A Study of a Dairy Plant – Issues and Constraints

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Abstract : A study of workings of High Range Dairy Cooperative Society. The study included understanding procurement, logistics, processing, inventory, quality control, human resource management and distribution. Further potential improvement suggestions were made.

IndexTerms **-Logistics, Quality Control, Procurement, Inventory, Manufacturing, Human Resource Management.**

I. INTRODUCTION

India has been the largest producer and consumer of milk since 1998. The dairy Industry of India provides livelihood for 70 million households. Dairy industry plays a vital role in enriching the socio-economic status of rural India and the empowerment of women. The production of milk and its value adding activities such as the processing, marketing and distribution of milk create employment opportunities for the society. India has always propagated the production by masses rather than mass production. In 2017, the average herd size in the U.S. was 191, 148 in the U.K., 160 in Denmark, while it was 2 in India. The milk production per bovine is also significantly low. India is home to the largest livestock population in India. India is contributing 30.7% of the cattle inventory to the world (cattle herd including buffaloes). Moreover, almost all the dairy produce is consumed domestically.

Dairy development in India is attributed to be the most successful developmental program. The dairy sector has come to be this successful due to the successful implementation of the White Revolution or "Operation Flood" in 1970. This initiative promoted the Anand Pattern of dairy cooperatives, focusing on the increase in quality of life of milk producers and providing quality milk and dairy products to consumers at reasonable rate in a free market environment. The initiative helped better the cooperative path, modernized dairy farms, milk production, processing and marketing progressed significantly. Private participation in the dairy sector has also increased significantly, attracted by the size and potential of the dairy sector in India.

Dairy industry has been changing worldwide due to concerns over sustainability, consumers demand and greater efficiency requirements. The major drivers of livestock products are economic growth, population growth and urbanization. Thus, the dairy demand in Asian countries have been increasing rapidly. Consequently, in developed nations, demand for healthy and nutritious foods and increased shelf life has significantly increased. As demand for dairy products is increasing worldwide, the dairy sector is looking at innovative methods and solutions to meet this current trends and improved value additions.

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1.1COMPANY BRIEF

The High Range Dairy Co-operative Society began in 1973. It started with very few members collecting milk from local farms and selling it locally. The milk that was leftover was sold to Milma Dairy. Around 1980's when they were collecting more milk than they could sell and when Milma wasn't able to collect all the milk leftover from sales they setup a chilling center in Anachal. By 1999, when Milma was not able to handle the surplus of the High Range Dairy, they decided to set up their own processing center.

They have around 20 collection centers distributed around Vellathooval Panchayat of the Idukki district in Kerala. They also have local farms selling their milk to High Range Dairy. Per day sale averages at 10000 l – 12000 l due to the impact of COVID-19. It had come down to 6000 l at a point. Before the pandemic lockdown, the dairy docked per day sales at an average of 16000 l-18000 l. Their products include milk, curd, ghee, order-based production for paneer and seasonal production of Sambharam which is a drink served in the summer season. They distribute mainly to 3 districts in Kerala, which are Idukki, Ernakulam, and Kottayam.

Now there are around 5000 members who are the primary milk suppliers and farmers associated with High Range Dairy. They become the member the first time they give the milk from their farm to the respective collection centers. It takes about a week for the processing of the membership. Every time they supply milk a certain rate from the milk supplied is taken as a share in the total stake of the society. The annual meeting of the stake holders is conducted in July in which the dividends, the subsidies and benefits for the shareholders, the government initiatives, the plan for the year ahead are all discussed

II. RESEARCH OBJECTIVE

The main objective is to study the supply chain processes and observe the issues and constraints of the dairy plants. The research project will do a detail study on the following topics.

1. To study the process used for the procurement and storage of raw materials and the production in a dairy plant.
2. To study and optimize the use of human resource in the plant.
3. To understand the techniques used to maintain quality and additional techniques which can be implemented to increase quality.
4. To increase the cost effectiveness of the dairy plant.
5. To observe the factory layout and to propose changes in the layout to optimize production.
6. To observe the logistics activities and to propose methods to optimize it.

III. LIMITATIONS

The limitations faced during the research were:

- Due to the impact of COVID-19 pandemic, the research had its constraints due to the lockdown and social distancing aspects.

- The reliability of research depends upon the information furnished by the officials.
- Due to time constraints and the lockdown it was difficult to go into details of the organization.
- The study is limited to a period of 2 months.
- The study is exclusively done on the activities of High Range Dairy Cooperative.

IV. RESEARCH METHODOLOGY

4.1 SAMPLING

4.1.1 Population

The population is all the dairy products associated with High Range Dairy Cooperative mainly milk.

4.1.2 Sampling Size

The sample for the study would be limited to the production and processes from 20th April to 20th June.

4.2 TOOLS FOR DATA COLLECTION

4.2.1 Primary Data

It is collected through personal interviews with the stake holders of the company like plant supervisor, plant workers, technicians, and the administrative employees. Interviews were also conducted with Anand Pattern of Cooperatives members to study the dairy industry in detail.

4.2.2 Secondary Data

Secondary data collection was mostly done through extensive study and review of research papers journals and articles related to the environment of research.

4.3 DATA ANALYSIS TOOLS

Data analysis was done using following tools,

4.3.1 Machinery efficiency

The boiler and chiller efficiencies were calculated to understand the how efficient the system was and how it could be bettered.

4.3.2 Costing

The different cost associated with production processes were noted to understand the cost breakdown with a production of a liter.

4.3.3 Time study

Time study of a plant worker was conducted to understand the efficiency of the human resource model incorporated in the plant.

V. THEORETICAL BACKGROUND

5.1 SUPPLY CHAIN MANAGEMENT

Supply Chain Management (SCM) is a rapidly evolving area of interest and practices both for industries and academicians. A crucial issue in SCM is coordinating the external and internal activities of the firm. Creating and implementing a responsive supply chain is critical in identifying and responding to the customer's needs. The supply chain not only includes manufacturers and suppliers but also retailers and customers. A supply chain is an integrated system wherein several business entities work together to address both materials flow and information flow. The important activities linked to the chain are logistics, supply chain strategy, supply chain planning, supply chain enterprises application, asset management, procurement, and product life cycle management. The effective integration of these activities in a systematic management leads to an efficient supply chain practice.

Operating processes of the supply chain could be described in five following steps (Juliana Hsuan, 2015, pp. 25-27):

1. Demand management (activities related to market such as forecasting customer service market coordination)
2. Distribution (connects production to the market)
3. Production (Influences inventory, transport, and time for delivery)
4. Procurement (Links stages of manufacturing together)
5. Returns (Closes the supply chain loop)

Agricultural research interest has increasingly been leaning towards supply chain management to incorporate the effects of rapid globalization, shifting consumer demand, dismantling state support schemes and technological progress. Firms no longer can depend on independent supply chain entities to have a competitive edge in the market. The food supply chain encompasses the organization that produce and distributes vegetables and animal-based products. Food supply chain networks are complex and require strategic collaborations to ensure an efficient system. Therefore, the SCM literature focuses on the successful collaboration among stakeholders of the supply chain like producers to end consumers to gain maximum satisfaction. Animal husbandry, fishing and dairying are some of the allied sectors which are contributing along with agriculture since many centuries.

The cold supply chain is the way of distribution of goods in a controlled temperature, including the transport as well as the storage. The cold chain mainly concerns the transport of food, pharmaceutical and chemical products. These products require to be handled in a controlled environment, i.e. handled in a strict specified temperature range. The cold chain management focuses on three key factors – product properties, origin, and destination the product and distribution channels. Interactions of the three key factors enable the description of cold supply chain. Most of the products transported in cold supply chain are highly temperature sensitive, any damage during transportation or handling may lead to the loss of quality and loss of market demand.

Dairy supply chain comprises of six core activities- production, transportation, processing, packaging, storage, and consumption. It is required to design and synchronize these activities to create an efficient, hygienic, and economic dairy supply chain. Due to high perishability of dairy products special treatments are implemented like cooling mechanisms, handling and quick actions starting from procurement to distribution to retail. Quality management seems to be the most important factor in dairy industry followed by inventory management, supplier management and technological innovations. While performing the milk supply chain management, storage is also a critical issue and challenge for producer. Storage of the raw milk can affect the quality,

yield, sensory values, and shelf life derived dairy products Supply chain practices is linked with milk quality, brand loyalty, customer demand and brand image.

The key challenges that the dairy supply chain faces are,

- Effective information systems
- Perishable nature of dairy products
- Traceability of quality related issues
- High risk of milk adulteration/contamination
- Effectiveness of cold chain
- High demand fluctuations
- Logistics, road infrastructure and transportation

5.2 LOGISTICS MANAGEMENT

Logistics is usually known as the process of coordinating and moving resources from source storage to destination storage. Resources include everything including equipment, food, inventory, materials, people etc. In the supply chain and business sense, it is the flow of things between point of origin and consumption, to fulfill the requirement of consumers or corporations.

A few of the different categories in logistics include:

- Third party logistics
- Fourth party logistics
- Inbound logistics
- Outbound logistics
- Reverse logistics

Logistics management focuses on the efficient and effective management of daily activities regarding the production of the company's goods and services. The management focuses on the planning, implementation and control of forward, and reverse flow and storage of goods. Effective logistical processes are important reduce cost and maintain and increase productivity. Substandard logistics will lead to late deliveries, failure to meet customer demands, finally leading to the crumble of business.

The different types logistics management are:

1. Supply Logistics: It deals with the planning and coordination of the materials needed at a specific time and location to help with the production or related activities. Supply logistics deals with the transportation, storage and the plans required to evaluate the level of supply, to make sure the flow of materials aligns with need.
2. Distribution Logistics: It deals with managing the supplied and stored goods that needs to be sent to the required locations for either further processing or retail.
3. Production Logistics: This type of logistics oversees the stages of combining distributed supplies into the product. It deals with the coordination of manufacturing and assembly processes.
4. Reverse logistics: Reverse logistics deals with the recalling of materials and goods from a production process. It also means the recalling of goods from market due to damage and low quality.
5. Inbound Logistics: It focuses on transportation and storage of goods and supplies coming into the company or plant. It usually deals with relation between the company and suppliers.
6. Outbound Logistics: It focuses on the transportation and storage of goods going out of the company and plant. It usually deals with relation between the company and retailers and customers.

As demand for milk and dairy related products are increasing considerably, the logistical activities are increasing along with it. Dairy products have a lifetime of production, transportation, and warehousing. The main processes include:

1. Collecting the milk
2. Warehousing it in the dairy plant
3. Distributing it to retailer and sale to customer

As discussed earlier dairy products require a specially conditioned journey owing to its highly perishable nature. The temperature sensitive system will create the necessary environment but will necessitate timing and cost.

Implementation of dairy logistics need to include key issues like:

- Short Shelf-life
- Quality
- Cooling and temperature
- Time and distance
- Humidity
- Cost
- Meeting demand

The transportation of fresh milk requires more interest than the processed milk. The three main ways to transport fresh includes

- Un-cooled vehicles
- Insulated vehicles
- Cold storage vehicles
- Milk tankers

The milk can be brought to the dairy plant in three different ways:

- Cooled collection centers
- Un-cooled collection storage
- Farmers bringing milk directly to the plant.

There are three different transportation strategies used:

- Warehousing
- Direct shipment
- Cross docking.

Cross Docking is the new method used worldwide. The method is just like warehousing, but the storage period is much less, ranging from a few hours to a maximum of a day. Owing to the perishability of dairy products direct shipment and cross docking is usually used. These methods are also cheaper considering traditional warehousing method. But when considering UHT milks and dairy products with larger shell life warehousing is also used.

For further distribution companies use self-transportation, third party logistics and fourth party logistics. They employ 3rd and 4th parties on commission basis. To meet the increasing demand and increase in product variety a mixture of all these methods and practices are carried out worldwide.

5.3 TOTAL QUALITY MANAGEMENT

Total quality management (TQM) can be described as system of management based on the principle that every member of the organization should commit to maintain high standards of work in every aspect of company's operations.

The 8 principles of TQM are:

1. Customer-focused: The customer ultimately establishes the level of quality. No matter what the organization does to increase quality, it is the customer who decides if the efforts were worthwhile.
2. Total employee involvement: It requires the total involvement of the employees, i.e. all employees work towards a common goal. Employee commitment can be guaranteed only once the employees are empowered, and after the management provides the proper working environment.
3. Process-centered: A fundamental part of TQM is focusing on process thinking. The steps required to carry out the processes are defined, and performance measures are continuously monitored to avoid fluctuations.
4. Integrated systems: An organization contains various departments with multiple functionalities into a vertical structure, integrating these processes efficiently is an integral part of TQM.
5. Strategic and systematic approach: The process, called strategic planning and strategic management to include a plan to integrate quality as the core.
6. Continual Improvement: A large part of TQM is continual process improvement. It is to find new methods analytically and creatively to better processes to become more competitive.
7. Fact-based decision-making TQM requires organizations to continually collect data and analyze data to improve decision making accuracy, achieve consensus and allow prediction based on history.
8. Communications: Effective communications plays large part in increasing production, increasing morale and in motivating employees at all levels.

Food safety and quality are a rising concern all over the world especially regarding human health. Food safety is a scientific dealing with handling, processing, and storage of it in a manner to prevent food borne illness. As mentioned earlier, quality assurance is all about critically planned and systematic activities implemented within all segment of the quality system, and concealed as needed, to provide satisfactory confidence that a certain food item will meet the required requirements. Wide range of food borne illness can be controlled by routine activities like keeping personal hygiene, proper processing of the food, heat treatment, cooking before consumption and storing the food at temperature where bacteria cannot grow. Most developing countries already have a food control system in place, usually based on hygiene and adulteration/fraud inspection.

Milk can show large quality differences, that processers need to consider. The two main types of criteria used for paying by quality are physio-chemical and bacteriological. Physio-chemical criteria usually relates to the fat and protein content. Testing for better bacteriological quality is the second criteria. Similarly, the presence of antibiotics and the temperature of milk during collecting can be used as quality criteria and for price reduction. In addition, the presence of chemical residues could alter the process of milk production and deriving dairy by-products.

Different and innovative new methods are used in the production of milk and milk products, the application of different heat treatment processes and or temperature control (cooling, freezing) are critical for maintaining the milk products at required quality standards. Collected milk must be kept in cold chain for protection of milk nutrient composition until it reaches the consumer. Therefore, the pathogen microorganisms are gotten rid of, while maintaining the nutritional value of milk with applied heat treatment. To avoid cross contamination, strict rules for cleaning and disinfecting are applied. Milk tankers and vehicles used for transportation to need to be cleaned and disinfected to avoid contamination. Discharging areas must have adequate drainage and should be easily rinsed to avoid accumulation of water and milk residue. Pipes and fluid transmissions inside the plant also need to be thoroughly cleaned and disinfected.

The two different types of heat treatment processes used by different countries are Pasteurization and Ultra high temperature process. Out of which pasteurization milk is largest milk being sold worldwide. The objective of both these processes is to ensure safety of fluid milk by killing pathogens. The pasteurization process is when the milk is heated to a temperature of 73º C and then cooled down to below 5º C rapidly. The Ultra high temperature process heats the milk to 123º C and then allowed to cool down to room temperature. Pasteurized milk needs to be further stored in cold chain, while UHT milk can be stored in ambient temperatures. UHT milk also has larger shelf life than pasteurized milk, i.e. UHT milk can be stored up to 1 month to 1 Year while the life pasteurized milk varies from 2 days to a week maximum. But the pasteurized process is cheaper process compared to UHT process and it is also argued that milk, when treated through UHT processes, loses its nutritional values.

The main quality management system used in dairy industry is the Hazard Analysis and Critical control point (HACCP), which is a systematic method, preventive and science based, for which the priority is identification of Hazards or risks and the management of it. A critical control point (CCP) is "a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level". The important words in this definition are prevent (to keep from happening), eliminate (to get rid of), and reduce (to bring down). A CCP requires:

- establishing critical limit(s) for criterion separating acceptability from unacceptability,
- validating the critical limit(s),
- making the measurements that are needed to monitor criterion and timely detect deviations (Cerf and Donnat 2011).

On record, the raw milk should be subjected to the following tests for quality assessments:

- measurement of pH value and of titratable acidity
- tests for sediment and antibiotic residues

- measurement of temperature, which should not exceed 10°C
- determination of its microbiological quality through validated rapid methods
- determination of its composition
- tests to ensure that milk has not been adulterated
- somatic cell count.

Some of the common test that occur throughout the processing of milk are:

1. Milkoscan: The milkoscan or lactoscan machine reads the required contents of the milk. It gives the reading for fat, proteins, Non-fat solids (SNF), Lactose, water content density and temperature among other contents.
2. Organoleptic test: It is a sensory based test. The grader uses his sense of sight, smell, and taste to detect the quality of milk.
3. Clot on boiling test: It is a test to detect whether the milk is too acidic or abnormal. A sample of 5ml is taken in a test tube and heated over a burner for 5 mins. If there is coating or coagulation in the test tube, then the sample has failed.
4. Acidity test: Bacteria that normally grow in raw milk produce ferment lactose and produce lactic acid. In the acidity test, lactic acid is neutralized with 0.1N solution of sodium hydroxide. The amount of sodium hydroxide is measured and from this amount, percentage of lactic acid is calculated.
5. Tests for adulterants like sugar cane, urea, formalin, hydrogen peroxide, sodium bi-carbonate, starch, soaps/detergents, sodium chloride. These products are added with raw milk to either increase its SNF content or total density. The presence of these adulterants can affect the final quality of milk and dairy products. Therefore, it is necessary to detect these and reject these milks.
6. Tests to detect the somatic cell count in the milk is also found out. The normal method is detecting through microscope.

5.4 INVENTORY

Inventory management can be defined as the management of non-capitalized asset, or inventory, and stock items. As a component of Supply chain management, it supervises the flow of goods from manufacturers to warehouses and from these point to sales. An important function of the inventory management is to keep a detailed record of every product as it enters or leaves a warehouse or point of sale.

Five basic reasons for keeping inventory:

1. Time: To overcome the constraints due to the lead time present in the supply chain, i.e. from the supplier to end user.
2. Seasonal demand: When and demand is seasonal, and production is fixed maintaining an inventory can help overcome this constraint.
3. Uncertainty: Inventories are maintained to s buffers for uncertainty of demand, supply and flow of goods.
4. Economies of scale: Though the Just in Time is ideal for a business, i.e. supplying the right amount at the right time, it can incur a lot of logistical costs. Hence, bulk buying, storing and movements brings in economies of scale.
5. Appreciation of value: In some business, stocking the product for a given time helps appreciate the value of the product. Examples like, alcoholic beverages, pickles, jams etc.

An inventory includes:

- Raw materials
- Work in progress goods
- Finished goods
- Goods for resale – that is goods that were returned but are in salable condition.
- Stocks in transit
- Consignment stock
- Maintenance supply

Some of the costs associated with inventory are:

- Ordering cost
- Setup cost
- Holding cost
- Shortage cost

Some widely used inventory management techniques are:

1. FIFO and LIFO: First in and first out (FIFO) assumes older inventory is sold first. While Last in First out (LIFO) assumes the latest inventory is sold first.
2. JIT: Just in time inventory is the technique where the right amount of product, goods or material is supplied at the required time. It is a technique to reduce inventory costs.
3. Economic order quantity: A formula for the ideal order quantity a company needs to purchase for its inventory. Overall goal of EOQ is to minimize related costs.
4. Reorder point formula: It is a technique that bases on the company's own purchase and sales cycles
5. Batch tracking: It is quality control inventory management technique wherein users keep track of the expiration of inventory or trace defective items back to their original batches.
6. Dropshipping: It is an inventory management fulfillment method in which a store does not keep the stock that it sells. When the store makes a sale, instead of picking from their own inventory they purchase from a third party and have it shipped.

5.4.1 Warehousing principles

A warehouse is building that a company uses for storing its inventory. The usually have loading docks for loading and unloading. They usually have cranes and forklifts are in-house logistical appliances, which are used to move inventory. They are stored or stacked using ISO standard pallets loaded into pallet racks.

The dairy industry uses cold storages. It helps in maintaining the cold chain aspect of dairy industries. The cold storages are usually ammonia or freon based refrigerants. But since ammonia is being the more environmentally suitable option, companies are

leaning more towards ammonia-based refrigerant. Dairy plants also have storage facilities for maintenance supply and packaging supply.

The most popular storage systems used are:

- Block stocking
- Pallet racking
- Cantilever racking
- Mezzanine
- Horizontal and vertical carousels
- Vertical lift modules

Warehouses today are increasingly moving towards automations. Pallets and product move on a system of automated conveyers, cranes and automated storage and retrieval systems programmed by logic controller and computers.

VI. ENVIRONMENT OF RESEARCH

6.1 PRODUCTION PROCESS

The moment the milk cannisters arrive at the plant, a lab technician does the primary test, the organoleptic test, i.e. the sensory based test that checks if there is a variation in the color of the milk, smell, or taste. Then a sample of the collective milk is taken for the cot on boiling test. This test tells us if the milk is too acidic or abnormal. Then a sample is taken to the Milkoscan to check for the contents of the milk, i.e. fat, SNF, proteins, lactose, and water content. The milk is required to maintain a fat percentage of 3% and Non-fat Solid or SNF percentage 8.5%. The milk that is received do not necessarily have these requirements. The fat percentage in the collected milk is usually at around 3.8% while the SNF percentage is usually around 8%. The milk is then poured into weighing balls that measure the amount of milk poured. After measuring the weight, the milk is released into the drop tank attached to the weighing balls. When the tank reaches the 3000L mark it releases the milk into the balancing tank. The deficit SNF is calculated and the required quantity is added by adding SNF powder through the funnel.

The balancing tank helps to maintain a cool temperature of the milk. From the balancing tank it moves in to pasteurizing machine. The pasteurizing machine is basically a Plate heat exchanging machine with medium for heat exchange being water. The pasteurizing process is first heating the milk to 73ºC then cooling it rapidly to below 5ºC. The machine is calibrated to the heating and cooling temperatures before the process then begins. The milk flows into the centrifugal tank. The excess fat percentage is removed in centrifugal process. The removed fat is what is then used for the making Ghee. The fat content can be maintained above 3% but the MRP structure provided includes the rate for 3% and the excess fat percentage becomes a loss for dairy. Hence it is recovered by selling the byproducts like ghee and paneer. But the percentage of SNF needs to be maintained at or above 8.5% as is the government standard for the milk to be sold. The milk after skimmed is released back into the chilling section of the PHE machine to chill the milk back to 5ºC. This processed milk is then released into the insulated tanks.

They produce 3 different types of milk- Toned, homogenous and double toned. Toned milk is the normal process. Homogenous Milk is the type of milk that has its fat molecules homogenously distributed into the milk. It occurs more thicker and does not create that layer of fat when heated. Double toned milk is skimmed for health-conscious individuals. The homogenous milk undergoes a further process inside the homogenization machine after pasteurizing and the double toned undergoes further fat removal process in the centrifugal tank.

A sample of the pasteurized milk is taken for secondary tests. The secondary test include test for acidity, contamination, life, and overall quality. When favorable results are obtained for the pasteurized milk, the milk is then proceeded to the packaging process. The milk from the tank is pumped into an overhead tank above the packaging unit. The packaging unit has three outlets in total. The milk is packed into half liter packets as High Range Dairy only sells half liter packets. The packets are stacked into milk crates. Each crate holds 30 packets. These stacks are stacked 30 at a time and then stored in the cold storage unit to be distributed later.

The total time taken by the pasteurizer to process 3000L of milk is 1 hour and the packaging process takes 50 minutes for packaging the 3000L. The total process including the primary test and secondary takes about 2 hours and 10 minutes. The total cycle time for one liter of milk to be processed and packed is 7 minutes.

The fat skimmed out in the centrifugal tanks are then used to make ghee. Both processes are manual. Traditional methods are used to produce curd, ghee, and paneer. For curd the required milk is taken in cannisters mixed with the required amount of curd and stored for the milk to be turned into curd. The ratio of milk to curd is 125 ml (half a cup) of curd for 2 liters of milk is used to make curd out of the milk. To produce ghee, the fat content is poured into big vessel over a wooden stove and heated till the fat content turns into ghee. For paneer milk is taken in a vessel and lemon juice is added to the milk and heated until the milk curdles. It is then poured onto a cheese cloth and the excess water is pressed out and stored under pressure. High range dairy uses traditional method as they believe it gives a very homely taste to their products.

6.1.1 QUALITY CONTROL

Milk is a product that has overly sensitive quality features. A remarkably high standard of quality measures needs to be undertaken to maintain quality milk. The process undergoes mainly two standard quality tests. The primary tests involve the organoleptic test and cot on boiling test. The whole process is also required to go rigorous hygienic and cleanliness processes to avoid exposure and contamination from the adulterants and contaminants.

After the complete production process of the milk the machineries undergo immediate sanitization process. The sanitization of the machinery occurs in three process,

1. The first run is done by passing a water and nitric acid mix through the machinery as the initial wash
2. The second run is done by passing a mixture of caustic soda and water as a cleaning agent and to neutralize any remnant acid in the machinery.
3. The third run is done with boiling water to finally wash out all cleaning agents and clean the machinery.

Before the process begins the machinery is again washed with hot water to sanitize the machinery.

The color of the milk is first noted for any deviation. Then the milk is tested by taking a whiff of the sample of milk, If it smells in deviation of the required standard it is rejected, If it does not smell bad it is then tasted, If it tastes in deviation of the standard it

is rejected, If it does not taste bad it is then tested by heating a small sample in the test tube, If the milk does not break off or curdle the milk is accepted for processing.

The second test occurs after the pasteurizing process. The milk is tested for the life, quality, and acidity of the milk. The milk is also checked if it maintains the required temperature of 5º C, if not the milk is further circulated in the balancing tank so that it reaches the favorable temperature.

For the sake of quality control, the whole process from the input of the milk into the weighing ball to the output, which is the packaging process, is maintained airtight and at a temperature of 5ºC. Even when sample is taken it is taken from a tap to maintain any exposure of milk with outside world. The whole pipelines that transfer the milk among machines are also insulated like the storage tanks to avoid leakage or exposure and maintain the milk in cold temperature.

At dispatching point to measure the life and quality of the milk that is two days, two packets from the dispatching batch is taken out and stored and checked on the first and second days to check the life.

6.1.2 ENERGY REQUIRMENTS

The boiler used is a firewood boiler and they have spare diesel boiler too. The boiler is required to heat the water to 80-90 degree Celsius. It takes about an hour for the boiler to reach the required temperature. The motor uses a 3HP motor to pump the water through the system. Then refrigeration unit is two types Ammonia-based and a spare which is run on Freon gas. It is required to cool the water to below 5 degree Celsius. The refrigeration unit uses a 25HP motor to pump the icy cold water through the system. The milk is pumped again with a 3HP motor, within a pipe capacity of 300l. The centrifugal tank uses a 7HP motor to run the tank. The homogenization tank uses a 30HP motor to run the tank. A 3HP motor is used to pump the milk from the cooling tank into the overhead storage for the packaging unit. A 7HP air compressor is used for the packaging unit. There are three packaging outlets in the packaging unit each using a separate 1HP motor for the packaging process.

6.2 LOGISTICS

6.2.1 INBOUND LOGISTICS

The collection centers are open for 1.5 hours in the morning and in the evening for the collection processes. The ideal time is to transport the milk to the plant and start the processing within five hours of the milking process. The collection and transportation from far off collection centers occur much earlier than the collection and transportation from nearby places, to keep in mind the five-hour window. The milk is transported by Mahindra Pick-up trucks. The milk is stored in 40L cans and transported. Private dairy farmers around the plant also deliver milk directly to the plant where it undergoes the primary tests.

There are three routes connecting the 20 collection centers,

1. Route one
    I. Chengulam
    II. Ambazhachal
    III. Aanaviratti
    IV. Odacka city
    V. Mangkadavu
    VI. South Mangkadavu
    VII. Shelliampara
    VIII. 1000 acre
    IX. Kallarooty
2. Route two
    I. West Vellathooval
    II. Vellathooval
    III. Kuthpara
    IV. Muthavankudi
3. Route three
    I. Anachal
    II. East Chengulam
    III. Aamakandam
    IV. Elleckal
    V. Kunjithanni
    VI. Vavayattmudi
    VII. Desheeyam

In route 1 the collection centers in 1000 acre and Kallarooty are only collected in the evening by the dairy vehicle the morning collection is taken up by the agency that goes for sale and return to the dairy.

At the collection centers, the pick-ups unload the empty cannisters required for the next collection and then the milk cans are loaded onto the truck. The driver fills up the truck sheet that has the total weight loaded, the no. of cans of milk loaded and the no. of empty cans unloaded, and then he goes onto the next collection center. This affair takes an average of 15 minutes.

The total time taken for the whole logistical activities from the first route took 2 hours and 40 mins, out of which 1 hour and 15 minutes went in travelling from one collection center to the other and the rest for the loading, unloading and paper works in each collection center.

6.2.2 OUTBOUND LOGISTICS

High Range dairy distributes milk in three districts, mainly Ernakulam, Kottayam, and Idukki. They receive and distribute around 16000l of milk daily. Their distributors centers are in Muvattupuzha in Ernakulam district and Vellathooval in Idukki district. The first dispatch, i.e. to Ernakulam and Kottayam occurs at 8 in the night. The dispatch to nearby areas occurs the next day morning at 5.

The sales call and runs are all outsourced to agencies. For one route, that is the Sooryanelli and Aatankadu route, order calls and delivery is undertaken by High range Dairy. For the Adimali route, only sales call is taken while distribution is taken up by

agencies. The distribution run to Muvattupuzha and Kottayam occurs in BharatBenz cold storage unit, while the local distribution occurs in Ashok Leyland insulated vehicle or Tata 407 covered body depending on the demand.

6.2.3 IN-PLANT LOGISTICS

The inbound logistic processes include the unloading of the milk cans from the truck and pouring it into the weighing balls. The procurement of sample for primary test. The loading of the SNF powder to maintain the SNF quantity in the milk. The procurement of sample for the secondary test. The loading of milk packets into crates and stacking it in numbers of 10 and transporting it into the storage units. Then these stacks are stacked into insulated trucks for distribution runs and sales runs, respectively.

The unloading of trucks happens manually, i.e. two laborers pick it, carry it to the weighing balls and pours it one by one. Then lastly stacked crates are transported into the storage unit using hand trolley. The stacks are transported to the loading docks and loaded manually by laborers.

6.3 HUMAN RESOURCE

The plant has employed a total of 10 laborers that look after the maintenance process and inbound logistical process. There are 5 lab technicians who perform the tests required for learning the quality of the milk. There is one supervisor who supervises and manages the whole process. There is a distributing manager who is also the customer care service operator of the plant. There is a president and a secretary who are part of the board of members. There are two staff who deal with the administration processes.

Out of the 10, two laborers are required to unload the milk from the trucks manually and pour into the input which is the weighing ball. There is a lab technician at the point who takes a sample from the lot to do the primary test. A technician is allotted for the pasteurization machine who calibrates the machine, a technician for the boiler and for the refrigeration and one for the packaging unit. There are two laborers who stack the packaged milk packets into crates and arrange them into stacks of ten that is then taken by a laborer to be stored in the storage unit. The packaging technician does random weight samples to check the error and calibrates the machine to required weight. There are 2 laborers employed for washing the canisters that bring the milk and for the upkeep of the plant in general. They are also used for the packing of ghee. As it is a fully manual process, with first sealing the bottle to avoid leakage then screwing on of the cap.

These many employees are employed in two shifts for morning production process and for evening production process.

The customer feedbacks are received and processed by the distributing manager of the plant. He receives the feedback and complaints received and forwards it to the supervisor to check with which processes that needs to be tend to. There is an email ID and a phone number to which we can approach them with our complaints. They are highly responsive and strive to provide the best service and customer satisfaction.

For the plant workers and technician who work on a per day basis, a monthly shift chart is put up on the first of every month. It states the shifts of every worker and technician and when he is allotted his leaves. Every worker and technician are allotted every month, which is predetermined. There are no paid leaves other than these four leaves and if a person decides to take leave, he is required to submit a leave application and his days wage will be cut.

Table 1: Salary/wage structure in the plant

SALARY/WAGE STRUCTURE	RATE
Plant technician	Rs 550-600/day
Plant worker	Rs. 380-440/day
Lab technician, desk dispatch	Rs. 30,000/month
Supervisor	Rs. 40,000/month

6,4 INVENTORY MANAGEMENT

The plant has 4 storage units, two of them are cold storage units to store the dairy products, one of the storage is to store the materials for packaging and the SNF powder and the fourth one for the cleaning agents nitric acid and caustic soda and for the maintenance equipment for the plant. The plant uses block stacking method to store its products in the storage. They also have a distributing warehouse in Muvattupuzha, Ernakulam that takes of the sales calls of Ernakulam district. They follow the FIFO technique, i.e. first in first out inventory management technique when it comes to the usage of products or dispatching.

The cleaning agent stock is replenished every month. The ordered placed for the cleaning agent is for 5000kg monthly. The lead time for the delivery of these products are 2 days. The order point is usually at 10 days from the required replenishment date, to cover for any unexpected circumstances like increased lead time or other constraints. The usage of caustic soda and nitric acid can be averaged at 2.5kg per agent daily.

The SNF powder which is required for maintaining the government standard of the milk to be sold, the stock is usually replenished every 3 months. The life of the SNF powder usually stays up to 1 year but to maintain quality it is only ordered for 3 months. The lead time for the delivery of these products are 2 days. The order point is usually at 15 days from the required replenishment date, to cover for any unexpected circumstances like increased lead time or other constraints. The usage of the powder can be averaged at 150-160 kg daily.

VII. STATISTICAL ANALYSIS

7.1 COSTING

Table 2: Electricity cost per liter

Particulars	Cost/month	Cost per day	Total liters per day	Cost per liter
Electricity before solar panel	Rs. 1,90,000	Rs. 6333.33	16000 liters	39 paise
Electricity after solar panel	Rs. 1,60,000	Rs. 5333.33	16000 liters	33 paise
Saved due to solar panel	Rs. 30,000	Rs. 1000	16000 liters	6 paise

Table 3: Salary/wage cost per liter.

Particulars	No. of employees/laborers	Wage per day	No. of shifts	Total wage per segment	Total liters per day	Cost per liter
Technician	3	Rs. 550	2	Rs. 3300	16000	20 paise
Plant worker	7	Avg Rs. 410	2	Rs. 5740	16000	35 paise
Lab technician	5	Rs. 1000	2	Rs. 10000	16000	60 paise
Desk dispatch	1	Rs. 1000	1	Rs. 1000	16000	6 paise
Supervisor	1	Rs. 1400	1	Rs. 1400	16000	10 paise
					Total	Rs. 1.31

Table 4: Cost breakdown for a liter

PARTICULARS	**COST**
The milk purchased from farmers	< > Rs. 33/liter^
Processing	80 paise/liter
Electricity	33 paise/liter
Labor	Rs. 1.31/liter
Packaging	15 paise/liter
Total cost per liter	Rs. 35.59/liter
Cost per packet	Rs. 17.79/packet*
Commission to distribution agencies	Rs 1.7/packet*
Total cost per packet	Rs.19.49/packet*
Selling price	Rs 21.9/packet*
MRP	Rs 24/packet*

^milk purchase liter rate depends on percentage content of fat, SNF, water and lactometer reading during collection process.

*The dairy only sells half liter packets.

From the table no. 2 it is found out the electricity cost is 33 paise. From the table no. 3 it is found the salary/wage cost per liter mounts up to Rs 1.31. The rest of the costs are as stated by the plant. The distribution agencies are paid a commission of Rs. 1.7 per packet. The total cost that is needed for a packet of milk is found out to be Rs. 19.49. The final selling price of a packet is Rs. 21.9 and the MRP of a packet of milk is Rs. 24 (other minute costs associated with processing are present but data for the same could not be procured.)

7.2 EFFICIENCY OF MACHINERY

7.2.1 Boiler efficiency

Quantity of steam generated per hour, Q= 30 kg per hour
Quantity of fuel used per hour, q = average 1.5 kg/hour
Temperature of feed water T1= room temperature i.e. around 25ºC
Final temperature, T2 = 80ºC
Type of fuel used = wood
specific heat of water, Cp= 4.2 J/gºC
Gross calorific value of wood, GCV= 18 MJ
Boiler efficiency = Q*Cp(T2-T1)/q*GCV
= [30*4.2*(80-25)]/ (1.5*18000)
=**25.66%**

7.2.2 Chiller efficiency

Mass flow rate, m= 3000 kg/hr
Specific heat, Cp = 1 kCal/hr
Initial temp, tin = 25 Celsius
Final temp, tout = 4 Celsius
Compressor power input= 25HP = 18.6425 kW
Net refrigeration capacity, NRC= m*Cp*(tin-tout)/3024 (Tons of refrigeration TR)
Power per ton, PPT = Power input/net refrigeration capacity (kW/Ton)
Coefficient of performance, COP= 3.516/Power per ton.
Energy efficiency ratio, EER=12/Power per ton
The coefficient of performance or COP (sometimes CP or CoP) of a heat pump, refrigerator or air conditioning system is a ratio of useful heating or cooling provided to work required. Higher COPs equate to lower operating costs. The value is typically above 1.
The Energy Efficiency Ratio (EER) of a piece of heating or cooling equipment is the ratio of the heat output (measured in BTU) to the power input (measured in watt-hour) whilst the system is in operation. The higher the ratio, the more efficient it is.

Net Refrigeration Capacity = [3000*1*(25-4)]/3024
= **20.833 TR**
Power Per Ton =18.6425/20.833
= **0.8948 kW/Ton**
Coefficient of Performance =3.516/0.8984
= **3.9136**
Energy Efficiency Ratio =12/0.8984
=**13.3570**

From the above calculations it is found out the firewood boiler runs at efficiency of 25.66%. The Ammonia refrigeration system has coefficient of performance of 3.9136, i.e. it provides 3.9136 useful cooling per unit of work. It also as an energy efficiency ratio of 13.3570, i.e. it provides 13.3750 cooling capacity per unit of electricity consumed.

7.3 OCCUPATIONAL TIME STUDY OF A PLANT WORKER

Table 5: Occupational Time study of a plant worker

Sl no.	Element description	Observed time	Allowance*	Standard Time
1	Calibrating path of pipeline for Processing.	3 mins	9 secs	3 mins 9 secs
2	Unloading 25 stacks of milk crates from loading vehicle.	13 mins	39 secs	13 mins 39 secs
3	Unloading 13 procured milk cannisters from vehicles.	6 mins	36 secs	12 mins 36 secs

4	Pouring milk into weighing ball.	5 mins	15 secs	5 mins 15 secs
5	Pouring SNF powder into milk.	8 seconds	0.4 secs	8.4 secs
6	Transporting 1 stacked milk crates from storage to loading vehicle.	40 seconds	2 secs	42 secs
7	Loading 2 empty cannisters into cleaning machines.	13 seconds	0.65 secs	13.65 secs
8	Transporting Stacked milk crates into storage.	30 seconds	1.5 secs	31.5 secs
	Total	34 mins 43.2 secs	1 min 43 secs	36 mins 26 secs

*The allowances used are 5% for fatigue.

From the above table it is noted the time a plant worker takes for doing his jobs at the plant. Due to constraints of the lockdown all intrinsic works were not noted down, but the list provides most of the work associated with the plant worker. Accordingly, the minimum time he takes for the observed jobs are found to be around 36 mins and 26 secs per shift.

VIII. POTENTIAL IMPROVEMENT SUGGESTIONS

8.1 LAYOUT IMPROVEMENTS

The main observation that was made during the field visits to the plant was that the plant seemed overly congested. The plant did not have enough space between machineries to allow the plant workers and technicians to move freely. When enquired with the plant supervisor they themselves felt this to be a problem and were undertaking steps onto expanding the floor space. In fact, when enquired they told about their expansion projects post the Covid-19 Lockdown period. It will include changing positions of the Lab and storage tanks to a common area along with other aspects to better the layout of the plant.

Another issue felt during initial was the workers had to walk all the way to end of the plant to mark their attendance. This again contributed to time being wasted on the plant floor. It could be suggested that this could be shifted to the entry gate where a fingerprint scanner could be installed or keeping the cost constraints in mind, an attendance register could be kept under the supervision of the entry gate security.

8.2 PRODUCTION PROCESS IMPROVEMENTS

8.2.1. MACHINERY EFFICIENCY

The current Plate Heat Exchanger machine used for the pasteurization process has an output of 3000 liters per hour. It is noted that the sales of the cooperative are gradually being increased. They are approached to sell their products in a new district that is Malappuram by a distributor. Such requirements are pushing the plant to increase their production. In their expansion projects they are replacing their old PHE machine with a machine with an output of 5000 Liters per hour. A plate heat exchanger with an output of 5000 liter/hour can cost from Rs 40,000 to Rs. 65,000.

The boiler they are using is firewood boiler. The efficiency of it is noted to be around 25% and takes a time of about 1 hour to reach the required water temperature. This again causes unnecessary wastage of time. The boiler could be replaced with natural gas boiler or electric boiler which could increase the efficiency 2 to 3 times. Though the initial cost of setting up an LPG boiler can be comparatively high, it is cleaner than other fossil fuels. Owing to more plants opting an environmentally friendly changes, this could be one of the steps.

The commercial electric boilers available today are again a cleaner option also have lower installation cost and maintenance cost. A 2000 kg/hour capacity commercial electric boiler can cost the plant about Rs. 60,000 per piece. While an LPG boiler with a 2000kg/hour capacity can cost around Rs. 90,000 per piece.

8.2.2 AUTOMATION

A major observation made during the field visits were that processes involving production were manual, i.e. changing the paths of the pipeline when required had to be manually done. The milk procured had to be manually unloaded and poured into the weighing balls. There were no visible sensors to check or maintain temperatures after entering the process. Everything had to be manually done which again owed to wastage of time and at junctures minute wastages of raw material.

By automating the production process manufacturers can decrease waste due to high tech machinery and reduce risk of injury as it decreases human involvement. Automation can also owe to detection of hazards or issues, reduce contamination, and increase the overall quality of milk. Automation will help in standardizing the process and will further enable the plant to decrease waste and increase efficiency.

8.3 HUMAN RESOURCE MANAGEMENT

During the field visits, it was noted that the plant was over staffed for the output they were producing. It was also noted that the workers mostly did not work out of their hierarchical positions, i.e. workers were not ready to multitask. It was also noted that there were an abundant of plant works appointed on plant floor. The plant has currently appointed 7 plant workers for the various processes in the plant. It was noted that a requirement of 5 were only needed. Like during the packaging process 3 workers and

technician is involved in the process for which only 2 plant workers and the technician were required. It was also noted during the loading and unloading process that the process involved more plant workers than required. It can also be said that if the technicians were ready to multitask the appointed plant workers were not required. The plant also had appointed 5 lab technicians out of which a maximum of 4 were only required as the lab uses basic quality tests for the primary and secondary tests and does not require elaborate testing.

If all the workers are not ready to multitask, then two plant worker and a lab technician is not required. The plant can save Rs. 1820 per shift. If all the workers are ready to multitask, then an additional plant worker is not required and add to a total saving of Rs. 2230 per shift. The plant management can decide not to refill these positions when the respective workers retire. It can also be noted that the plant workers can be trained under the technician of respective machinery and he can replace the technician when he decides to retire, and the position of the plant worker can be kept vacant.

8.4 LEAN MANAGEMENT TOOLS

The plant management may also look at the following Lean management tools. The implementation of these tools will help the plant to identify wastage and increase the overall efficiency of the plant, thus, adding value to their products.

1. Benchmarking: This is the practice of comparing business performances and performance metrics with the other players in the industry. It can be used to identify what practices other players excel and to what degree they themselves can successfully implement it in their plant. The dimensions usually compared are quality, time, and cost.

2. Value stream mapping (VSM): VSM is a lean management tool used to analyze the current state and design a future state for the steps that the plant takes from the production to the customer stage. Value stream maps show the flow of both materials and information as well as it focuses on the areas where it adds value to the product or services.

3. JIDOKA (Autonomation): It is process of implementing "intelligent automation" or "automation with a human touch". It basically implements supervisory function rather than production functions. It helps to detect abnormalities, stop the production, make necessary immediate change, and investigate the root cause for the abnormality. It helps prevent the production of defective products, helps maintain quality and helps understand problems and abnormalities faster. The firm being a producer of highly perishable goods this tool can be highly effective.

4. Simplifying information flow: The plant uses offline methods for information flow regarding procurement, production, and sales. If an online integrated system is implemented, it could reduce the complexity and wastages an offline could cause.

IX. CONCLUSION

Any company must outline and deeply research innovations before it can be implemented into their supply chain environment. All the decision must be based on through calculations and should benefit the company in the long run.

The main objective of this research project was to understand the dairy supply chain practices of High Range Dairy Cooperative, identify the possible weak links and find possible optimization solutions for the same. Theoretical background and the current operating environment were studied to understand the dairy supply chain in general and the company's activities. As methodology, both quantitative and qualitative methods were used. Information was gathered through field visits to the plant, interviews with the supervisor, employees, and the top management officials while secondary data was accumulated through extensive literature reviews and online browsing of articles and journals.

It can be identified from the plant that though the plant has been around since 1999 they have not made any possible updates to encompass the technological changes in the market. In this rapidly progressing environment, the meeting of customers' requirements and expectations and even exceeding the expectations further increase the competition among firms. The renewal and development of production systems and management techniques have become requirements in the intensive competitive environment. The plant needs to start its possible transition to a more automated system to be a relevant competitor in the market in the future. The improvements suggested encompasses different areas in the supply chain environment. The possible weak links that were identified, and improvements suggested are as follows,

1. Layout improvement.
2. Production process improvements that include replacing existing machinery with machinery of higher efficiency and the process of automation.
3. Improvement in human resource management.
4. Possible usage of lean management tools to reduce wastage and increase overall efficiency.

All the results of improvement suggestions are of recommendation nature. It is solely up to the company to implement the offered suggestions or work with the current operating environment. Most of the suggestion involve enough initial investment that could be a financial burden for the company. But they could implement the suggestion involving the human resource management as it does not involve further investments. Most of the improvements suggested are backed with rough cost calculations to prove that the suggestions are worth considering and the firm can work on further costs involved for the proper implementation. The research project could have significance for a small to medium size dairy manufacturing firm.

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ABBREVATIONS

1. SCM – Supply Chain Management
2. PHE – Plate Heat Exchanger
3. TQM – Total Quality Management
4. UHT – Ultra High Temperature
5. HACCP – Hazard Analysis and Critical Control Point
6. FIFO – First in First Out
7. LIFO – Last in First Out
8. JIT – Just in Time
9. EOQ – Economic Order Quantity
10. NRC – Net Refrigeration Capacity
11. PPT – Power per Ton
12. COP – Coefficient of Performance
13. EER – Energy Efficiency Ratio
14. LPG – Liquid Petroleum Gas
15. VSM – Value Stream Mapping