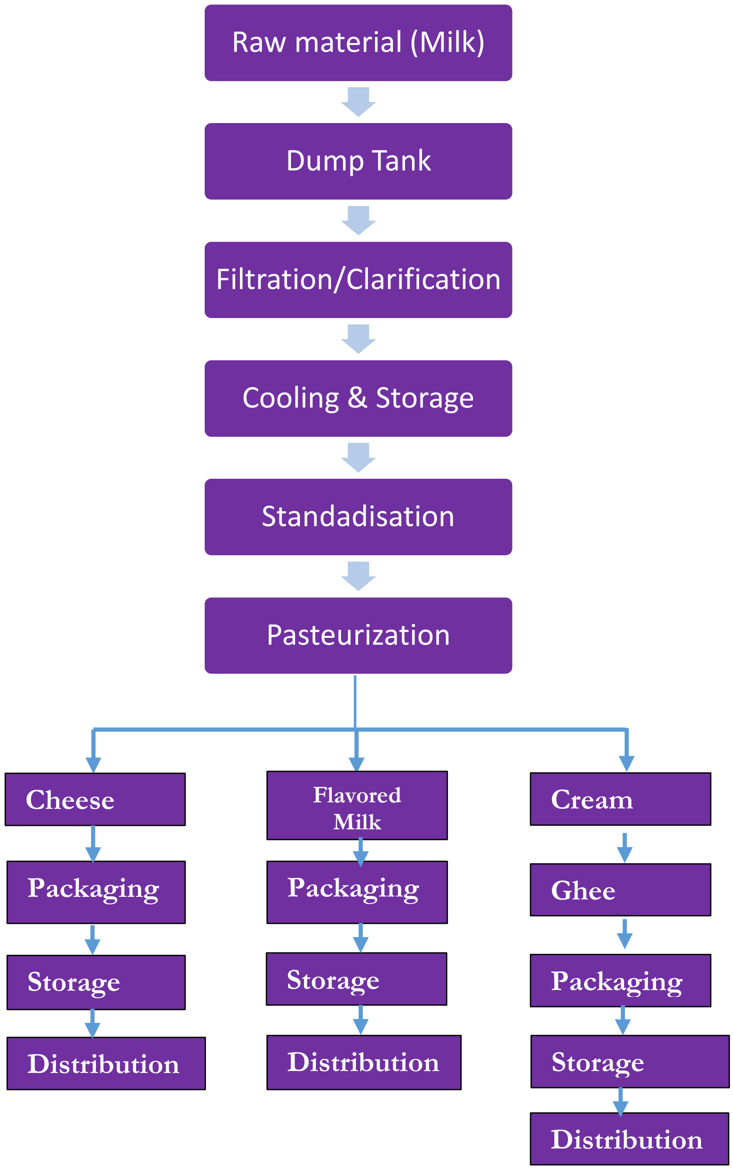


In practice, none of these factors can be eliminated completely, so if anyone is accentuated, the life of milk will decrease. Therefore, every effort must be made to minimize these factors on the farm, during collection at milk plant and during distribution to consumers. At the farm, the aim must be to cool milk as soon as possible after milking. Ideally, the milk should be chilled to 4˚C within two hours after milking. If for any reason this cannot be done at farm, quick transport of milk to the plant is essential. If milk can be stored conveniently at the farm or local collecting depot at low temperature, the organization of transport to milk processing plant is simplified to greater extent by transporting bulk quantity in insulated tankers. The type, size and number of vehicles necessary are, therefore determined not only by the usual factors such as distance or nature of roads but also by the condition of milk production. When the milk is drawn from the udder of the Milch animals (Goats, buffaloes, goat, sheep, etc.), the quality of milk is almost sterile. The milk has its own anti- microbial system present which is active till 2 to 3 hours of milking. The components in milk such as lacto-peroxidase system, immunoglobulins, lactoferrin, etc. have the anti- microbial effect. The perishable nature of milk comes into picture with the contamination from air, huma n, and milking utensils. The temperature of milk during milking is equal to body temperature i.e., 37°C. The milk being very rich in nutrients such as carbohydrates, fats, proteins, minerals, vitamins and water, becomes good media for the growth of micro-organisms. So the milk should be immediately sent to the dairies within 2 or 3 hours of milking, before it gets sour. If the dairy is very far away from the milk collection area, it should be chilled to below 10°C in the bulk milk coolers at the farm level (village co-operatives and/or chilling centers) so that the microbial activity is inactivated.

Figure 42: Raw Milks Quality Requirement



Product Mix:



Raw material (Milk)
Dump Tank
Filtration/Clarification
Cooling & Storage
Standadisation
Pasteurization
Cheese
Packaging
Storage
Distribution
Flavored Milk
Packaging
Storage
Distribution
Cream
Ghee
Packaging
Storage
Distribution

3.1.1 Milk Processing

- Raw milk would be collect from milk collecting centre and transfer through milk tanker/cane to diary. Transfer from milk tanker/cane to silo through milk Chiller.
- The child milk storage in milk silo for further process, Child milk collect in balance tank from silo.
- Pasteurization
- Separation of cream & skimmed milk by centrifugal device
- Homogenization for reducing the size of the fat globules
- Milk storage tank to store pasteurized skimmed milk
- Addition of flavours
- Packaging

3.2. Ghee Processing

Ghee production is the largest segment of milk utilization in India. Most of the dairy plants have ghee production facility to meet the demand of the market as well as to utilize the excess fat in profitable manner. Since simple technology involved in ghee production and relatively less investment for ghee production unit as already plant have steam boiler with them. Method of production varies from small scale to large scale. Cost reduction on energy consumption for production of unit quantity of ghee is the recent trend and equipment's are designed to meet the requirement. Following are the various processes available in the industry to make ghee including Desi method which is following largely at rural household level.

3.2.1. Methods of Preparation

The principle involved in ghee preparation include;

- Concentration of milk fat in the form of cream or butter.
- Heat clarification of fat rich milk portion and thus reducing the amount of water to less than 0.5%.
- Removal of the curd content in the form of ghee residue.

Ghee production is the largest segment of milk utilization in India. Most of the dairy plants have ghee production facility to meet the demand of the market as well as to utilize the excess fat in profitable manner. Since simple technology involved in ghee production and relatively less investment for ghee production unit as already plant have steam boiler with them. Method of production varies from small scale to large scale. Cost reduction on energy consumption for production of unit quantity of ghee is the recent trend and equipment's are designed to meet the requirement. Following are the various processes available in the industry to make ghee including Desi method which is following largely at rural household level.

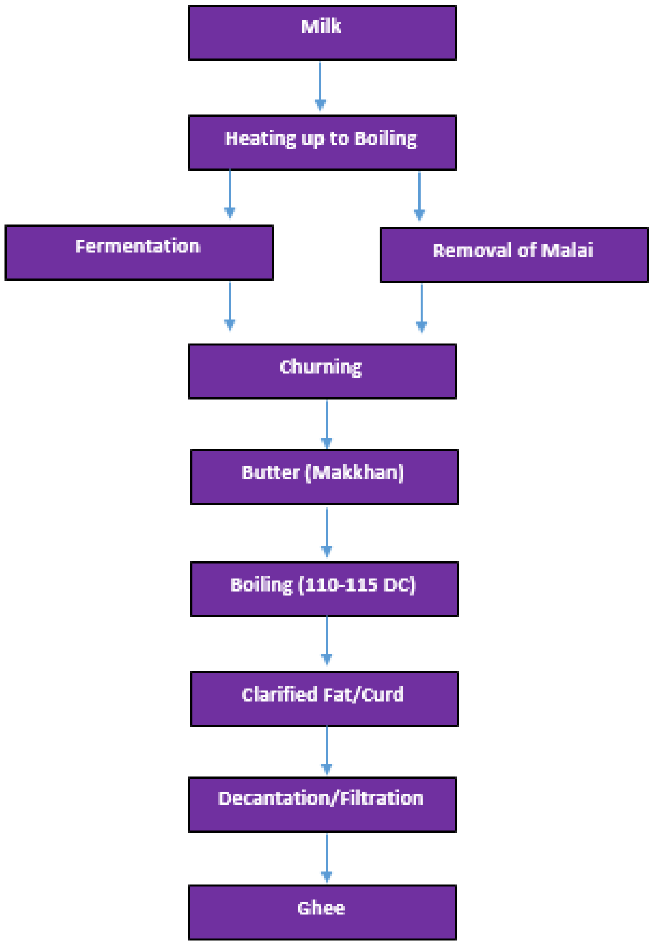
3.3. Methods of Preparation

The principle involved in ghee preparation include;

1. concentration of milk fat in the form of cream or butter.
2. Heat clarification of fat rich milk portion and thus reducing the amount of water to less than 0.5%.
3. Removal of the curd content in the form of ghee residue**.**

Figure 43:Different Methods of Ghee Making

3.3.1 Desi Method of Ghee Preparation:



This was the practice from age-old days in rural areas where excessive milk will be cultured and kept for overnight for fermentation. Resultant curd was churned using hand driven wooden beaters to separate the milk fat in the form of desi butter. Some follow slightly different method wherein milk is heated continuously to about 80°C, the Malai (creamy layer) that forms over the surface was collected manually. This Malai is then churned to get the desi butter. After collection of desi butter over a period of time, this butter is melted in a metal pan or earthenware vessel on an open fire. Extent of frothing is an index to judge when to terminate heating. Heating should be stop when sudden foaming appears and leave the contents undisturbed after heating. Curd particles starts settling down over a period of time and decant the clear fat carefully. In this method it is possible to achieve only 75 – 85% fat recovery.

This method involves separation of cream of 60 to 70% fat from milk by centrifugation process.

- Fresh cream or cultured cream is heated to 114±2°C in a stainless steel, jacketed ghee kettle.
- This kettle is fitted with an agitator, steam control valve, pressure and temperature gauges.

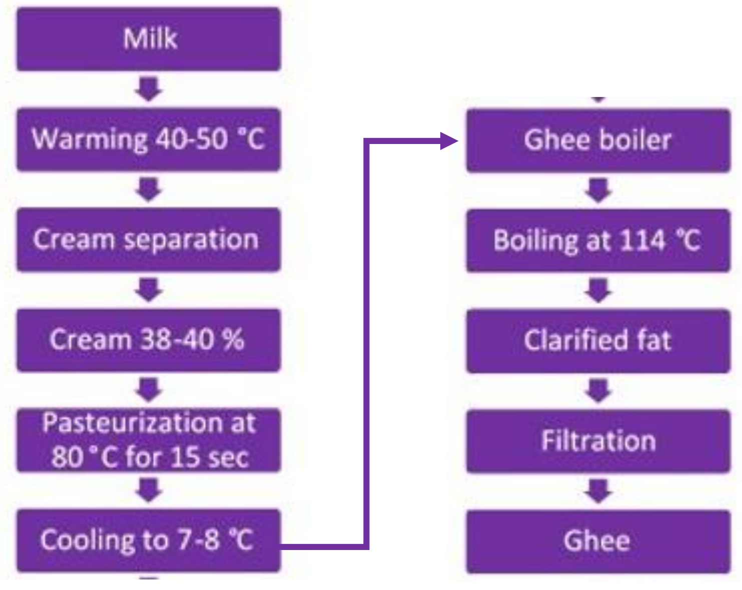
3.3.2. Direct Cream Method of Ghee Preparation:

At this stage the typical ghee flavour emerges and this indicates that the final stage in the preparation of ghee. Advantage of this method is that it does not require butter production prior to manufacturing of ghee. Whereas, limitations are:

- This process takes Long heating time to remove the moisture.
- High content of serum solids in the cream may also produce a highly caramelized flavour in the ghee.
- 4 – 6% loss of butter fat in the ghee residue & during the handling operations.
- So, 70 – 80% fat cream is recommended to minimize both fat loss and steam consumption

3.3.3. Creamery Butter Method of Ghee Preparation:

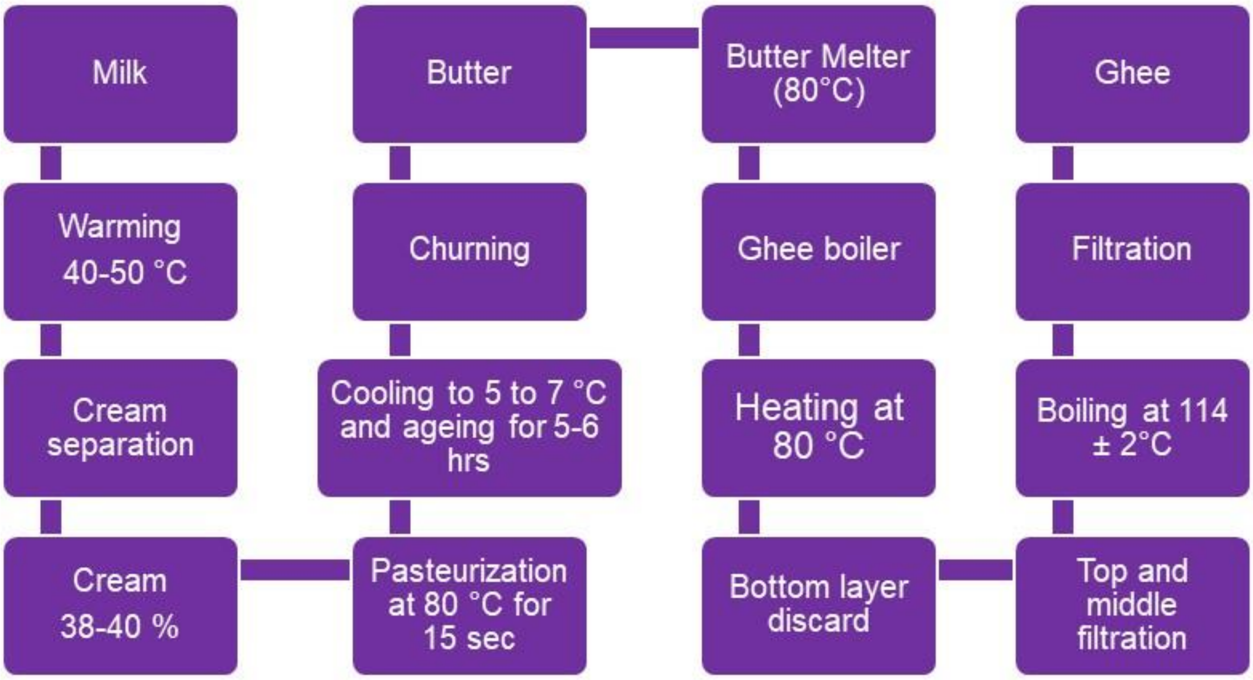
This is the standard method adopted in most of the organized dairies. Unsalted or white butter is used as raw material. Butter mass or butter blocks are melted at 60°C to 80°C in butter melter. Molten butter is pumped into the ghee boiler where final heating will be done using steam as heating medium. Increase the steam pressure to raise the temperature.



Scum which is forming on the top of the surface of the product is removed from time to time with the help of perforated ladle. Moment of disappearance of effervescence, appearance of finer air bubbles on the surface of the fat and browning of the curd particles indicates to stop heating. At this stage typical ghee aroma is produced. Final heating temperature is adjusted to about 114±2°C. To get the cooked flavour, heating beyond this temperature is also being in practice. Ghee is filtered via oil filter into the settling tank.

3.3.4. Pre- stratification Method of Ghee Preparation:

Butter is produced from aged cream of 38 to 40% fat using continuous butter making machine or batch churn. Butter is then transferred to butter melter, and melt at 80°C. This molten butter is kept undisturbed in a ghee kettle or boiler at a temperature of 80-85°C for 30 min.



Here, in ghee kettle, of mass takes place, product stratifies into 3 distinct layers. Denatured protein particles (curd particles) and impurities are collected on top layer and floats on surface. Middle layer consists of clear fat and bottom layer consists of buttermilk serum carrying 80% of moisture and 70% of solids-not-fat contained in butter.

Advantages of pre-stratification method:

- Removal of buttermilk (bottom layer) eliminates prolonged heating for evaporation of the moisture
- Formation of significantly low quantity ghee residue
- Low quantity of ghee absorbed into ghee residue so less fat loss along with ghee residue
- Production of ghee with lower FFA and acidity

3.3.5. Continuous Method of Ghee Preparation:

This method was developed to meet the requirement of high volume production and to overcome the limitation of batch method. Limitations of batch method are as follows:

- Requires high energy, due to low heat transfer co-efficient
- Cleaning and sanitation of equipment's, not satisfactory
- Equipment's and process unsuitable for large volume of production
- Floor becomes slippery due to ghee spillage
- Handling losses are more

So, continuous method was invented and has following benefits;

- Better control on quality of the product
- Only small hold-up of raw material in the plant at any time and hence no chance for whole batch getting spoiled

- Contamination by handlers can be eliminated
- CIP can be possible
- No foaming of the product during production

Butter is heated in a butter melter to molten state and then transfer into balance tank, and pumped further to scraped surface heat exchanger(SSHE), followed by flashing in vapours separator. And this heating in SSHE and flashing are repeated in next two stages to reduce the moisture level. Ghee is then pass through centrifugal clarifier where residue will be removed. Clarified ghee is stored for filling and packing.

3.4. Granulation and Cooling of Ghee

Granulation is important criterion of quality; higher temperature of clarification gives better grain size due to high phospholipids content.

3.4.1. Phenomenon

Completely melted ghee on cooling to prevailing Indian temperatures, can assume the form of large, coarse grains suspended discretely or in clusters in a liquid phase. The process of crystallization is initiated with the formation suitable nuclei. Rate of cooling strongly influences the rate nucleus formation. Stirring or agitation and seeding (at the rate of 1 – 3%) encourage the nucleus formation. For better granulation, ghee should be slowly cooled to 28°C in 2-3 hours' time and agitation is required during granulation to form smaller granules.

3.4.2. Causes of granulation

The partly granular form assumed by ghee is primarily due to certain content of glycerides of higher melting saturated fatty acids, especially palmitic & stearic. Thus buffalo milk ghee shows predominant granulation than Goat milk ghee.

3.4.3. Yield

The yield of ghee from cream or butter is influenced by fat content of raw material. Factors which influence the yield are listed below.

Following factors influence the yield of ghee,

- Method of production: The fat recovery in indigenous method is lowest in range of 80-85% in creamery butter method it ranges from 88-92% and highest in direct cream method ranging from 90-95%.
- The fat content of the raw material used: Higher the fat content higher will be the yield and vice versa.
- Quality of milk or cream: If the acidity of milk or cream intended to use in ghee production is higher than fat losses in ghee residue will be higher, thus it reduces the yield.
- Fat recovery from ghee residue: Scientific reports suggest to extract as much as fat from ghee residue by dissolving ghee residue in hot water followed by filtration and centrifugation. By this method, it is possible to extract the fat from ghee residue and that fat can be added back to cream or butter melter.

Use of Substandard Milk for Ghee Production:

India is a tropical country, where in ambient temperatures touches the mark of 40°C in summer. Collection system for raw milk in rural area is still carried out at ambient temperature. Especially in summer while collecting the milk cans from ton-of places causes acidity of milk to increase and results in souring of milk. This milk cannot be useful for making market milk or for thermal process.

Therefore, there is a need to utilize, this milk for products preparation. Where in it does not affect such the quality of end product. So, in commercial dairy plants such milk is diverted and collected separately based on platform tests (COB, sensory etc…). This sourced milk is collected in balance tank and circulated using high sped pump. This causes the breakdown of far globule membrane and release the fat. After a circulation of 30 min milk is kept undisturbed. This facilitates the separation of cream base or gravity. Then this cream is used for ghee production directly or collected over-a-period of time and neutralized to produce butter from this cream. This butter will be used for ghee making.

Packaging and storage of Ghee: Ghee has a long keeping quality; it can be stored for 6 to 12 months under ambient temperature provided proper packaging and filling. Ghee should be filled up to the brim in a rust free tin cans/container for bulk packing. Regular pack sizes available in the market are 15 lit, 5 lit, 1 lit and 500 ml. Self-standing laminates are used for 14 lit and 500 ml packs which have barrier to moisture, air and light. Exposure of ghee to sunlight for a long time also causes oxidation and produce off flavours in the ghee.

Exposure of ghee to light, air, water vapours and metals causes deterioration of ghee as shown below So, packaging material should prevent the entry of light, air, water vapour and contact with metals. Minimum or no head space should be provided while filling, better to fill the product up to the brim of the container.

Tin cans: Lacquer coated tin cans are used for bulk pack of 15 lit & 5 lit can should be sealed properly to prevent the entry of oxygen as it causes oxidation in the product during storage. It is very essential that tin cans be properly lacquered because rusted cans are liable to accelerate the lipid deterioration. Only drawback in tin cans is the cost. Higher cost renders its use and to search for cost competitive packaging material.

Glass bottles: provide excellent protection to the product quality as they do not react with the food material. Glass bottles can be used for high-speed operations, but are not in much use for bulk or large size packaging of ghee because of their fragility and high weight. Since ghee is an expensive commodity and all consumers cannot afford to buy large size packs, some of the ghee producers have started packaging ghee in glass bottles for retailers in sizes of 100g to 500g.

Semi-rigid plastic containers: are replacing tin plate containers. These are mainly made from high density polyethylene (HDPE). The advantages of using these containers are lightweight, economical and transport-worthy. These are of several types viz., blow moulded HDPE (high density polyethylene), PET (polyethylene terephthalate) bottles, PVC (poly vinyl chloride) bottles, lines cartons and tetra packs. Blow moulded HDPE are, available in form of bottles (200, 400g), jars (1 kg and 2 kg), and jerry cans (2kg, 5 kg, and 15 kg). PET bottles have excellent clarity odour free and have gas barrier properties. All these semi-rigid containers have good scope for packaging of ghee and butter oil.

Flexible pouch: may be made from laminates or multi-layer films of different composition. The pouch may be in the form of pillow pouch or as self-standing pouches. The most attractive feature of packaging ghee in flexible pouches is that they are cheapest than any other packaging system. The selection of laminate or a multi-layer film is governed primarily by the compatibility of the contact layer, heat-sealing ability and heat-seal strength and shelf life required.

The indigenously available flexible materials, which have very good values for the above, mentioned properties are HDPE, polypropelene, Aluminium foil, Nylon, PVC, Polyester and numerous laminates of flexible films. Sachets made from a laminate of PVDC/ PVC Al foil/PP (polyvinyliedene chloride/aluminium foil/polypropylene) are suitable or long-term storage of butter oil and ghee.

Desirable characteristics of packaging material for ghee:

- Packaging material should not react with ghee
- Easily available at low cost
- It should be non-toxic
- It should not allow printing ink to penetrate into the product
- It should protect against tempering
- It should have good barrier properties against spoilage causing agents
- It should withstand wear and tear during transportation

Storage of Ghee: At higher temperature of storage, development of oxidized flavour especially with ghee which has appreciable initial acidity is more pronounced. At Lower (refrigerated) temperature storage, although it delays acid development there by prolongs shelf life but it imparts greasy and pasty texture to ghee. So, storage temperature of 21°C is recommended. Ghee can be stored up to 12months at 21°C.

Keeping Quality: It is the duration in which product is acceptable for safe consumption as well no abrupt changes in its aesthetic quality and chemical quality. Ghee is more prone to oxidation induced changes during storage. Several factors influence the keeping quality of ghee and are listed below.

Factors Influencing Keeping Quality of Ghee:

- Temperature of storage: Higher the temperature of storage. Lower will be the keeping quality and vice versa.
- Initial moisture content: Higher the initial moisture content. The lower the keeping quality and vice versa.
- Initial acidity: Higher the initial acidity, lower the keeping quality and vice versa.
- Exposure to metals: When ghee comes in contact with metals especially iron and copper, its keeping quality gets reduced. Since these is an act as catalytic agents for oxidation.
- Exposure to light: Greater exposure to sunlight causes oxidation of ghee and thus reduces the shelf life.
- Method of packaging: Higher the air-content in the head-space the lower will be the keeping quality.

Preservation of Ghee: First and foremost, thing to preserve ghee is to packaging air tight container. Ghee is very much susceptible to oxidation. Reaction of oxygen with unsaturated fat, aggravated by metallic contamination or sunlight, is a major cause for spoilage. Further to extend the shelf life of the product antioxidants can be added. Butylated Hydroxy Anisole (BHA) at concentration of not exceeding 0.02% can be added. In recent time, use of ghee residue to extend the shelf life ghee has been a practice. Phospholipids present in ghee acts as antioxidants and preserve the ghee.

3.5. Feta Cheese

Feta is one of the most popular, internationally known, white brine cheese produced in Greece from ancient times It is produced from sheep milk or goat milk. The major characteristics of Feta cheese are the snow white colour, the pleasant slightly acid taste and the rich favour. The texture is smooth and creamy, and some irregular small mechanical openings are desirable.

Feta differs from other brined cheeses in being dry salted and free from food additives. Feta has a remarkable nutritional value since 100 g cheese are sufficient to cover the nutritional needs of a normal working man, that is 33% of high biological value proteins and vitamins A and B2 and the 50% of needs in calcium. Feta is the principal cheese in Greece & In India it is at nascent stage.

3.5.1. Feta Cheese flow diagram

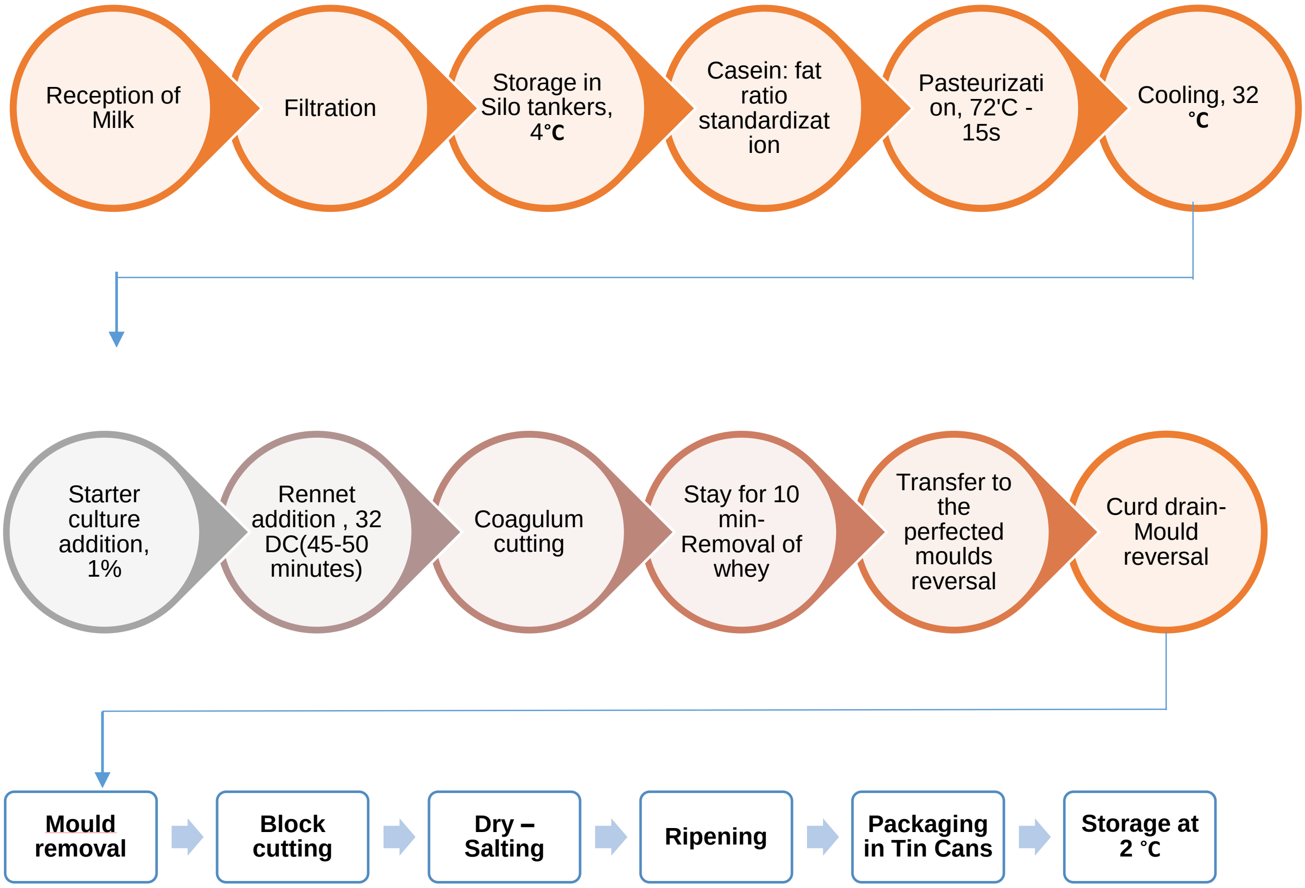
After milking, the raw milk is chilled to below 4°C and kept at this temperature during its transportation to the dairy factory. After reception, milk is filtered and stored in large silo tanks and is sampled for analyses. The milk is standardized (casein/fat = 0.7-0.8), pasteurized (72°C,15 s) and cooled down to 32°C. At this temperature, a starter culture is added and after 30 min rennet is also added and the milk is coagulated in 50-60 min.

The coagulum is cut by using a 2 cm wire knife, it stays for 10 min and is transferred in thin layers into perforated moulds. The moulds are rectangular of dimensions 23 X 23 X35 cm3. The curd is drained without pressing, until it is enough to remove the moulds. The cheese is cut into four blocks of 11 X 11 X 8 cm3.

These blocks are dry salted on the surface. After 12 hours the blocks are reversed and salted again. This is repeated until the salt content of cheese reaches 4%. After the cheese blocks have thus remained on the cheese tables for a few more days, the cheeses are packed into tin cans, containing 6- 8% salt solution and kept at 14-16°C for about 15d until they attain pH 4.6 and moisture content 55%.

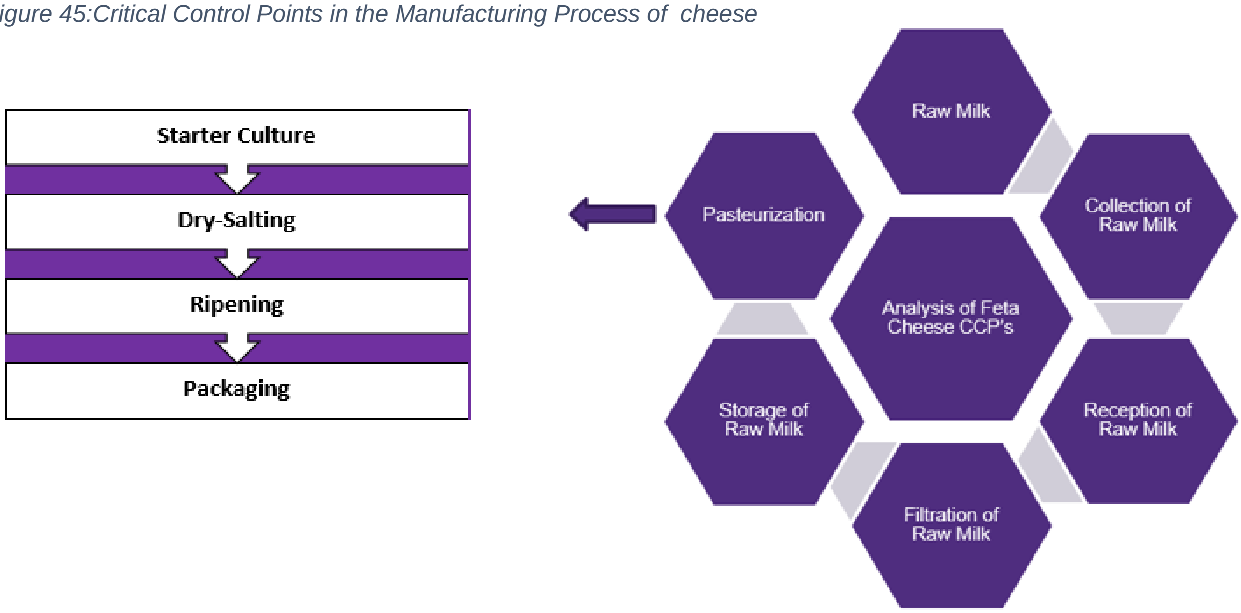
The cheeses are then transferred to new containers where more brine is added and the containers are sealed and stored at 4°C. The cheeses can be consumed after two months have elapsed after manufacture.

Figure 44:Process flow diagram for manufacture of Feta Cheese



3.5.2. Analysis of Feta Production CCP's

Figure 45:Critical Control Points in the Manufacturing Process of cheese



Raw Milk: The milk should be obtained from healthy goat under hygienic conditions. The animals may often suffer by mastitis. These microorganisms contaminate the nipple of udder because of their presence in the environment and milk equipment. The preventive measures are cleaning the udder before and after milking them. An increase in somatic cells indicates an unhealthy animal. Then, antibiotics should be given to the animal and its milk is considered inappropriate for collection for at least 72 h. The potential existence of antibiotic residues in raw milk prevents the efficacy of starter culture. The animal feeding must be also controlled regarding its content in various metals or other elements (Pb, As, Se, Hg, F, Mb and Cu), chemical organic substances (aflatoxins, chloride products) and presence of toxic plants (Phalaris minor, Melilotus alba, Trifolium repens, Conium maculatum, etc.) (Efstathiou, 1996). It is suggested that the animal should not be always fed with the same food.

Collection of the raw milk: Milk is an excellent medium for growth of microorganisms. Therefore, there is a high risk of a quick microbiological deterioration of quality between the milking stage and the stage of plant processing. The milk should be transported in milk tankers directly to the dairy factory thus avoiding any unnecessary delay. Prior to transportation, the driver should check the milk acidity using portable pH meters. During transportation the temperature of milk should not exceed 10°C. The latter can be easily and quickly controlled with Time Temperature Indicators (TTI). Milk tankers should be thoroughly cleaned and the cleaning efficiency should be regularly checked.

Reception of Raw Material: This stage is a CCP1 because the reception test stands for an acceptance test. The long exposure of milk to high temperature during transportation may favour the growth of pathogens and the production of heat resistant toxins. Raw milk contains pathogen bacteria, such as Salmonella, Mycobacterium bovis, Brucella, Campylobacter and Listeria monocytogenes. Moreover, raw milk may contain antibiotics and aflatoxins (e.g. aflatoxin M). Control of raw milk includes the determination of milk acidity, aerobic mesophilic count, freezing point, antibiotic and metabolite residues.

Filtration of Raw Milk: The raw milk is filtered in order to ensure the removal of any extraneous material which represents a physical hazard.

Storage of Raw Milk: If the milk is to be kept beyond the day of production, it should be kept refrigerated at a temperature below 6°C, However, at the temperature, growth of psychrotrophic microorganisms and consequent production of proteolytic and lypolytic enzymes are observed. Although, these microorganisms are completely inactivated by pasteurization, the enzymes are very heat resistant and will continue to cause favour problems even after the heat treatment. At temperatures below 6°C, Bacillus cereus grows and forms spores, which are unaffected by pasteurization. Bacillus cereus is of great importance because it is capable of producing a food poisoning toxin to avoid the risk of further growth of potentially troublesome microorganisms in raw milk, milk should be kept at the lowest possible temperature (4°C) and treated within 72 h. In order to extend the storage time, a number of complementary procedures have been reported, such as thermization (65°C, 15 s), carbon dioxide addition and thiocyanate/lactoperoxidase/hydrogen peroxide addition, that is lactoperoxidase system (LPS) initiation. Mixing already stored raw milk with recently received raw milk could result in cross-contamination and should be avoided.

Pasteurization: In a HTST system (High Temperature Short Time), the typical temperature-time conditions are 72°C for 15 s. The flow of pasteuriser cannot exceed that at which the 15 s hold was measured. Pasteurization is followed by cooling at 32°C. A positive pressure is maintained so that if a leak occurs it is from pasteurised milk. Moreover, routine checks of plates for leaks are carried out. Flow divert on under-pasteurisation temperature and key thermometers are verified daily. Holding time takes into account divert valve response time. This heat treatment will destroy all the vegetative forms of bacteria, the psychrotrophic microorganisms, the yeasts and the moulds The surviving microorganisms are Micrococcus, Streptococcus, Lactobacillus, Bacillus and Micro bacterium which constitute indicators of hygienic condition of equipment. Pasteurization must focus on minimizing the probability that pathogenic microorganisms might survive the process so that the public health risk is considered negligible. The procedure of pasteurization, however, can neither destroy nor eliminate the presence of toxins, bacterial agglomerations and residues of chemical and physical substances, such as antibiotics and metals. Therefore, the existence of at least one critical control point before pasteurization is essential (e.g. reception of raw milk).

The most appropriate routine method to ensure that milk has been correctly pasteurized and afterwards not cross-contaminated by raw milk, is Flurophos which is far more sensitive than the standard alkaline phosphatase test. During pasteurization, the deposition of residues of milk components (proteins and minerals), at the inner surface of the processing plant (fouling), lowers the efficiency of heat transfer. The insufficient heat treatment may favour the survival of pathogenic bacteria. Should fouling occur because of insufficient heat treatment the pasteuriser should divert. The plate heat exchanger should be cleaned at least once a day (0.5% NaOH, 65-70°C). Cross-contamination of milk after pasteurization stands probably for the greatest risk of a hygiene breakdown. The essential sources of heat treatment contamination are air, water, equipment, utensils, people, starter cultures, rennet and packaging. The quality control laboratory does frequently the sampling from the sources which are regarded suspect and prone to contamination.

Starter Culture: For Feta cheese the following starters of lactic acid bacteria are used: Lactobacillus bulgaricus-Streptococcus thermophillus (1:1), Lactococcus lactis-Lactobacillus bulgaricus (1:3) and Lactococcus lactis-Lactobacillus casei (1:1). The percentage of added culture is approximately 1%. After the starter addition, the mixture remains for half an hour at 32°C to promote the starter growth (milk ripening) and rennet is added. The preventive measures of this stage consist of monitoring the temperature of milk and controlling the development of acidity (pH reaches 5.0-5.2 within 6-8 h). The continuous activity of starter should be ensured. Any change in activity may indicate either contamination with bacteriophages or a decreased activity of the starter due to excessive presence of antibiotics and/or disinfectants and considerable variations in the composition of milk. The most significant problem arises from bacteriophage, normally present in cheese making environment and especially in the whey. In order to avoid them, phage inhibitory media (PIM) for starter growth have been developed. It is generally suggested that culture addition should be supervised by experienced personnel under strictly hygienic rules.

Dry- Salting: To assure an even distribution of salt, every 12 h the cheese-blocks are turned upside down and salted again on the surface. This continues until the cheese content in salt varies within the range 3-4%. Within the firrst 24 h, salt in moisture must be 2.5% (moisture content 60%). Higher values are not required because pH has already reached 4.8-5.0. The slime formation on the surface of Feta is essential for the development of the characteristic Feta flavour during ripening. The composition of microbial flora at the surface should be also checked. The salt is usually of the size of corn and must be obtained from reputable supplier. Salting and ripening temperature must be monitored and kept at 16°C. Following dry-salting, which takes 4 to 5 days, the cheese is placed into tins and covered with brine of about 8% salt content. The tins are covered and left for ripening.

Ripening: Ripening occurs within approximately 15 days at 16°C and RH=85%. Higher values of RH may favour the growth of moulds which produce mycotoxins. The ripening room must be separate and checked for its hygienic conditions. By the end of ripening, the salt in moisture is 5-6 %, pH is not above 4.6 and moisture content varies around 55%.

Packaging: The tin cans are refilled with 8% salt solution (brine) and the blocks of cheese are completely submerged to avoid mould growth at the surface and the potential aflatoxin production. The removal of each block from the ripening room should take place according to the FIFO-method (First In First Out). Saltin-moisture levels within the cheese must be lower than the corresponding concentration of salt in brine. The tin cans are sealed and the efficiency of sealing must be also checked. Cans must be obtained from reputable supplier, and must be kept at controlled RH to prevent rusting. Prior to use, they are washed with potable water and their hygienic condition is checked with microbial techniques. After packaging the tin cans are transferred to the storage room at 4-5°C.

Storage: Ripening is completed within 2 months. During storage, psychrotrophic bacteria contribute to the continuing ripening thus improving the organoleptic characteristics and killing the pathogens Salmonella, Brucella, Staphylococcus aureus and coliforms. These bacteria might contaminate the product after milk has been pasteurized. The pathogen Mycobacterium endures extreme pH conditions and high values of salt concentration. For that reason, pasteurization must ensure the killing of this bacterium. The tin cans must be placed at dry places where the temperature remains at 4°C and RH is kept low.

Technical Collaboration: Technical collaboration may be for supply of machinery, technical know-how for manufacture & marketing of products.

Power: Normally a three phase electricity supply is required for milk processing plants. The power requirement depends upon the load to be connected and the necessary approval from State Electricity Board (SEB) should be obtained for connection. Depending upon the position of power supply, standby generators may be considered for connecting the essential sections.

Water: A milk processing plant requires the water in the ratio of 2:1 (2 liters of water for 1 liters of milk processed) which includes cleaning of equipment’s, cold storage & drinking purposes.

Source of Water: There is a bore well within the Project Premise. Submersible Pump, Base Tank, Overhead Tank & Necessary Pipe fitting may be purchased for complete operations. As per the current quality of the water- Water softening plant is required & the cost of the same is included in the total project cost.

Steam: The steam requirement (kg/hr) depends upon the processes involved and the source of steam will be met by available Oil Fired Boiler.

Compressed Air: It will be required for various pneumatic operations flow control operations as well as for cleaning purposes.

Environmental Aspects and Pollution Control:

- ETP: The process involved is milk pasteurization and processing of milk into toned milk and products such as Cheese, Flavoured Milk and ghee. The effluent will be in the form of washed water and milk solids apart from the detergents and sanitizers used in the plant. There are no hazardous effluents generated from a milk processing plant. However, construction of effluent treatment plant is necessary for treating the effluents before discharging for proper disposal. The final effluent should meet the requirements of Pollution Control Board and is necessary to get clearance from them. The treated water can be utilized for irrigation or creating a biotic zone where plants can be grown in and around the dairy plant.

- Rajasthan Pollution Control Board: In addition to above Consent to Establish & Consent to Operate will be required from State pollution control Board.

- Grant of Manufacturing License will be required from Department of Factories & Boilers- Jaipur.

- FSSAI License

- Packaging & Labelling

- Local Authority/Panchayat

- Electricity Board

Chapter 4- Indicative Project Profile

Indicative project profile is further bifurcated in to two phase:

- **Phase 1**: Indicative project profile (Short Term)
- **Phase 2**: Indicative project profile (Green Field)

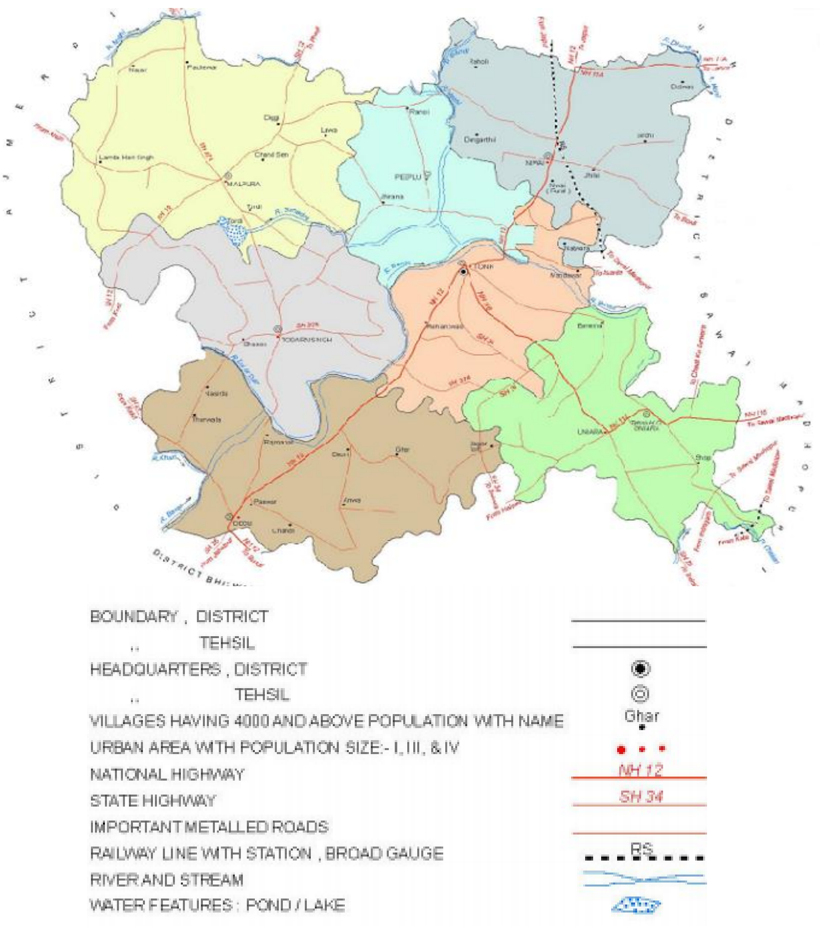
4.1. Tonk: Project District Profile

- Tonk district ranks 23rd in terms of population, 18th in terms of area and 19th in terms of population density.
- Tonk district has seven tehsils, in which Uniara tehsil has the highest number of villages (222) whereas Peeplu tehsil has lowest number of villages (126).
- Tonk district has 1183 villages, out of them 1116 villages are inhabited and 67 villages are uninhabited. In Tonk district 92 new villages and 1 new census town have created as compared to 2001 Census.
- In Tonk district, Dooni (Tehsil: Deoli) is the most populous (11,295 persons) village; and Parvan (Tehsil: Uniara) and Chimanpura (Tehsil: Niwai) are the least populous (01 person) villages.
- Tonk district consists 77.6 percent rural and 22.4 percent urban population whereas the State percent of rural and urban population is 75.1 and 24.9 respectively.
- The sex ratio of Tonk district (952) is significantly higher than the State sex ratio (928).
- The literacy rate in Tonk district is 61.6 percent which is lower than the State Average (66.1 percent) and it ranks 23rd among the other districts of the state.
- Gender Gap of the literacy rate is 31.7 percent in the district.
- The Scheduled Caste and Scheduled Tribe population in Tonk district is 20.3 percent and 12.5 percent respectively whereas the State percent of Scheduled Caste and Scheduled Tribe population is 17.8 and 13.5 respectively.
- The economy of Tonk district is mainly dependent on agriculture as 67.7 percent workers in the district are either cultivators or agricultural labourers. However, the district percent of such workers is higher than the state average of 62.1 percent. Work participation rate (WPR) of Tonk district has recorded 45.7 percent and gender gap in WPR is 11.1 percent points. In Tonk district among the workers the percentage of cultivators, agricultural labourers, workers in household industry and other workers (category of workers) are 50.2, 17.5, 2.5 and 29.8 percent respectively.
- Work participation rate (WPR) of Tonk district has recorded 45.7 percent and gender gap in WPR is 11.1 percent points.

- In Tonk district among the workers the percentage of cultivators, agricultural labourers, workers in household industry and other workers (category of workers) are 50.2, 17.5, 2.5 and 29.8 percent respectively.

Location & Size: Tonk, one of the erstwhile princely States of Rajasthan is located in its north eastern part between East longitudes 750 07' and 760 19' North latitudes 250 41' and 260 34'. Tonk District is situated at a distance of about 82 km from Jaipur, the capital of Rajasthan. The total area of the District is 7194.00 sq.km area figures according to 2011 census, which accounts for 2.1 % of the total area of Rajasthan. Tonk district stands 18th in terms of area among the 33 districts of the state. It is bounded in the north by Jaipur district, in the south by Bundi and Bhilwara districts, in the west by Ajmer district and in the east by Sawai Madhopur district.

Physiography: The district is flat and has a shape of a kite. Generally, it has an elevation of about 264.32 meters above sea level. The only important river of the district, Banas, divides it into two halves. The soil is somewhat sandy but fertile. Though the depth of water level in general is not much, but in most of the areas after 20 ft. of underground water level, bed rock formations are found with the result that sub-soil water for irrigation is limited. Some off-shoots of Aravalli hills are also found scattered here and there. The general slope in the district is from the north-west to the south and east. Bisalpur Dam is situated 17 Km. from Deoli. The water storage capacity of this dam is 115.50 meter. Besides providing water to Jaipur, Ajmer, Nasirabad, Beawar, Kishangarh etc. this dam will provide irrigation facilities to Deoli, Tonk, & Uniara Tehsils. Due to dam subsoil water level also rise in Deoli, Tonk, Malpura & Toda Raisingh which will result in increasing the Agricultural produce.



Dooni is a Village in Deoli Tehsil in Tonk District of Rajasthan State, India. It belongs to Ajmer Division. It is located 45 KM towards South from District headquarters Tonk. 10 KM from Deoli Village. 137 KM from State capital Jaipur.Dooni Local Language is Hindi. Dooni Village Total population is 11295 and number of houses are 2372. Female Population is 49.0%. Village literacy rate is 56.6% and the Female Literacy rate is 21.1%.

Census Parameter	Census Data
Total Population (No's)	11295
Total No of Houses (No's)	N
Female Population %	49.0 % (5540)
Total Literacy rate %	56.6 % (6397)
Female Literacy rate	21.1 % (2382)
Scheduled Tribes Population %	3.7 % (413)
Scheduled Caste Population %	27.4 % (3095)
Working Population %	44.80%
Child(0 -6) Population by 2011	1623
Girl Child(0 -6) Population % by 2011	47.7 % (774)

Phase 1: Indicative project profile (Short Term) for Maitri Mahila Dairy and Agriculture Producer Company Limited (MMDAPCL), Dooni, Tonk:

MMDAPCL was registered in 2013 and has 940 shareholders. The FPC works through SHGs and milk federations at the grassroots level. The FPC collects around 4000-5000 liters of Cow/buffalo milk per day and supplies to various private dairies like Lotus, Payas dairy etc. However, these companies procure milk only when there is shortfall in their existing channel and hence the FPC sells milk in local and mid-day meal scheme too.

The FPC has 940 members out of which 745 members are from RACP MTGs and ten out of 12 board members are also members are from RACP MTGs. Out of 28 villages in Dooni Cluster, the FPC is operating in 24 villages and has 11 milk collection canters in RACP project area. Based upon the field surveys linked to initial level market analysis it is envisaged that MMDAPCL starts their Goat milk business in their existing Milk Plant with the available infrastructure & resources with minimum cost involved for successful running of the plant. As this is an innovative business model & very few players have tested & tried, it is proposed that MMDAPCL starts the business by collecting low volume of Goat milk and Processing it further for product mix: Sterilised milk so that the shelf life of the product increases thus mitigating the risk of product damage. Since the Green Field project model will take 6 to 12 months for complete establishment, the current short term business plan is proposed for 1 year so that in the meantime FPC gets experienced in Goat milk procurement, Value addition, Demand generation, Sales & Marketing etc., following which FPC can scale up their production & diversify their product mix basis business plan proposed in the Green field project model.

The short term business plan for one year is mentioned below.

1) **Assumptions:**

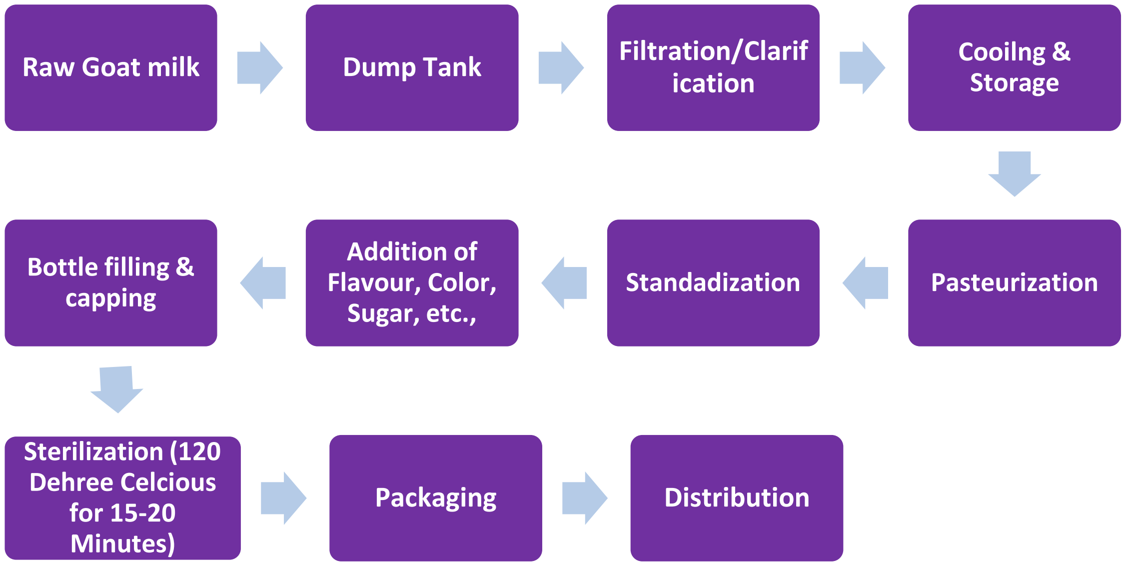
Table 5:Critical Assumptions

Particulars	Year-I
Goat Milk required per batch	100 Liter
No. of operation days (Maximum1 week/month)	84 Days
Raw material required per year	8,400 Liter
Product Wise Milk Distribution	
Sterilized Milk (100%)	8,400 Liter
Product Obtained after Processing Loss	
Sterilized Milk (98%)	**8,232 Liter**

- In the first quarter FPC procures 300 Litres goat milk per month & process it in batches.
- In the second quarter FPC procures 500 Litres goat milk per month & process it in batches.
- In the third & fourth quarter FPC procures 1000 Litres goat milk per month & process the same in batches.
- Goat milk procurement price is at Rs. 30 Per Litre.
- Packaging will be in Glass Bottles 200 ml with MRP as Rs. 30 Per bottle.
- Minimum Selling price on B2B model will be Rs. 25 Per bottle (200ml).

Steps for Goat Milk Sterilization:

Figure 46:Steps for Goat Milk Sterilization



Below mentioned table represents month wise Raw goat milk required and subsequent output as a Packed Sterilized milk bottles.

Table 6:Month wise goat milk requirement & output: Glass milk bottles (200ml)

Month	Goat milk Required /month (in liter)	Output: Number of Glass milk Bottles per month: (200 ml each)	Number of Bottles to be sold per day (Assuming 30 Days in a Month)
1	300	1,470	49
2	300	1,470	49
3	300	1,470	49
4	500	2,450	82
5	500	2,450	82
6	500	2,450	82
7	1,000	4,900	163
8	1,000	4,900	163
9	1,000	4,900	163
10	1,000	4,900	163
11	1,000	4,900	163
12	1,000	4,900	163
Total	**8,400**	**41,160**	

Sales Strategy: Since the Product MRP is kept at Rs. 30 and Minimum Selling Price per bottle is Rs. 25 there is a margin of Rs.5 per bottle which amounts to 20%. As the product falls under exploratory market & the demands are still at nascent stage, it is imperative to keep good margins for the distributors/Wholesalers/Retailers. It is proposed to sell the product through the distribution model by having strategic linkage with the milk & milk product distributors already operating in Jaipur & allied areas. Given below table details the list of active milk & milk distributors in and around Jaipur.

Table 7:List of Milk & Milk product distributors in Jaipur

#	Name of the Milk Product Distributor	Address	City
1	Pioneer Industries	Shastri Nagar	Jaipur
2	Chaderi Daryr	Vaishali Nagar	Jaipur
3	Mahadevlal Jagdesh	Central Jaipur	Jaipur
4	Shri Krishna milk Bhandar	Kartarpura	Jaipur
5	Radhe Shyam Bhatiya	Raja Park	Jaipur
6	Hasif Milk Traders	Jalupura	Jaipur
7	Chatuji Garakwale	Bagru walon ka rasta	Jaipur
8	Jatin Tredars	Johari Bazar	Jaipur
9	Gopal V Krishna Dhood Bhandar	Central Jaipur	Jaipur
10	Hanshika Dairy Products	Central Jaipur	Jaipur
11	Pancholi Milk Bhandar	Khorabisal	Jaipur
12	Balaji Doodh Bhandar	Central Jaipur	Jaipur
13	Balaji Milk Center	Vaishali Nagar	Jaipur
15	Jyoti Agency	Malviya Nagar	Jaipur
16	Khandelwal Marketing	Delhi Road	Jaipur

Basis discussion concluded with some of the key distributors mentioned in the above table, they intend placing the product at the retail outlets in & around major customer footfalls area including key tourist attraction centres such as: Hawa Mahal, City Palace, Albert Hall Museum, Jantar Mantar, Jaigarh Fort, Jal Mahal, Central Park, Nahargarh Fort, Birla mandir etc.,

2) Total Project Cost

Table 8:Total Project Cost

#	Particular	Amount (Rs.)
1	Machinery and Equipment	345,000
2	P&P Expenses	310,000
3	Working Capital	346,921
	Total	**1,001,921**

3) Plant & Machinery Cost

Table 9:Plant & Machinery Cost

#	Description	No. Required	Amount (Rs.)
1	Autoclave (35 Litre Capacity):Double walled Fully Automatic	1	200,000
2	Manual Crown Capping Machine (Mechanical)	1	60,000
3	SS Table	2	50,000
4	Plunger	2	5,000
5	Filling Containers	1	20,000
6	Lab Wares	1 Set	10,000
	Sub Total		**345,000**

4) Preliminary & Preoperative expenses

Table 10:P&P Expenses

#	Particular	Amount (Rs.)
1	Legal Charges	10,000
2	Repairs, Maintenance, Paintings, Glass Fixtures etc.	300,000
	Total	310,000

5) Working Capital

Table 11:Working Capital details

#	Item	Duration	Amount (Rs.) Year-I
1	Stock Raw Material (Milk)	3 Months	27,000
2	Stock of packing material	3 Months	37,485
3	Trade receivables	1 Months	29,400
4	Advertisement, Marketing , website related	1 Year	132,000
5	Indirect Employees	6 Months	120,000
Working Capital Requirement			**346,921**

6) Means of Finance

Table 12:Means of Finance

#	Particular	Amount (Rs.)
1	Own Contribution	100,192
2	Grant/ Subsidy	901,729
Total		**1,001,921**

7) Revenue Schedule

Table 13:Revenue Schedule

Particular	Unit Price (Rs.)	Year-I
Sterilized Milk Bottle	27	1,111,320
Total		**1,111,320**

- MRP of 200 ml Glass milk bottle is Rs 35 per bottle
- Minimum Selling Price of each Glass milk bottle of 200 ml is Rs 27 (B2B)
- So total revenue in the year 1 is (41,160 Glass Milk Bottles X Rs 27 Per Bottle= Rs. 1,111,320)

8) Operational Expenses

Table 14:Operational Expenses

#	Particulars	Year-I
A.	**Fixed**	
`	Administration Expense	24,000
	Insurance (@ 2% of P&M)	6,900
	Electricity Charges	12,000
	Indirect Employees	120,000
	Sub-Total	**162,900**
B	**Variable Cost**	
	Raw Milk - Goat Milk (INR 30 per liter)	252,000
	Grease/ Oil	4,500
	Fuel Charges	25,200
	Electricity Charges - Variable	23,520
	Water Charges	10,500
	Advertisement and Sales Expense	132,000

#	Particulars	Year-I
	Packaging Cost - Bottle Milk	349,860
	Transportation - Raw Milk (INR 1.25/liter)	10,500
	Transportation - Bottled milk (INR 2.5/liter)	20,580
	Sub-Total	**828,660**
	Total	**991,560**

9) Profit & Loss Statement

Table 15:Profit & Loss Statement

Particulars	Year-I
Revenue from sales of Glass Milk Bottles (41,160 Bottles X Rs 27)	**1,111,320**
Fixed Cost	162,900
Variable Cost	828,660
Total Operational Expenses	**991,560**
Earnings Before Interest, Depreciation, Taxes and Amortization (EBITDA)	**119,760**
Depreciation	2,875
Amortization	62,000
Earnings Before Interest and Taxes (EBIT)	**54,885**
Earnings Before Taxes (EBT)	**54,885**
Earnings After Taxes (EAT)	**54,885**
Profit (loss) carried to Balance Sheet	**54,885**

10) Balance Sheet

Table 16:Balance Sheet

Particulars	Year-I
ASSETS	
Current Assets	
Cash and Bank Balance	**466,681**
Accounts Receivables	0
Other Current Assets	0
Total Current Assets	**466,681**
Gross Fixed Assets	345,000
Less: Depreciation	2,875
Net Fixed Assets	**342,125**
Preliminary Expenses	**248,000**
TOTAL ASSETS	**1,056,806**
LIABILITIES & SHAREHOLDERS EQUITY	
CURRENT LIABILITIES	
Short Term Debt (Working capital loan)	**0**
Accounts Payable & Accrued Expenses	0
Other Current Liabilities	0
Total Current Liabilities	0
Long Term Debt	0

Particulars	Year-I
Differed Tax Liabilities	0
TOTAL LIABILITIES	**0**
Share capital	**100,192**
RACP Grant	**901,729**
Reserves and Surplus	
Add: Opening Balance (P/L Account)	0
Profit & Loss) During the Year	**54,885**
Appropriation - Dividend	0
Total Reserves	**54,885**
TOTAL EQUITY	**1,056,806**
TOTAL LIABILITIES & EQUITY	**1,056,806**

Green field Project: Long Term:

Table 17:Project Details

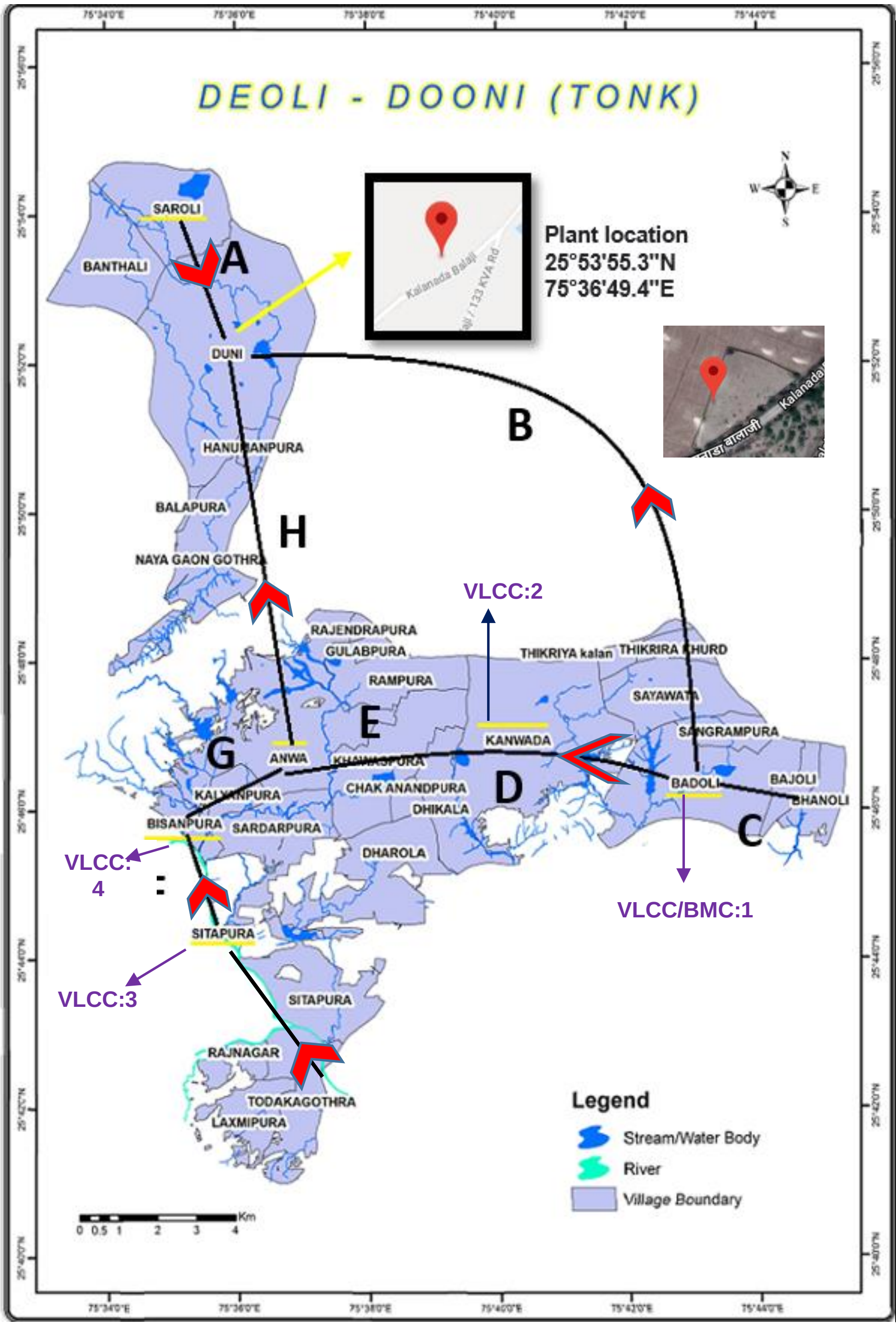
#	Project Details	
1	**Adequate Volume and Wider Mix of Raw Materials/Days of Operation in a Year (Suitability of Location & Project Site)**	
(i)	Availability of Raw Materials, product mix, No. of Days of Operation	Raw material- Goat Milk Product mix- Flavoured Milk, Goat Milk Cheese, Goat Milk Ghee & Skimmed Milk Number of days of operations- 365 days The primary Zone of influence (VLCC) at Dooni will include- 1. Kanwada 2. Bisanpura 3. Thikriya 4. Bhanoli 5. Badoli 6. Dharola 7. Sardarpura 8. Sitapura 9. Gulabpura 10. Toda ka Ghotda 11. Chandsinghpura In total Three Village Level Milk collection centres will be established in required village. Each milk collection centre will collect milk from the villages which are situated within the Radius of 4-5 Km from Central BMCC.
(ii)	Village level milk collection centre & Bulk Milk Chilling centre	1) Bulk milk chilling centres- One BMCC at Badoli which is 30 Km Approximately from the Project Site. This centre will also collect available marketable surplus milk of 200 Litres/Day 2) Village level Milk Collection Centre: • One at Kanwada which is at a Distance of 25 Km Approximately from the Project site & has Available marketable surplus of 200 Litres Per day • One at Bisanpura, which is at a distance of 20 Km approximately from the project site & has Available marketable surplus of 100 Litres Per day • One at Sitapura which is at a distance of 15 Km approximately from the project site & has available marketable surplus of 220 Litres/Day.
(iii)	Processing Unit	The Processing unit will be established at Dooni Town Tonk District (Coordinates: 25°53'55.3"N 75°36'49.4"E). The project proposes to establish a Goat milk dairy plant at Dooni town. The proposed site is 3.5 Km from The NH 52 & 20 KM Approx. from BMCC. Out of 0.5 Ha initially Net Built up area for The Goat Milk Dairy plant would require 20,000 sq. ft. area for Raw milk pasteurization, cheese processing & other by-products make. Type of Land: Lease Deed
2	**Experience**	
	Maitree Mahila Dairy And Agriculture Producer Company Limited is a Private incorporated on 09 August 2013. It is classified as Non-govt company and is registered at Registrar of Companies, Jaipur. Its authorized share capital is Rs. 2,000,000 and its paid up capital is Rs. 994,500. It is involved in Growing of crops; market gardening; horticulture. Directors of Maitree Mahila Dairy And Agriculture Producer Company Limited are Amalesh Meena, Kajodi Jangid, Ladi Meena, Kamala Meena, Meera Jat, Panchi Meena, Prem Gurjar, Ramdhani Meena, Ratani Jat and Lada Gurjar. Maitree Mahila Dairy And Agriculture Producer Company Limited's Corporate Identification Number is (CIN) U01122RJ2013PTC043444 and its registration number is 43444.	

	Maitree Mahila Dairy And Agriculture Producer Company Limited's Annual General Meeting (AGM) was last held on 29 September 2017 and as per records from Ministry of Corporate Affairs (MCA), its balance sheet was last filed on 31 March 2017. Registered address of the Company is at: VPO-Dooni, Anwa Road Near Shani Dev Mandir Deoli Tonk RJ 304802 IN.

Figure 47: Project Site at Dooni

National Highway 52 is at a distance of 3.5 KM Approximately from the above project site which leads to the State capital Jaipur & other cities such as Tonk & Kota.

Figure 48:Locations of Village level collection centers (VLCC), BMC, Dooni Goat milk dairy plant & Possible route Map



- There are 11 collection centers in total which comes under RACP Project area.
- Out of 11 collection centers seeing the Geographical area & Marketable surplus milk availability in total 3 Village level collection center (Sitapura, Kanwada, Bisanpura) & One integrated Village level collection center/Bulk milk collection center is Proposed.
- VLCC Kanwada is 25 Km from the Dooni Project site.
- VLCC Bisanpura is 20 Km from the Dooni Project Site
- VLCC Sitapura is 15 Km from the Dooni Project Site. This center will receive milk from Toda Ka Ghotda & allied area.
- VLCC/BMC Badoli is 30 Km from the Dooni Project site. This center will also receive milk from Thikriya, Bhanoli, Dharola & Sardarpura
- Milk from Chandsinghpura & Gulabpura will come to Dooni plant directly as distance from dooni plant is 3 Km & 10 Km respectively.

- In the above map A,B,C,D,E,F,G, H Depicts proposed Milk collection Route.

Financial Analysis:

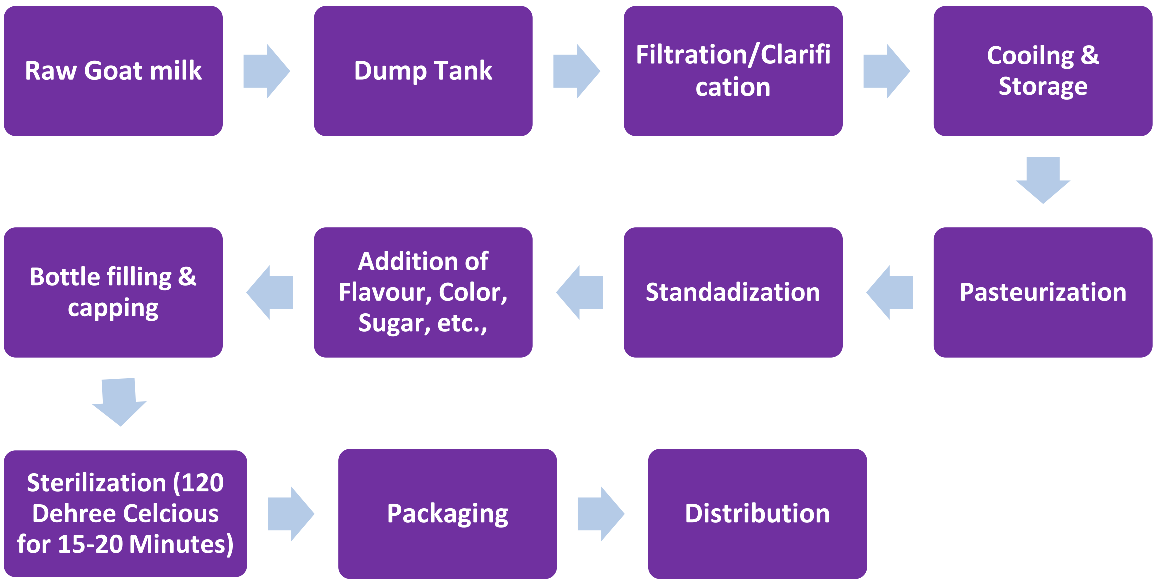
1) **Assumptions**

Table 18:Critical Assumptions

Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
YoY increase	0%	10.00%	10.00%	10.00%	10.00%
Milk availability per day (Liters)	800	880	968	1,065	1,171
No. of operation days	365	365	365	365	365
Raw material availability per year (Liters)	292,000	321,200	353,320	388,652	427,517
Product Wise Milk Distribution					
Flavored Milk (30%)	87,600	96,360.00	105,996	116,596	128,255
Cheese (65%)	189,800	208,780.00	229,658.00	252,623.80	277,886.18
Ghee (5%)	14,600	16,060	17,666	19,433	21,376
Product Obtained					
Flavored Milk (98%)	85,848.00	94,433	103,876	114,263.69	125,690.06
Cheese (10%)	18,980.00	20,878	22,966	25,262	27,788.62
Ghee (2.5%)	365.00	401.50	441.65	485.82	534.40
Skimmed Milk (95%)	13,870.00	15,257.00	16,782.70	18,460.97	20,307.07

Steps for Goat Milk Sterilization(Flavoured):

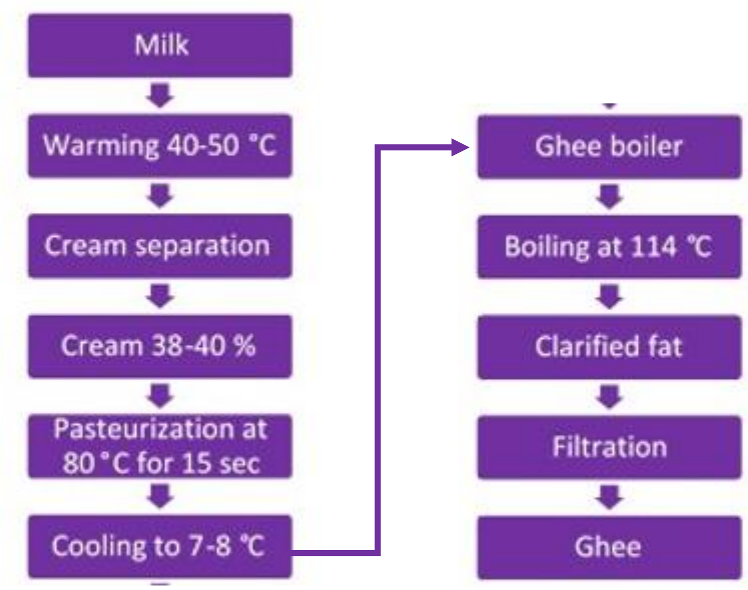
Figure 49:Steps for Goat Milk Sterilization



Steps for Manufacturing Ghee:

This is the standard method adopted in most of the organized dairies. Unsalted or white butter is used as raw material. Butter mass or butter blocks are melted at 60°C to 80°C in butter melter. Molten butter is pumped into the ghee boiler where final heating will be done using steam as heating medium. Increase the steam pressure to raise the temperature.

Figure 50:Creamery Butter Method of Ghee Preparation:



Scum which is forming on the top of the surface of the product is removed from time to time with the help of perforated ladle. Moment of disappearance of effervescence, appearance of finer air bubbles on the surface of the fat and browning of the curd particles indicates to stop heating. At this stage typical ghee aroma is produced. Final heating temperature is adjusted to about 114±2°C. To get the cooked flavour, heating beyond this temperature is also being in practice. Ghee is filtered via oil filter into the settling tank.

Steps for Manufacturing Feta Cheese:

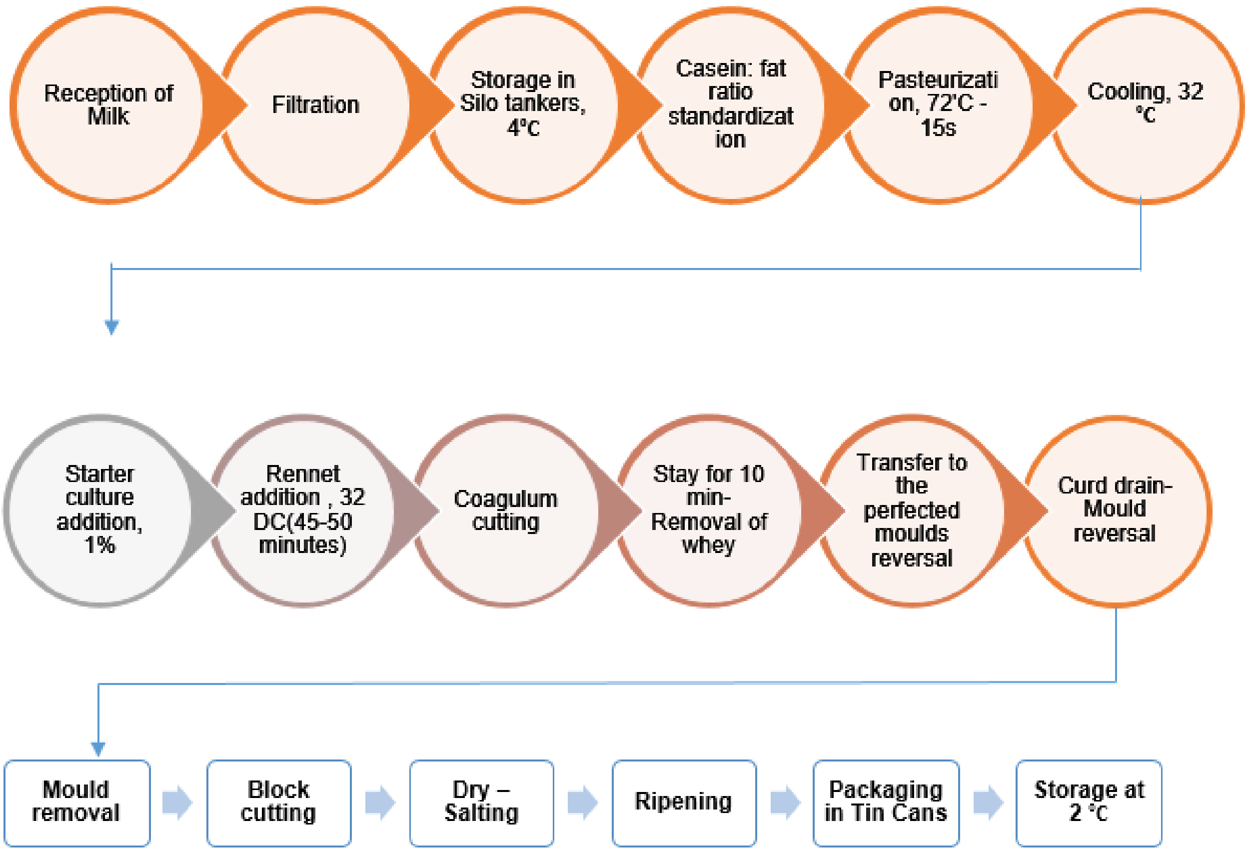
After milking, the raw milk is chilled to below 4°C and kept at this temperature during its transportation to the dairy factory. After reception, milk is filtered and stored in large silo tanks and is sampled for analyses. The milk is standardized (casein/fat = 0.7-0.8), pasteurized (72°C,15 s) and cooled down to 32°C. At this temperature, a starter culture is added and after 30 min rennet is also added and the milk is coagulated in 50-60 min.

The coagulum is cut by using a 2 cm wire knife, it stays for 10 min and is transferred in thin layers into perforated moulds. The moulds are rectangular of dimensions 23 X 23 X35 cm3. The curd is drained without pressing, until it is enough to remove the moulds. The cheese is cut into four blocks of 11 X 11 X 8 cm3.

These blocks are dry salted on the surface. After 12 hours the blocks are reversed and salted again. This is repeated until the salt content of cheese reaches 4%. After the cheese blocks have thus remained on the cheese tables for a few more days, the cheeses are packed into tin cans, containing 6- 8% salt solution and kept at 14-16°C for about 15d until they attain pH 4.6 and moisture content 55%.

The cheeses are then transferred to new containers where more brine is added and the containers are sealed and stored at 4°C. The cheeses can be consumed after two months have elapsed after manufacture.

Figure 51: Steps for manufacturing Feta Cheese



Selling Price Assumptions:

As all the product falls under exploratory market it is imperative to keep good margins for the distributors/Wholesalers/Retailers. It is proposed to sell the product through having strategic linkage with the buyers based out in major metro cities such as Nutragoat, Courtyard farms, Milk & Value added products distributors etc.,

Flavored Milk: MRP will be Rs 40 Per 200 ml glass bottles, whereas minimum selling price on B2B will be Rs 30 per bottle. Since the MRP is kept at Rs. 40 and Minimum Selling Price per bottle is Rs.30there is a margin of Rs.10 per bottle and the same may be used for offering margins to the Distributors/Wholesalers/Retailers.

Goat Milk Cheese: MRP per kg will be Rs. 1,600/Kg, whereas minimum selling price on B2B will be Rs.1100/kg. Since the MRP is kept at Rs. 1,600/Kg and minimum selling price is Rs. 1,100/Kg, there is a margin Rs.500/Kg which amounts to 45% and the same may be used for offering margins to the Distributors/Wholesalers/Retailers.

Goat Milk Ghee: MRP will be Rs. 2,000/Kg, whereas minimum selling piece on B2B will be Rs. 1,500/Kg. Since the MRP is kept at Rs. 2,000/Kg and minimum selling price is Rs. 1,500/Kg, there is a margin Rs.500/Kg which amounts to 33% and the same may be used for offering margins to the Distributors/Wholesalers/Retailers.

Skimmed Milk: MRP will be Rs.40/liter, whereas minimum selling price on B2B will be Rs.35/Liter. Since the MRP is kept at Rs. 40/liter and minimum selling price is Rs. 35/Liter, there is a margin Rs.5/Liter which amounts to 20% and the same may be used for offering margins to the local Distributors/Wholesalers/Retailers.

2) Total Project Cost

Table 19: Total Project Cost(Rs Lakhs)

#	Particular	Amount (Rs.)
1	Building	10,600,000
2	Machinery and Equipment	15,301,750
3	Furniture and Fixture	100,000
4	IT & Infrastructure	120,000
5	P&P Expenses	485,000
6	Working Capital	3,562,067
	Total	**30,168,817**

3) Means of Finance

Table 20: Means of Finance (Rs Lakhs)

Sr. No.	Particular	Amount (Rs.)
1	Own Contribution	3,016,882
2	RACP Grant	27,151,935
	Total	**30,168,817**

4) Building Cost

Table 21: Building Cost (Rs Lakhs)

Sr. No.	Particular	Unit	No. of Unit	Rate per unit (Rs.)	Amount (Rs.)
1	Building	Sq. Ft.	20000	530	10,600,000
			Total		10,600,000

- Land cost is not considered.
- Building cost will be at Rs.530/Square feet (Pre-engineered building) inclusive of GST.
- Pre-engineered Building cost is inclusive of planning, designing, manufacturing & on-site installation.

5) Plant & Machinery

Table 22: Plant & Machinery details

#	Description	No. Required	Amount (Rs.)
A	**Dock Section**		
1	Weighing Bowl, Weighment System etc. (Capacity-500 Kg)	1	300,000
			300,000
B	**Milk Processing Section**		
1	Pump SS (3000 LPH)	1	40,000
2	Separator (Capacity-3000 LPH)	1	2,000,000
3	Milk Transfer Pump (Capacity-3000 LPH)	2	80,000
4	Milk deodorizer (Capacity - 60Lt/hr.)	1	1,000,000
5	Autoclave	1	150,000
			3,270,000
	Milk Packing Section		
1	Balance Tank (Capacity-500 Liters)	1	50,000
2	SS Pump	1	40,000
3	Bottle filling machine & capping machine	1 Set	250,000

#	Description	No. Required	Amount (Rs.)
			340,000
C	**Cheese Section**		
1	Cheese Vat , triple walled rectangular vat, with rounded corners, sloping bottom, discharge valve with whey strainer and also with cutting harps & cheese shovel/spatula (500 L)	2	400,000
2	Mechanical Cheese Press, screw type press, with whey collection tray (50 Kgs)	1	40,000
3	Cheese Hoops in SS-304, 3-PC design, rectangular.(10 Kgs)	10	20,000
4	Brine Tank 500 liters, rectangular tank, self-supported, plain in SS-304 for dipping cheese blocks.(300 L)	1	30,000
5	Electronic weigh scale smart or equivalent make.(5 Kgs)	1	10,000
6	Vacuum Sealer , self-supporting , single chamber, model DZ-400 (Up to 1 kg)	1	200,000
7	Manual Sealer for heat sealing of ghee jars with pre-cut PE lined aluminum foil closing lid.	1	20,000
			720,000
D	**Ghee and butter section**		
1	Ghee Kettle (Capacity-500 Liters)	1	325,000
2	Ghee Clarifier (Capacity-1000 LPH)	1	300,000
3	Product Pumps (Capacity-500 LPH)	1	20,000
4	Ghee Storage Tank (Capacity-1000 Liters)	1	50,000
5	Tin Filling & Sealing Machine	1	25,000
			720,000
E	**Utility section**		
1	Water Softening Plant & RO Water	1	500,000
2	ETP (Capacity-10000 LPD): Machineries with Civil Construction	1	1,500,000
3	Empty Crates	500	200,000
4	SS Pipes & Fittings	1 Set	200,000
5	GI & MS Pipelines, Fittings & Installation of chilled water lines	1 Set	400,000
6	Manual Trolley	2	10,000
7	Submersible pump (Positive Pressure Pump)	1	250,000
			3,060,000
F	**Electric Section**		
1	Transformer(200KVA)/ & Metering Devices including Wiring & Paneling	1	750,000
2	Main Circuit Breaker , Automatic Power Factor Controlling Panel , Synchronizing Panel		1,450,000
G	**Cables etc.,**		200,000
H	Water Storage Tank	2	50,000
I	Automation	1	211,750
	Sub Total (A)		**2,661,750**
J	**Village level Collection Centre 1**		
1	Milk Can (Aluminum 40 Liters)	6.00	20,000

#	Description	No. Required	Amount (Rs.)
2	Milk Testing Equipment (Lacto scan)	1.00	50,000
3	Weighing Scale	1.00	10,000
4	Miscellaneous		15,000
K	**Village level Collection Centre 2**		
1	Milk Can (Aluminum 40 Liters)	6.00	20,000
2	Milk Testing Equipment (Lacto scan)	1.00	50,000
3	Weighing Scale	1.00	10,000
4	Miscellaneous		15,000
L	**Village level Collection Centre 3**		-
1	Milk Can (Aluminum 40 Liters)	6	20,000
2	Milk Testing Equipment (Lacto scan)	1.00	50,000
3	Weighing Scale	1.00	10,000
4	Miscellaneous	1.00	15,000
	Sub Total		**285,000**
M	**Bulk Milk Collection Centre**		-
1	Milk Can (Aluminum 40 Liters)	18	60,000
2	Milk Testing Equipment (Lacto scan)	1.00	50,000
3	Weighing Scale	1.00	10,000
4	Computer Set & Printers	1.00	75,000
5	Miscellaneous		25,000
	Sub Total		**145,000**
N	**Transportation and installation**		**400,000**
O	**CIP System**		200,000
P	**Existing Machineries**		3,200,000
	Total		**15,301,750**

6) List of Existing Machineries in working condition or reparable

Table 23: List of existing machineries

#	Inventory	No's/Set	Date Of Purchase	Value as on 31st March 2019 (Rs.)
1	Lacto Scan & Vibrator	1 Set	6th September 2013	11,000
2	Electronic Weighing Scale	1 Nos	6th September 2013	1,000
3	Milk Can Aluminium (40 Litres)	2 Nos	1st April 2018	4,000
4	Bulk Cooling Unit of Capacity of (5000 Litres) Positioned Near Pasteurization unit : Can work as Storage tank	1 Nos	28th December 2018	690,484

#	Inventory	No's/Set	Date Of Purchase	Value as on 31st March 2019 (Rs.)
5	Storage Tank (2000 Litres): Opposite of Pasteurization Unit	1 Nos	1st April 2018	200,000
6	Dump Tank (200 Litres): Near Main Entrance	1 Nos	NA	NA
7	Dump Tank (1000 Litres)	1 Nos	NA	NA
8	DG Set	1 Nos	1st April 2018	100,000
9	a) HTST Pasteurizer, b) Refrigeration System • Ice Bank Tank: 5.5 TR • Refrigerant Compressor: ZB95UKQE-TFD-551) c) Steam Boiler: Capacity:500 Kg/Hour d) Pouch Packing Machine: Capacity: 200 Litre/Hour	1 Set Each	13 th July 2016	2,193,516
Total Value of Inventory				**3,200,000**

7) Furniture's and fixtures

Table 24: Furniture's & Fixtures

Sr. No.	Particular	Amount (Rs.)
1	Miscellaneous fixed assets (furniture, fixtures, firefighting equipment, first-aid equipment)	100,000
Total		**100,000**

8) IT & Infrastructure

Table 25: IT & Infrastructure

Sr. No.	Particular	No. Required	Rate per unit (Rs.)	Amount (Rs.)
1	Computers	2	40,000	80,000
2	Printers	2	20,000	40,000
Total				**120,000**

9) Preliminary and Preoperative expenses

Table 26:Preliminary & Preoperative Expenses

Sr. No.	Particular	Amount (Rs.)
1	Legal Charges	60,000
2	Decommissioning and Recommissioning of existing machineries	425,000
	Total	**485,000**

10) Working capital requirement

Table 27: Working capital requirement

Sr. No.	Item	Duration	Amount (Rs.)				
			Year-I	Year-II	Year-III	Year-IV	Year-V
1	Stock Raw Material (Milk)	50 Days	1,200,000	2,376,000	2,613,600	2,874,960	3,162,456
2	Stock of packing material	8 days	60,608	73,262	88,182	105,730	126,318
3	Trade receivables	15 days	1,429,650	1,622,140	1,838,831	2,082,639	2,356,820
4	Stock finished goods	6 days	571,860	648,856	735,532	833,056	942,728
5	Creditors - raw material	12 days	288,000	316,800	348,480	383,328	421,661
Working Capital Requirement			**3,562,067**	**5,050,202**	**5,639,084**	**6,295,617**	**7,027,478**

11) Revenue Schedule

Table 28:Revenue Schedule

Particular	Unit Price (Rs.)	Year-I	Year-II	Year-III	Year-IV	Year-V
Flavoured Milk (200 ml Glass Bottle Each)	30	12,877,200	14,164,920	15,581,412	17,139,553	18,853,509
Cheese	1100 Per Kg	20,878,000	24,114,090	27,788,618	31,956,911	36,680,976
Ghee	1500 Kg	547,500	632,363	728,723	838,031	961,914
Skimmed Milk	35 Per Litre	485,450	560,695	646,134	743,054	852,897
Total		**34,788,150**	**39,472,067**	**44,744,886**	**50,677,549**	**57,349,295**

12) Operational Expenses

Table 29: Operational Expenses

#	Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
A.	**Fixed**					
`	Administration Expense/Consultants	1,200,000	1,260,000	1,320,000	1,380,000	1,440,000
	Repair and Maintenance (0.5% @ P&M and Civil)	1,135,087	1,191,842	1,248,596	1,305,351	1,362,105
	Insurance (@ 2% of P&M)	242,035	254,137	266,238	278,340	290,442
	Electricity Charges	396,000	415,800	435,600	455,400	475,200
	Indirect Employees	2,215,000	2,325,750	2,558,325	2,942,074	3,530,489
	Sub-Total	**5,188,122**	**5,447,529**	**5,828,760**	**6,361,165**	**7,098,235**
B	**Variable Cost**					
	Raw Milk - Goat Milk (INR 25 per litre)	8,760,000	9,636,000	10,599,600	11,659,560	12,825,516
	Consumables					
	Grease/ Oil (3000 kg per month @ INR 300 per kg)	216,000	226,800	237,600	248,400	259,200
	Salt/Additives/Bacteria Cultures (INR 1.5 per litre of Milk: Cheese)	189,800	219,219	252,624	290,517	333,463
	Flavouring Agent Cost	42,924	49,577	57,132	65,702	75,414
	Fuel Charges (10500 kg per day @ INR 3.5 per kg)	290,759	319,835	351,818	387,000	425,700
	Electricity Charges - Variable (60 Units @ INR 5.5 per hour @ 8hours per day)	1,226,400	1,287,720	1,349,040	1,410,360	1,471,680
	Water Charges (5,000 Litre water @ INR 0.05 per litre per day)	730,000	766,500	803,000	839,500	876,000
	Advertisement and Sales Expense	3,500,000	3,675,000	3,850,000	4,025,000	4,200,000
	Packaging Cost - Flavoured Milk	2,575,440	3,123,365	3,770,702	4,533,412	5,429,810

#	Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
	Packaging Cost - Cheese	189,800	219,219	252,624	290,517	333,463
	Packaging cost Ghee	18,250	21,079	24,291	27,934	32,064
	Packaging cost Skimmed milk	6,935	8,010	9,230	10,615	12,184
	Transportation - Raw Milk (INR 1.25 per litre of raw milk procured)	365,000	421,575	485,815	558,687	641,276
	Transportation - Milk Product (INR 2.5 per litre/ kg of product sold)	416721	481312	554655	637853	732145
	Sub-Total	18,528,029	20,455,211	22,598,131	24,985,058	27,647,916
	Total	23,716,151	25,902,739	28,426,891	31,346,223	34,746,151

13) Profit and Loss Statement

Table 30: Profit and Loss Statement

Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
Milk products	34,788,150	39,472,067	44,744,886	50,677,549	57,349,295
Total Revenue	**34,788,150**	**39,472,067**	**44,744,886**	**50,677,549**	**57,349,295**
Fixed Cost	5,188,122	5,447,529	5,828,760	6,361,165	7,098,235
Variable Cost	18,528,029	20,455,211	22,598,131	24,985,058	27,647,916
Total Operational Expenses	**23,716,151**	**25,902,739**	**28,426,891**	**31,346,223**	**34,746,151**
Earnings Before Interest, Depreciation, Taxes and Amortization (EBITDA)	**11,071,999**	**13,569,328**	**16,317,996**	**19,331,326**	**22,603,143**
Depreciation	2,082,175	2,082,175	2,082,175	2,082,175	2,082,175
Amortization	97,000	97,000	97,000	97,000	97,000
Earnings Before Interest and Taxes (EBIT)	**8,892,824**	**11,390,153**	**14,138,821**	**17,152,151**	**20,423,968**
Interest Expense	-	-	-	-	-
Earnings Before Taxes (EBT)	**8,892,824**	**11,390,153**	**14,138,821**	**17,152,151**	**20,423,968**
Tax	-	-	-	-	-
Earnings After Taxes (EAT)	**8,892,824**	**11,390,153**	**14,138,821**	**17,152,151**	**20,423,968**
Profit (loss) carried to Balance Sheet	**8,892,824**	**11,390,153**	**14,138,821**	**17,152,151**	**20,423,968**

14) Cash Flow statement

Table 31: Cash Flow Statement

Sr.	Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
1	**Revenue**					
	Total Revenue	34,788,150	39,472,067	44,744,886	50,677,549	57,349,295
2	**Equity/ Share capital**	3,016,882	-	-	-	-
3	**Grant**	27,151,935	-	-	-	-
4	**Long Term Loan**	-	-	-	-	-
5	**Short Term Loan**	-	-	-	-	-
4	**Amortization**	97,000	97,000	97,000	97,000	97,000
5	**Depreciation**	2,082,175	2,082,175	2,082,175	2,082,175	2,082,175
	Sub Total (A)	**67,136,142**	**41,651,242**	**46,924,061**	**52,856,724**	**59,528,470**
	Cash Outflow (Rs.)					
1	**Capital Expenditure**					
a	Furniture and Fixtures	100,000	-	-	-	-

Sr.	Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
b	IT and Infrastructure	120,000	-	-	-	-
c	Land and Building	10,600,000	-	-	-	-
d	Plant and Machinery	15,301,750	-	-	-	-
e	Preliminary Expenses	485,000	-	-	-	-
2	**Operational Expenditure**					
a	Fixed Cost	7,367,297	7,626,704	8,007,935	8,540,340	9,277,410
b	Variable Cost	18,528,029	20,455,211	22,598,131	24,985,058	27,647,916
3	**Loan**					
	LTL - Principal	-	-	-	-	-
	LTL - Interest	-	-	-	-	-
	STL - Principal	-	-	-	-	-
	STL - Interest	-	-	-	-	-
4	**Dividend**					
5	**Tax**	-	-	-	-	-
	Sub Total (B)	**52,502,076**	**28,081,914**	**30,606,065**	**33,525,398**	**36,925,326**
	Net Cash Flow (A-B)	**14,634,066**	**13,569,328**	**16,317,996**	**19,331,326**	**22,603,143**
	Opening Cash and Bank		14,634,066	28,203,394	44,521,390	63,852,716
	Cumulative Cash Balance	**14,634,066**	**28,203,394**	**44,521,390**	**63,852,716**	**86,455,859**

15) Balance Sheet

Table 32: Balance Sheet

Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
ASSETS					
Current Assets					
Cash and Bank Balance	**14,634,066**	**28,203,394**	**44,521,390**	**63,852,716**	**86,455,859**
Accounts Receivables	0	0	0	0	0
Other Current Assets					
Total Current Assets	**14,634,066**	**28,203,394**	**44,521,390**	**63,852,716**	**86,455,859**
Gross Fixed Assets	26,121,750	24,039,575	21,957,400	19,875,225	17,793,050
Less: Depreciation	2,082,175	2,082,175	2,082,175	2,082,175	2,082,175
Net Fixed Assets	**24,039,575**	**21,957,400**	**19,875,225**	**17,793,050**	**15,710,875**
Preliminary Expenses	**388,000**	**291,000**	**194,000**	**97,000**	**0**
TOTAL ASSETS	**39,061,641**	**50,451,794**	**64,590,615**	**81,742,766**	**102,166,734**
LIABILITIES & SHAREHOLDERS EQUITY					
CURRENT LIABILITIES					
Short Term Debt (Working capital loan)	-	-	-	-	-
Accounts Payable & Accrued Expenses	-	-	-	-	-
Other Current Liabilities	-	-	-	-	-

Particulars	Year-I	Year-II	Year-III	Year-IV	Year-V
Total Current Liabilities	-	-	-	-	-
Long Term Debt	-	-	-	-	-
Differed Tax Liabilities	-	-	-	-	-
TOTAL LIABILITIES					
Share capital	3,016,882	3,016,882	3,016,882	3,016,882	3,016,882
RACP Grant	27,151,935	27,151,935	27,151,935	27,151,935	27,151,935
Reserves and Surplus					
Add: Opening Balance (P/L Account)	0	8,892,824	20,282,977	34,421,798	51,573,949
Profit & Loss) During the Year	8,892,824	11,390,153	14,138,821	17,152,151	20,423,968
Appropriation - Dividend					
Total Reserves	8,892,824	20,282,977	34,421,798	51,573,949	71,997,917
TOTAL EQUITY	**39,061,641**	**50,451,794**	**64,590,615**	**81,742,766**	**102,166,734**
TOTAL LIABILITIES & EQUITY	**39,061,641**	**50,451,794**	**64,590,615**	**81,742,766**	**102,166,734**

16) Financial indicators

The feasibility analysis is summarily presented below in the form of estimates. The indicators validate the sustainability potential of the proposed project.

Table 33: Financial Indicators

#	Particulars	Value	Inference	Acceptable range of the indicators
2	Internal Rate of Return (IRR)	39.73%	Project Viable	>15%
4	Payback period	2.44 years	With grant-in-aid assistance from RACP	< 5 years

Grant Thornton
An instinct for growth