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To the Graduate Council:

I am submitting herewith a thesis written by T. Prabhakaran entitled "Economics of a cooperative milk plant in Trichur (India)." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Irving Dubov, Major Professor

We have read this thesis and recommend its acceptance:

Stanton P. Parry, Cecil E. Fuller, William E. Goble, Charcles C. Thigpen

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

December 6, 1962

To the Graduate Council:

I am submitting herewith a thesis written by T. Prabhakaran entitled "Economics of A Cooperative Milk Plant in Trichur (India)." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Irving Dubov
Major Professor

We have read this thesis and recommend its acceptance:

Stanton P. Parry

Charles Higgins

Cecil E. Fuller

William E. Goble

Accepted for the Council:

Hilton A. Smith
Dean of the Graduate School

ECONOMICS OF A COOPERATIVE MILK PLANT

IN TRICHUR (INDIA)

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

T. Prabhakaran

December 1962

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T. P.

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CHAPTER I

INTRODUCTION

I. STATEMENT OF PROBLEM

From the very early days of domestication of animals, milk has been a vital food and is still recommended as an essential food containing most of the nutrients required for body growth. Because of the importance of milk in the diet, in most of the advanced nations there has been an increase in its production and use. This increase in milk production has been associated with incentives to producers in the form of increased returns.

In the early "take off" stage of a developing nation, both producers and consumers move to a position where they can obtain knowledge about each others wants and capacities. In the case of milk consumption, consumers, as their standard of living rises, are likely to demand more milk, especially if the per capita consumption is low in the beginning of the "take off." As the level of education rises also, consumers become more conscious of the quality of the products they buy. So the availability of pure and wholesome milk at reasonable prices becomes an important matter in a nation with a developing economy.

As producers become aware of an increased demand for milk, they can,in anticipation of increased returns, increase their production and thus the supply of milk will also increase. But a mere increase in milk production on farms will not help the producers unless form, place and time utilities are added to basic product. In the case of milk, which should satisfy a high sanitary standard for human consumption in fluid form, processes such as pasteurization or sterilization are necessary, requiring the use of elaborate and specialized equipment. The financial investment required to set up a milk processing plant is so high that under the present economic conditions in Trichur district (India) an individual producer can not process his own milk economically enough to sell it at prevailing prices. Also, in areas where the per capita income as well as the output of milk per producer is very low, processing can be done economically only by pooling resources of producers for the establishment of a processing plant through cooperative effort.

This thesis involves an inquiry into the feasibility of organizing such a cooperative enterprise in Trichur (Kerala State, India) through which producers can find an uninterrupted market for their milk and thus a continuous income besides sharing the profits of the organization. By the analysis of costs involved in processing and distribution, as well as by the analysis of prospective demand for milk, the study is expected to reveal the following:

1. The changes in cost associated with changing daily volumes of milk receipts in a plant of size appropriate to the local milk supply and demand situations.

2. The costs associated with distribution of milk from this plant to consumers in Trichur.

3. Minimum amounts of milk required to be sold per day to break even on processing and distribution costs from the plant.

4. The anticipated demand for milk as affected by changes in population, per capita income, and social and educational levels in the Trichur area.

5. The supply trends and rate of increase in production of milk necessary to meet the demand.

The problem is of importance to the milk producers and consumers of the district. Many producers might commercialize their milk production and so increase their output and gain full-time employment if proper incentives are present. Through cooperative effort many producers can be helped financially and otherwise in producing more high quality milk. The organization not only will act as a marketing institution, but also as a source of information to producers on various technical subjects connected with the production of milk. Consumers, on the other hand, are assured of the availability of pure and wholesome milk. Those consumers in the urban areas of Trichur who at present keep cows (mostly uneconomically) for milk will be encouraged to give up production of milk. This will reduce the number of producers operating uneconomically while producers commercializing production will expand output. Initially the plant might confine its activities to pasteurization and distribution of milk in the Trichur town area only. Later, as demand develops and supply expands, the amount of milk received at the plant may be increased and activities extended to the production of such products as butter and cheese as well as service to a wider market area.

II. PRESENT STATUS

In Trichur district (Kerala State, India) milk production has not been taken up as a real commercial enterprise. Numerous households, therefore, maintain their own animals for milk supply, however uneconomical this venture may be. Farmers who do produce milk for sale do so as a supplementary business and do not devote much time to this activity. Most of them do not have sufficient capital for any expanded activity; and the low productivity per animal coupled with relatively high maintenance costs has discouraged producers from taking up milk production as a full-time employment on a commercial basis.

At present the marketing system for milk is disorganized. The establishment of small scale industries in and around Trichur town, has resulted in a potential increase in the demand for milk in the urban area. But within the last decade, there has been no significant increase in the quantity of milk produced. In the state of Kerala the production of milk increased by 23.7 per cent during 1951 to 1956, that is about 4.7 per cent per annum from 42,462,090 gallons to 52,548,870 gallons.[1] This slow rate is because producers are unaware of the potential outlets available for the milk. They do not know "who" wants the milk, "when" and "where" they want it, in "what form" and "how much" they want. The price of pure, wholesome milk is high enough to be beyond the reach of the majority of consumers. Mostly consumers buy milk which is very low in

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[1] Agricultural Situation in India, 1959, 13 (10), Indian Dairyman, April 1959, Vol. XI, No. 4 (Bangalore, India: Indian Dairy Science Association), pp. 82-83.

quality. Shahani[2] in 1957 has reported that 13.3 million animals are maintained within city areas of India for milk production, and that the factors responsible for this are inadquate facilities for transporting milk, quick spoilage due to warm climate and lure of better prices in the city. This congestion of animals in the urban areas naturally contributes to the unsanitary conditions of milk production.

There has been no study of the market channels for milk in the district so far. It has not been possible to get any information or data regarding the flow of milk from the producer to the consumer. Shahani[3] reports that the most common marketing practice in India is that, after retaining some part of the milk for domestic consumption, the rest is sold to milk collector, shops or plants. The collector transports the milk to the nearby urban area in cans or other vessels by head-loads, bicycles or ox-carts. The methods in Trichur area, not much different from those in other part of India, are as follows:

1. Direct from producer to consumer.
   a. Taking the animals to the consumers, milking the animals there and delivering the milk.
   b. Carrying the milk and delivering it to the consumer at the latter's place.
2. Middlemen buying milk from sub-urban areas and selling it in the town.

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[2]K. M. Shahani, "Dairying in India," Journal of Dairy Science 40 (7) 867-73, 1957, p. 868.

[3]Ibid.

3. Consumers keeping their own animals.

Recently a small cooperative union has started distribution of 750 pounds of unpasteurized milk in Trichur town daily. Due to the absence of a steady market, up to 43 per cent of the milk produced[4] is converted into ghee and sold. This process is very unremunerative as can be seen from the fact that it takes 25.0 pounds of 4 per cent fat corrected milk to produce 1 pound of ghee. At the present market price of 8.61 cents (Rs. 0.41) per pound for cows' milk, 25 pounds of fluid milk will yield a return of $2.16 (Rs. 10.25), whereas 1 pound of ghee will bring only $1.05 (Rs. 5) to the producer, a loss of over 50 per cent in revenue. This gives an accurate picture of the situation and emphasizes the necessity for providing facilities for an orderly flow of milk from the producer to the consumer.

The sources of milk supply in Trichur district are cows, buffaloes, and goats. Goats, however, do not contribute significantly to the total milk production, so they are omitted from consideration in this thesis. According to the 1961 census by the Animal Husbandry Department, Kerala state, there are 8,335 producers in the district who keep 31,112 milking cows and 10,554 milking buffaloes. The production per animal per day is 1.5 to 2 pounds for cows and 3 to 4 pounds for buffaloes testing on an average 4 and 7 per cent fat, respectively. On the basis of 1.75 pounds for cows and 3.5 pounds for buffaloes per day, the total milk production for the district from this source is about 10,626 gallons per day.

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[4] _Ibid_, p. 869.

The milk yield per animal in these areas is much less than those in the northern states of India. A number of cattle development projects have been started in these areas by the Government and a gradual increase in milk yield per animal is expected.

Based on the above information the average output per producer is about 11 pounds of milk per day. As explained earlier, due to the lack of transport facilities for milk, larger demand and higher prices in the urban areas, the number of milking animals kept by producers in and around the towns is much more than those in the rural areas, resulting in an average daily output of slightly over 20 pounds per producer. The district occupies an area of 1,147 square miles with an average output of about 80 pounds of milk per square mile. The Trichur town area, where it is intended to distribute the pasteurized milk, is 5 square miles and has an urban and suburban supply of about 1,200 gallons of milk per day. Including the milk production from goats the output per capita is approximately 1.2 ounces per day.

The state of Kerala, of which Trichur is one of the districts, has a very low milk producing area when compared to other states of India. Consequently the per capita consumption also has been very low. In the 1950's the all-India average consumption rose from about 4.5 ounces to 5.5 ounces[5] per day. In the state of Kerala, by 1961 the per capita consumption rose to 1.83 ounces from 1.2 ounces in the early 1950's.

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[5]Ibid., p. 871

III. GENERAL ECONOMIC CHARACTERISTICS OF THE DISTRICT

The topography of the district which covers 1,147 square miles is made up of approximately 33 per cent arable land, 5 per cent permanent grazing land, about 33 per cent forest, about 2 per cent barren land and the remaining about 27 per cent buildings, roads and canals. The area receives an annual rainfall of 104.07 inches (2625.5 mm) with an average day-time shade temperature of 85° F. According to the 1961 census the population of the district was 1,634,251 of whom 117,800 live in the 5 square mile area of Trichur town. This means a population density of 1,425 persons per square mile in the district and 23,560 persons per square mile in Trichur town. Farming practices comprise mainly cultivation of rice and leguminous and plantation crops. Many households raise a few chickens and keep one or two animals for work or milk. There are 273 small industries with an average employment of about 61 employees. Out of the total employed in the district 55 per cent are engaged in agriculture and 45 per cent in non-agricultural jobs. The factories are quite small and do not have the capacity to employ more people. New industries will have to be started to reduce the rising percentage of unemployed. The annual per capita income is about $52.52 (Rs. 250). According to a national sample survey conducted in 1952[6] in urban areas 61.3 per cent of consumer expenditures was on food articles, whereas in the rural areas the percentage was 64.1.

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[6] India 1961--A Reference Annual (New Delhi: Publications Division, Ministry of Information and Broadcasting, Government of India), p. 171.

CHAPTER II

FRAMEWORK AND PROCEDURE OF STUDY

I. FRAMEWORK

In the operation of a milk pasteurization and bottling plant, input-output ratios are a means for measuring the efficiency of its organization. Efficiency, according to Bressler[1], is the capability of producing a greater output for any particular combination of inputs or that output which utilizes the minimum cost combination of inputs rather than some alternative organization. These ratios when graphed in the form of production functions reveal input-output and cost-volume relationships.

The production function relating to cost-volume relationship is more relevant to the study of model milk plant operations, as the chief concern there rests in the unit processing cost. Costs involved in pasteurizing and bottling milk are the prices paid for utilization of productive services. Technically the process, in brief, consists of transformation of raw milk into a more hygienic and palatable form for human consumption, while economically it is the addition of form, place and time utilities to the raw milk. Basically the study of this production function is to give an insight into the economies of scale possible through increase in volume processed per day.

[1]Raymond G. Bressler, Jr., "Efficiency in the Production of Marketing Services," Economic Efficiency Series, Paper No. 6 (Chicago: University of Chicago, Summer, 1950), p. 2.

According to Viner[2], volume changes can be brought about by either change in the intensity of use of existing plants, change in the scale of plants or change in the number of plants. Volume changes have great influence on cost functions and help decide the unit processing cost associated with alternative volumes of milk received at the plant. As the study here involves one plant of given size the only possible way of increasing the volume of milk pasteurized a day is by the change in its intensity of use. Change in intensity is achieved either by full utilization of plant capacity or operation of plant for longer hours each day. Plant capacity, says Bressler,[3] is hard to define in highly mechanized plants, but physical capacity may be taken as approximately the most economical output. Ordinarily, a majority of the milk processing plants operate on the average at less than 70 per cent capacity,[4] thus resulting in the availability of excess capacity in those plants. The utilization of full technical capacity of a plant may be inhibited frequently by bottlenecks in pasteurization or related activities.

Synchronization of capacities of all plant equipment is of utmost importance in the full normal utilization of plant physical capacity. Equipment such as bottle filler, can washer, bottle washer or refrigeration

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[2]Jacob Viner, "Cost Curves and Supply Curves," A. E. A. Readings in Price Theory, Vol. VI by George Stigler and Kenneth E. Boulding, (Chicago: Richard D. Irwin, Inc., 1952), p. 205.

[3]R. G. Bressler, Jr., "Research Determination of Economies of Scale," Journal of Farm Economics, XXVII (August, 1945), 530, (Menasha, Wisconsin: The American Farm Economic Association).

[4]Ibid.

unit when undersized restricts the output of milk by pasteurizing unit and thus the daily output by the plant. Thus capacities and degree of flexibility of each piece of equipment have a great bearing in the designing of model plants for perfect integration of operations.

Besides equipment integration the nature and behavior of various productive services influence the cost-volume relationship. In the synthetic approach to the development of plant costs the actual quantities of variables are computed and multiplied by the price of the respective variable. While the synthetic approach to cost estimates is theoretically conceivable, the behavior of some productive services render such estimates for the short-run too rigid for alternative volumes of milk processed.

Labor, for instance, is conventionally estimated through job analysis: the process by which the duration required for each plant activity is computed and the number of man hours per day determined. But often labor practices are such that labor units form indivisible, "lumpy" inputs. Further, various assumptions regarding the nature of work and skill of workers is usually made in cost estimates in order to simulate a situation closer to reality.

Synthetic approach of cost estimates uses elaborate engineering procedures in determining the quantities of variables such as electricity, fuel and water. Generally each stage of processing milk is taken separately and the quantities of productive services required to carry out that stage for any given volume of milk is estimated. For instance, the total quantity of heat (B.T.U.'s) transmitted (added or extracted) between the product (example, milk) and medium (example, water) is computed by knowing the initial and final temperature, weight in pounds and specific heat of the product.[5] The total B.T.U.'s is in turn used to estimate the quantities of electricity, fuel and water. Similar procedures are adopted for all stages of processing. In these theoretical estimates errors will be introduced if practical capacities and efficiencies of equipment are not taken into consideration.

Lack of information on standards or relationship between volume of milk processed and quantities of variables like stationary and office supplies, postage and telephone and cleaning supplies form further impediment to reliable cost synthesis. Seasonal fluctuations in the volume of milk processed have great influence on unit processing cost.[6] Excess capacity in integrated plants, if available, can be made use of during flush season. But ordinarily flush seasonal processing is accompanied by increase in average cost.

Larger volumes are generally handled through increase in the duration of plant operation. This increase is arranged in the form of shifts as the duration per day for each worker is limited. The total amount of milk processed by plants operating one shift a day is restricted considerably as all the processing and cleaning activities are done by one set of laborers. More laborers will have to be hired for two or three shifts a day. However, some of the plant activities such as cleaning of equipment and floor, setting up processing, boiler and refrigeration units need not be repeated. Thus, by increasing the number of shifts,

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[5] Ibid., p. 535.

[6] Ibid., p. 536.

costs of variables, especially labor, do not increase proportionately. Owens and Clarke[7] state that cost increases due to shift differential are relatively small since the bulk of labor requirements fall within the first shift. They further report the arrangement of three shifts during a day in milk receiving stations and state that "overlapping" of workers' schedules is essential for efficient utilization of labor, that is reporting times for the first shift is staggered over several hours and this provides for economies in the use of labor.[8]

Summarizing, it can be said that though the synthetic approach to plant cost has certain limitations it is the best estimate under given conditions and for a short-run situation. Combining all the relevant variables in their proper proportions for alternative volumes of milk processed and deriving their cost functions will indicate the economies in unit processing cost obtained through processing of larger volumes, which can be used advantageously for planning prospective plants.

II. ANALYTICAL PROCEDURE

The first set of cost calculations are those associated with the pasteurization of milk. This is done in various steps. First estimates are made of the total investment necessary for the establishment of fixed assets such as equipment, building, and land. Secondly the operating

[7] T. R. Owens and D. A. Clarke, Class III Milk in the New York Milkshed, Part 3, Costs of Manufacturing Dairy Products, United States Department of Agriculture, Agricultural Marketing Service, Marketing Research Report No. 400, (Washington: Government Printing Office, May 1960), p. 8.

[8] Ibid., p. 10.

expenses per day for pasteurizing the milk are calculated. A daily output by the plant of 2,000 gallons (7,570 Litres) is assumed. The daily operating expenses are separated into the absolute minimum costs required to put the plant into operation regardless of volume handled, and the costs (variable) that vary directly with changes in volume handled.

Based on the present economic conditions and Government policies towards the establishment of cooperatives, possible means of raising the capital required and its budgeting are laid out. Total daily processing costs are then estimated for alternative volumes of milk received at the plant. Per unit distribution costs associated with to-door delivery of pasteurized milk are developed on the basis of the standards described by Babb and Butz[9].

Using the current supply and demand trends for milk, the possibilities for future expansion of the plant and its effect on the quantity and pattern of milk production are discussed.

Fixed Elements

In the operation of a milk pasteurization and bottling plant the fixed assets required are equipment, building and land.

Equipment

Under this category processing equipment, semi-durable supplies for handling milk and office equipment are grouped as given in Table 1.

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[9]E. M. Babb and W. T. Butz, Improving Fluid Milk Distribution Practices Through Economic-Engineering Techniques, Bulletin 622 (University Park: Pennsylvania Agricultural Experiment Station, June, 1957).

TABLE I

EQUIPMENT (PROCESSING AND HANDLING)

Item	Cost		Per Cent of Total Investment
	Dollars	Rupees	
Equipment (Processing[1])	175,317	834,838	74.8
Office Equipment[2]	1,050	5,000	0.4
Supplies[3]	11,859	56,472	5.1
Total	188,226	896,310	80.3

[1]Includes the recommended installation cost of $12,600 and shipping charges of 15,871 which is 10 per cent of the equipment cost of $158,705.

[2]Mostly to be purchased locally.

[3]Includes bottles, cans, cases and dollies.

The model plant is represented by a high temperature short time pasteurizer having a maximum capacity of processing 528 gallons (2,000 litres) of milk per hour. Sufficient flexibility is incorporated to accommodate larger volumes of milk if the need arises, as it is anticipated that the proposed cooperative association will gradually expand its output of pasteurized milk. A list of the equipment is given in Appendix Table XIII. The prices of equipment quoted are f. o. b. Bombay and furnished by Messers. Larsen and Toubro, Bombay, importers of such equipment in India. According to them, this plant can, with slight modifications, handle 729 gallons (3,000 liters) per hour. Installation costs were also provided by the distributors.

Raw milk storage tanks in the plant have a capacity of 1,584 gallons (6,000 liters). Two tanks are required to handle cow and buffalo milk separately. The can washer handles 4 cans per minute, while the bottle washer cleans 48 bottles per minute. The bottle filling and capping machine can turn out up to 100 bottles a minute. All pieces of equipment have sufficient capacity to insure uniform, uninterrupted flow of milk during processing and related activities.

Boilers have a theoretical capacity of steam output each of 1,320 pounds per hour, and 2 such boilers are necessary. The refrigeration capacity of the compressor is 11 tons per hour, and is operated by a 25 horse power motor. A cooling tower is provided to cool and reuse the water used for compressor cooling.

Henry _et al._[10] recommend an allowance of 20 per cent of

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[10] W. F. Henry, R. G. Bressler, Jr. and G. E. Frick, "Economies of Scale in Specialized Pasteurizing and Bottling Plants," _Efficiency of Milk Marketing in Connecticut_, Bulletin No. 259 (Storrs: Agricultural Experiment Station, Connecticut, June 1948), p. 19.

equipment cost to cover shipping and installation charges, but as installation charges already are accounted for, only 10 per cent is taken here as shipping charges. The total equipment cost including shipping and installation charges is $175,317 which is 74.8 per cent of total investment.

Office Equipment

The cost involved in the purchase of minimum office equipment listed in Appendix Table XIII is $1,050.

Supplies

The supplies required for processing the basic volume of 2,000 gallons of milk per day are 777 gross one pint bottles, 500 cans, 1,086 cases and 62 dollies, the details of which are given in subsequent sections. The cost of these items work out to $11,859.

Building

The size and floor space for the building are adapted from the plan provided by Messers. Larsen and Toubro. Appendix Figure 3 shows the floor plan, dimensions and equipment layout recommended for each section. The building which occupies 8,291 square feet has sufficient capacity for future expansion of the plant volume. The walls are of brick with cement, and concrete floor cement and roofing tiles. Construction costs average $5.25 per square foot. The total building cost of $43,528 is 18.7 per cent of the total investment.

Land

Land is required for the erection of the building and the clearance all round. A clearance of 30 feet in front and rear and 20 feet on either side from the walls is to be added to the total floor area occupied by the building in order to get the total required land area of 18,391 square feet.[11] The price of land differs greatly from place to place, depending on location, use and demand. A price of $4,200 per acre is taken as the best estimate under prevailing conditions, resulting in a cost of $2,558 which is one per cent of the total investment. The total investment required is given in Table II.

III. VARIABLE INPUT ITEMS

Variable input items consist of labor, electricity, fuel, water, supplies and other miscellaneous inputs. The quantities of electricity, fuel and water required to process the basic volume of 2,000 gallons of milk per day are given in Table III. The fixed quantities indicated are the absolute minimum required to put the plant into operation irrespective of volume of milk processed.

Labor

In the estimation of labor requirements, the time required for each operation is computed through the procedures followed by Conner, Taylor and Bressler.[12] With a basic daily volume of 2,000 gallons

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[11] Fred C. Webster, Specifications and Costs for A Moderately Small Milk Pasteurizing and Bottling Plant, Bulletin A. E. 1031 (New York: Cornell University Ag. Expt. Station, May 1956), p. 5.

[12] M. C. Conner, Leland Spencer and C. W. Pierce, Specifications and Costs for a Milk Pasteurizing and Bottling Plant, Ag. Experiment Station Bulletin No. 463, (Blacksburg: Virginia Polytechnic Institute); James C. Taylor and Ralph W. Brown, Fluid Milk Plants in the Southeast--Methods, Equipment and Layout, United States Department of Agriculture, Agricultural Marketing Service, MRR 232, (Washington: Government Printing Office); and Henry, Bressler and Frick, op. cit.

TABLE II

TOTAL INVESTMENT

Item	Cost		Per Cent of Total Investment
	Dollars	Rupees	
Land	2,558	12,180	1.0
Building	43,528	207,275	18.7
Equipment[1]	188,226	896,310	80.3
Total	234,312	1,115,765	100.0

[1]Plant with maximum capacity of 528 gallons of milk per hour and includes handling and office equipment besides installation and freight.

TABLE III

QUANTITIES OF ELECTRICITY, WATER AND FUEL CONSUMED PER DAY

Item	Unit	Units Consumed			Per Cent Fixed Relative to volume
		Fixed	Variable	Total	
Electricity	Kilowatt	70	328	398	17.5
Water	Gallons	1060	4574	5634	18.8
Steam	Pounds	1046	4595	5641	18.5
Fuel (coal)	Pounds	183	807	990	18.5

(7,570 litres), labor time is allocated to the various operations from the time raw milk is received at the plant until it is loaded out for delivery. The plant operates seven days a week. The assumptions regarding plant labor made by Webster[13] are used in this study with necessary modifications to suit local conditions as follows:

1. All employees work 8 hours a day including personal time of about 30 minutes but excluding lunch break of 1 hour.

2. All employees, though paid for 7 days, work only 6 days a week.

3. The wages per month of all employees include the allowances and fringe benefits payable to workers under existing state regulations.

4. Employees are shifted from one position to another for efficient utilization of labor.

5. All employees have normal skills and experience.

It is not possible, under existing conditions of labor practices, to hire any worker by the hour. Hence, full day wages must be paid to any worker, working 8 hours or part thereof. The extra men hired to take the place of other workers on their days off are considered as part of the crew. No time limitation is fixed on the manager's and plant foreman's work. However, it is assumed that up to a certain volume (3,500 gallons) the two can manage the affairs of the plant technically and administratively. Wages on the basis of 95 per cent utilization of plant capacity are calculated to allow a slight excess capacity in order to handle extra milk that may be received during flush seasons. Regarding

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[13]Webster, op. cit., p. 7.

office staff, it is assumed that one employee will be necessary, irrespective of volume handled and arbitrarily for every 1,000 gallons of milk handled an additional employee is required. This assumption conforms to the data on office staff published by Henry.[14] The office employees work 7 hours a day and 6 days a week. The daily work schedule is given in Appendix Figure 4. The time workers report for duty is staggered over three to four hours for efficient utilization of labor.

Electricity

Electricity in the plant operation is needed mainly for the refrigeration unit. The total refrigeration load is calculated for the various cooling operations by the methods suggested by Farral[15] and Henry et al.[16] (formulas in Appendix Table XIV). This gives the total British Thermal Units the milk gives up when cooled to the required temperature. The total B. T. U.'s of all processes give the daily refrigeration load required and based on this the compressor capacity and duration of operation are computed on the basis of manufacturer's specifications. A number of motors of various sizes are needed for pumping, cleaning and refrigeration operations. For the operation of all the motors, including the refrigeration motor, the procedure outlined by Owens and Clarke[17] is used. That is, theoretically 1 horse power consumes

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[14]Henry, Bressler and Frick, op. cit., p. 47.

[15]Arthur W. Farral, Dairy Engineering, 2nd. Edn. (New York: John Wiley & Sons, Inc., 1953) Chapter VIII, pp. 143-211.

[16]Henry, Bressler and Frick, op. cit., pp. 29-30.

[17]Owens and Clarke, op. cit., p. 23.

0.746 kilowatts of electricity per hour. But under practical conditions commonly encountered, a conversion ratio of 1 horse power to 1 kilowatt is used. The hours of operation of the various motors are calculated and the total power requirement per day is thereby estimated.

The standard illumination recommended by Farral[18] for the various rooms is used for evaluating the total electricity for lighting (see Appendix Table XIV). From the formulas given in the Appendix, the number of luminaires required per room are computed. The average length of time the lights will be on each day is obtained from the duration of the various plant operations. Using the rate of 100 watts of electricity per hour consumed by each luminaire the total power required for lighting is derived.

Steam and Fuel

Steam is used for pasteurization and washing equipment and floor. The total heat obtained per pound of steam (95 per cent) is estimated by subtracting the total heat of condensate above 32° F. from the total heat of steam. Heat in B. T. U.'s required for pasteurization is calculated by the methods suggested by Farral[19] (formula in Appendix D). A boiler efficiency of 85 per cent is assumed. The manufacturer's specification of 250 pounds of steam per hour consumed by the can washer, and Henry's[20] suggestion of 1 pound per case of bottles for soaker type bottle washing machine is modified to 2 pounds to include the washing of cases, and

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[18]Farral, op. cit., p. 429.

[19]Farral, op. cit., Chapter VII, pp. 108 - 143.

[20]Henry, Bressler and Frick, op. cit., p. 35.

their recommendation of 1 pound of steam for every 3 square feet of floor area for general cleaning is used in the computation of steam required for cleaning. Steam required for plant heating has not been taken into account as the climate is tropical and no heating is necessary.

Coal having a heat value of 15,000 B. T. U. per pound and theoretically capable of producing 12.5 pounds of steam, is selected as fuel. A coal efficiency, for practical purposes, of 65 per cent is assumed as suggested by Mortensen[21] which gives about 8 pounds of steam per pound of coal, and using his method (formula in Appendix D), a total of 990 pounds of coal is necessary per day.

Water

Milk pasteurization plants usually require large quantities of water for such operations as cleaning, heating and cooling milk, cooling condensers, and making steam. For pasteurization, quantities are estimated from the ratios recommended by manufacturers. During pasteurization, heated milk and hot water flow at the ratio of 1:4. Pre-cooling of milk is done by well water which flows in the ratio of 2 to 1 of milk. Chilling is done by sweet water in the ratio of 4 to 1 of milk. As a large portion of the total requirements are reused, only the actual amounts used up are taken as the daily requirements.

Water for cleaning purposes is computed at the rate of 50 gallons per 1,000 pounds of milk handled, the maximum suggested by Farral.[22] The

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[21] Martin Mortensen, Management of Dairy Plants, Revised Edition, (New York: The Macmillan Company), pp. 93-94.

[22] Farral, op. cit., p. 442.

latter's suggestion of 2 gallons per minute per ton of refrigeration for compressor cooling is taken as a basis. But as this water is cooled in a cooling tower and reused only 2 per cent of it is wasted per day due to evaporation. Twice the amount of this 2 per cent is allowed to suit the local hot weather conditions.

The amount of steam required daily is taken into account in deciding the approximate quantity of water for the boilers, while 25 gallons per head per day for personal use is taken as recommended by Owens and Clarke.[23]

Supplies

Supplies that vary with volume are bottles, cases, cans, dollies and bottle caps. The basic volume of 2,000 gallons pasteurized and bottled a day is used as the basis in cost estimations. The milk is filled in 1 pint bottles, and an output of 16,000 pints a day requires 16,000 bottles. According to Clements[24] bottles had an average life of 35 trips. This, and the fact that the bottles may be retained by the customers for one or two days necessitates a total stock of 7 bottles for each bottle checked out a day.

Regarding cans, it is assumed that milk will be received at the plant in 10 gallon cans, containing on an average 70 pounds of milk.[25] This requires a total of 250 cans per day to receive 17,374 pounds of

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[23]Owens and Clarke, op. cit., p. 25.

[24]C. E. Clements, Effect of Plant Arrangement, Equipment and Methods of Operation in Relation to Breakage of Bottles in Milk Plants, Cited by Bressler, Henry and Frick, op. cit., p. 36.

[25]Owens and Clarke, op. cit., p. 15.

milk for an output of 16,000 pints after 1 per cent shrinkage. As part of the cans may be retained by the producers, at collection centres, or in the cold room it is necessary to have twice the minimum number required.

The number of cases depends on the number of bottles checked out every day. Cases that can hold 30 bottles each are used here, which works out to 543 cases including 2 per cent extra as replacement. The plant, while sending out a day's output, has to store in the cold room an equal amount of pasteurized milk for the next day, which requires an equal number of cases. So, 2 cases are required for every 30 bottles of milk pasteurized.

Dollies are used in bottling plants to stack up cases in the cold room and to facilitate easy movement of cases in and out of the cold room. The dollies used have a capacity for storing 32.43 gallons of milk each. As the dollies are used exclusively for this purpose the minimum number only is necessary, which is 62 for the basic volume of 2,000 gallons of milk per day.

The number of bottle caps used up every day is equal to the number of bottles filled every day with pasteurized milk. So filling up of 16,000 pints of milk requires 16,000 bottle caps every day.

Other Variable Inputs

The actual physical loss in the volume received has been taken as 1 per cent from the range of 1-2 per cent suggested by Henry,[26] of the original volume received at the plant. For office and laboratory supplies

[26] Henry, Bressler and Frick, op. cit., pp. 36-37.

the procedure suggested by Owens and Clarke[27] is used. Telephone and postage charges, laundry expenses and other miscellaneous items are computed as approximate estimates, in the absence of other information.

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[27]Owens and Clarke, *op. cit.* p. 30.

CHAPTER III

PROCESSING COST AND SOURCE OF CAPITAL

I. PROCESSING COST

In the computation of total variable costs the prevailing prices for the variables are multiplied by the actual quantities of the input items required for processing. Table IV shows the variable costs associated with the processing of 2,000 gallons of milk a day.

Variable Costs

Labor. Total labor requirements are calculated as explained earlier. Relief men must be hired in order to operate the plant 7 days a week. The administrative staff works only 6 days a week and no relief workers are necessary for them. The monthly wage rates that are used for employees in the plant and office are consistent with existing state government wages for comparable employments.

To handle the basic volume of 2,000 gallons per day, a crew of 15 men is necessary. Processing operations require 7 men in addition to the plant manager and foreman, and an additional 2 are required as relief men. There are 3 on the office staff and 1 laboratory technician.

The same pattern was followed in computing the labor requirements when plant volume is varied. The total expenditure on wages and salaries per month is then broken down to arrive at daily labor cost. This amounts to $18.69 per day, that is 18.8 per cent of the total variable cost or 10.55 per cent of total daily processing cost.

TABLE IV

VARIABLE PLANT COSTS (2,000 GALLONS OF MILK PER DAY)

	Fixed	Variable	Total	Variable Cost Rupees	Per Cent of Total Variable Cost	Per Cent of Total Processing Cost
Plant Variable Cost						
Wages[1]	9.59	9.10	18.69	89.00	18.8	10.55
Water	0.47	2.02	2.49	11.87	2.5	1.40
Electricity[2]	0.78	3.70	4.48	21.32	4.5	2.52
Fuel[3]	0.67	2.97	3.64	17.33	3.7	2.05
Lab & Office Supplies	--	1.89	1.89	9.01	1.9	1.06
Miscellaneous[4]	--	5.05	5.05	24.04	5.1	2.85
Total Plant Cost (Variable)	11.51	24.73	36.24	172.57	36.5	20.43
Packing Costs						
Supplies[5]	--	35.61	35.61	169.56	35.8	20.10
Bottle Caps	--	12.72	12.72	60.56	12.8	7.18
Total Packaging Cost	--	48.33	48.33	230.12	48.6	27.28
Product Shrinkage and Loss[6]	--	14.80	14.80	70.47	14.9	8.35
Total Daily Variable Cost	11.51	87.86	99.37	473.16	100.0	56.06

[1] At the rate of $126.00 per month for plant manager
$ 94.50 per month for foreman
$ 42.00 per month for laboratory technician
$ 25.29 per month for operators
$ 25.29 per month for operators
$ 25.29 per month for office staff

[2] Rate of Knoxville Utilities Board used, which is $1.00 per month per kilowatt as demand charge and $0.008 per kilowatt hour for the first 15,000 kilowatt hours per month.

[3] Coal is used as fuel for generation of steam

[4] Includes estimates on postage, chemicals, detergents, cleaning appliances and laundry.

[5] Consist of bottles, cans, cases and dollies

[6] One per cent loss of original volume received

Water. While handling its basic volume the plant uses a total of 5,643 gallons per day. Of this, only 2,375 gallons (for the boiler and personal use from city supply) need be paid for, as the balance is from a nearby well. A rate of $1.05 per 1,000 gallons is assumed as close estimates for the water rates charged in the area. This amounts to $2.49, 2.5 per cent of the total variable cost or 1.4 per cent of the total cost.

Electricity. Through the methods explained in the previous chapter, 398 kilowatts was found necessary per day for operation at 95 per cent of the capacity. The rates charged by the Knoxville Utilities Board are used as close estimate to existing rates in Trichur. The rates charged to customers who demand at least 50 kilowatts but not more than 5,000 kilowatts are as follows:

Demand Charge: $1.00 per month per killowatt for 30 minute peak period consumption

Energy Charge: 0.8¢ per kilowatt hour for the first 15,000 kilowatt hours per month.

The charge for the 30 minute peak period consumption, or the "demand charge" per month, is for 39 kilowatts and is $39.00. The $0.008 per kilowatt hour energy charge rate is used for the consumption of 11,940 kilowatts per month. So, the total electricity cost is $134.52 per month or $4.48 per day, which is 4.5 per cent of total variable cost or 2.52 per cent of the total processing cost.

Fuel. Nine hundred and ninety pounds of coal per day is necessary to produce 5,641 pounds of steam required for processing and cleaning activities. A price of $7.35 per metric ton is estimated as the prevailing price in the Trichur area, and, therefore, $3.64 is the expenditure on fuel per day for pasteurizing 2,000 gallons of milk. This is about 3.7 per cent of the total variable cost or 2.05 per cent of the total processing cost.

Semi-durable supplies. The supplies that vary with daily volume of milk are grouped together. Initially the plant requires 777 gross--1 pint bottles, 500 cans--10 gallon capacity, 1,086 cases of 30 bottle capacity and 62 dollies for handling 16,000 pints of milk per day. According to the prevailing prices of $0.38 per dozen bottles, $8.40 per can, $1.97 per case and $26.55 per dolly, the total investment required for semi-durable items including replacement costs works out to $4,412.52 for bottles, $4,410.00 for cans, $2,520.00 for cases and $1,699.53 for dollies. For the pasteurization and bottling of 16,000 pints of milk a day an initial investment in supplies of $13,042.05 is required for the first year, which is otherwise a daily expense of $35.61 or 35.8 per cent of total variable cost.

The usage of bottle caps are directly proportional to the number of bottles filled every day. Thus 16,000 bottles filled with milk require 16,000 bottle caps daily, the cost of which works out to $12.72, that is 12.8 per cent of total variable cost.

Shrinkage. According to Henry[1] actual physical loss of milk

[1]W. F. Henry, R. G. Bressler, Jr. and G. E. Frick, "Economies of Scale in Specialized Pasteurizing and Bottling Plants," Efficiency of Milk Marketing in Connecticut, Bulletin No. 259 (Storrs: Agricultural Experiment Station, Connecticut, June 1948), pp. 36-37.

resulting from spillage and breakage, leakage from cans and equipment, evaporation, and adhesion to the cans and equipment averages from 1-2 per cent of the volume received. As the model plant under consideration weighs and receives milk from producers at the plant much of the loss during collection and transportation is reduced, hence a shrinkage of only 1 per cent, the probable loss during processing and bottling, is accounted as a cost of operation. For an output of 2,000 gallons the plant incurs a loss of 174 pounds of milk. Based on the purchase price of 7.98 cents per pound for cow's milk and 8.40 cents per pound for buffalo milk and assuming the plant receives equal amounts of both types, the shrinkage cost works out to $14.80, that is, 14.9 per cent of total variable cost or 8.35 per cent of total processing cost.

Laboratory and Office Supplies. Walker and others[2] report a figure of $0.07 per 1,000 pounds of milk received as average daily cost for office supplies. This figure is assumed for the present study, giving a daily office supply expense of $1.20 for the basic volume.

For laboratory supplies, the rate of $0.04 per 1,000 pounds used by Owens and Clarke[3] is used, giving $0.69 as the daily cost. So, there

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[2] S. A. Walker, H. I. Preston and C. T. Nelson, An Economic Analysis of Butter Non-fat Dry Milk Plants, Idaho Bulletin 20. Cited by T. R. Owens and D. A. Clarke, Class III Milk in the New York Milkshed, Part 3, Costs of Manufacturing Dairy Products, United States Department of Agriculture, Agricultural Marketing Service, Marketing Research Report No. 400 (Washington: Government Printing Office, May 1960), p. 29.

[3] T. R. Owens and D. A. Clarke, Class III Milk in the New York Milkshed, Part 3, Costs of Manufacturing Dairy Products, United States Department of Agriculture, Agricultural Marketing Service, Marketing Research Report No. 400 (Washington: Government Printing Office, May 1960), p. 30.

is a total of $1.89 (Rs. 9.01) as cost for laboratory and office supplies per day, which is 1.9 per cent of total variable cost.

Other Variable and Miscellaneous Items

Costs associated with postage, telephone calls, detergents, soap, brushes, uniforms and laundry are assumed to amount to $5.05 (Rs. 24.04) per day. This is about 5.08 per cent of total variable cost on 2.85 per cent of total processing cost per day.

Fixed Costs

Daily fixed costs consist of depreciation, interest, amortization, insurance, taxes and repairs and maintenance. Table V shows the fixed costs associated with the fixed factors used in processing milk.

Depreciation. Items of equipment decrease in value through use the obsolescence and need replacement at the end of their useful life. The annual rate of depreciation on equipment and building calculated by the straight line method is broken down to a daily basis. It is assumed the equipment has no scrap value. According to Farral[4] the life of different major plant equipment vary from 12 to 25 years. An average of 18 years is assumed for the model plant. The life span of 33-1/3 years recommended by Owens and Clarke[5] for buildings is used and results in an annual depreciation rate of 3 per cent. Depreciation is calculated on a base

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[4]Arthur W. Farral, Dairy Engineering, 2nd. Edn. (New York: John Wiley & Sons, Inc., 1953), Chapter VIII, pp. 143-211.

[5]Owens and Clarke, op. cit., p. 19.

TABLE V

ESTIMATED DAILY FIXED COST FOR THE PASTEURIZING AND BOTTLING PLANT

Item	Amount Per Day		Per Cent of Total Fixed Cost	Per Cent of Total Processing Cost
	Dollars	Rupees		
Depreciation[1]	25.93	123.46	33.34	14.63
Repairs[2]	21.31	101.46	27.40	12.02
Amortization[3]	10.61	50.55	13.65	5.99
Interest[4]	15.71	74.80	20.20	8.86
Insurance & Taxes	4.20	20.00	5.40	2.36
Total	77.76	370.27	100.00	43.86

[1]Based on investment in building and equipment, straight line depreciation.

[2]Five per cent of original investment on equipment and 1 per cent for building.

[3]Repayment on loans from Bank and Government.

[4]Based on 5 per cent and 6 per cent annually on bank loan and stocks respectively.

of $146,846.00 for equipment and $43,528.00 for building. Thus total depreciation cost amounts to $25.93 per day, which is 33.34 per cent of total fixed cost or 13.63 per cent of total daily processing cost.

Repairs and maintenance. The rate on original investment of 5 per cent for equipment ($146,846.00) and 1 per cent for building ($43,528.00) per annum used by Owens and Clarke[6] is used in the computation of repair and maintenance cost. This amounts to $21.31 per day which is 27.4 per cent of total fixed cost or 12.02 per cent of total daily processing cost.

Amortization of loans. In order to finance the high initial capital requirement for the plant the proposal outlined in the next chapter is assumed to be feasible. The proposed cooperative association will borrow up to $103,950.00; an amount of $31,500.00 from a local bank to be amortized within 10 years and carrying 5 per cent interest, and another $73,450.00 interest free loan from the Government, which is to be amortized at the rate of 1 per cent of the original loan in the first year, 2 per cent in the second year, 3 per cent in the third and so on. This repayment of loans works out to a daily cost of $10.61, that is 13.65 per cent of total fixed cost or 5.99 per cent of daily processing cost.

Interest. The model plant is operated by a cooperative association, which is a non-profit organization and any revenue over and above the cost are shared by the members. Hence no interest is charged on the total

[6]Ibid., p. 20.

capital. However, interest has to be paid on the loan of $31,500.00 from the bank and on $69,300.00 the amount expected to be realized from the sale of stocks. At proposed annual rates of 5 per cent on bank loan and 6 per cent on stocks which are most prevalent, the daily expense by way of interest is $15.71 which is 20.20 per cent of total fixed cost or 8.83 per cent of total processing cost.

Insurance and taxes. Exact information regarding the types of insurance policies and premiums available for cooperative marketing associations in Kerala as well as the taxation policies of Government could not be obtained. Accordingly, $4.10 per day has been allotted as insurance and tax. That is $3.15 as daily insurance rate on $200,000 and $1.05 as an estimate of local tax rate.

Based on the costs in Tables IV and V, total daily processing costs were computed for alternative volumes ranging from 1,000 to 4,000 gallons of milk and are shown in Table VI. Total daily processing cost ranged from $135.84 to $260.31 and corresponding processing cost per pint from $.01698 to $.00813.

The prevailing market prices for milk in pounds and its equivalent in pints are given in Table VII, which includes prices proposed to be paid by the model plant. The price per pound of 7.98¢ for cows' milk and 8.4¢ for buffaloe's milk proposed to be paid to the producers as well as the selling price of 9.66 cents and 10.08 cents per pint for cows' and buffaloes' milk respectively by the model plant are consistent with present economic and market conditions. Under the previous assumption of processing equal quantities of cows' and buffaloe's milk, the total quantity of milk

TABLE VI

TOTAL AND UNIT PROCESSING COST AT DIFFERENT VOLUME LEVELS (95 PER CENT HOURLY CAPACITY)

Pints Processed Per Day	Daily Processing Cost (Dollars)			Total Daily Processing Cost (Rupees)	Unit Processing Cost (per pint)	
	Fixed	Variable	Total		(Dollars)	(Rupees)
8,000	77.76	58.08	135.84	646.84	0.01698	0.08085
12,000	77.76	80.36	158.12	752.96	0.01317	0.06275
16,000*	77.76	99.37	177.13	843.43	0.01107	0.05271
20,000	77.76	120.36	198.12	943.42	0.00990	0.04717
24,000	77.76	135.46	213.46	1,016.48	0.00889	0.04235
28,000	77.76	160.78	238.54	1,135.89	0.00851	0.04056
32,000	77.76	182.55	260.31	1,239.58	0.00813	0.03873

*Volume on which calculations are made.

TABLE VII

AVERAGE MILK PRICES IN THE DISTRICT OF TRICHUR DURING THE FIRST SIX MONTHS OF 1962

	Cents Per Pound		Cents Per Pint	
	Cow	Buffalo	Cow	Buffalo
Rural[1]	6.51	6.93	6.80	7.45
Urban[1]	8.61	9.03	9.25	9.70
Existing Cooperative[2]				
Purchase	7.98	7.98	8.61	8.61
Selling (urban)	9.45	9.45	10.15	10.15
Model Plant[3]				
Purchase	7.98	8.40	--	--
Selling (urban)	--	--	9.66	10.08

[1]From prices furnished by Information Officer, Trichur for the period January to June, 1962.

[2]No difference in price between cow and buffalo milk handled by existing cooperative milk union.

[3]Prices proposed for the model plant both purchase and selling prices at the plant.

to be purchased in order to accommodate the 1 per cent shrinkage ranges from 1,010 to 4,040 gallons for outputs from 1,000 to 4,000 gallons daily. The purchase cost excluding shrinkage ranges from $704.34 to $2,817.36 per day and the anticipated revenue from $789.60 to $3,158.40. Table VIII summarizes the cost and returns associated with the processing of alternative volumes of milk.

The results of Table VIII when transferred on to Figure 1 reveals that under the present conditions the plant has to process a minimum of 2,125 gallons of milk a day in order to break even. That is, the model cooperative, while setting targets, should aim for a minimum daily volume of 2,125 gallons of milk, to be received, processes and sold at the plant.

III. SOURCES OF CAPITAL

The establishment of the processing plant described requires a substantial amount as capital, about $236,383, as detailed below.

	Dollars	Rs.
Equipment (including freight and installation)	187,175.10	891,310
Building	43,527.75	207,275
Land	2,557.80	12,180
Office Equipment	1,050.00	5,000
Operating Expenses (1 month)	2,071.65	9,865
Total	236,382.30	1,125,630

The capital is proposed to be raised through the following methods.

TABLE VIII

COST AND RETURNS AT DIFFERENT VOLUME LEVELS
(95 PER CENT HOURLY CAPACITY)

Pints Processed and Sold Daily[1]	Daily Cost--Dollars			Daily Revenue[4] Dollars	
	Purchase[2]	Processing	Total	Total	Net
8,000	704.34	135.84	840.18	789.60	-50.58
12,000	1,056.51	158.12	1,214.63	1,184.40	-30.23
16,000	1,408.68	177.13	1,585.81	1,579.20	- 6.61
20,000	1,760.85	198.12	1,958.97	1,974.00	+15.03
24,000	2,113.02	213.46	2,326.48	2,368.80	42.32
28,000	2,465.19	238.54	2,703.73	2,763.60	59.87
32,000	2,817.36	260.31	3,077.67	3,158.40	80.73

[1]Fifty per cent cow and fifty per cent buffalo milk.

[2]Payment to producers @ $0.0798 per pound for cow and $0.084 per pound for buffalo milk.

[3]As per Table VI.

[4]Based on the selling price of $0.0966 per pint for cows and $0.1008 per pint for buffalo milk.

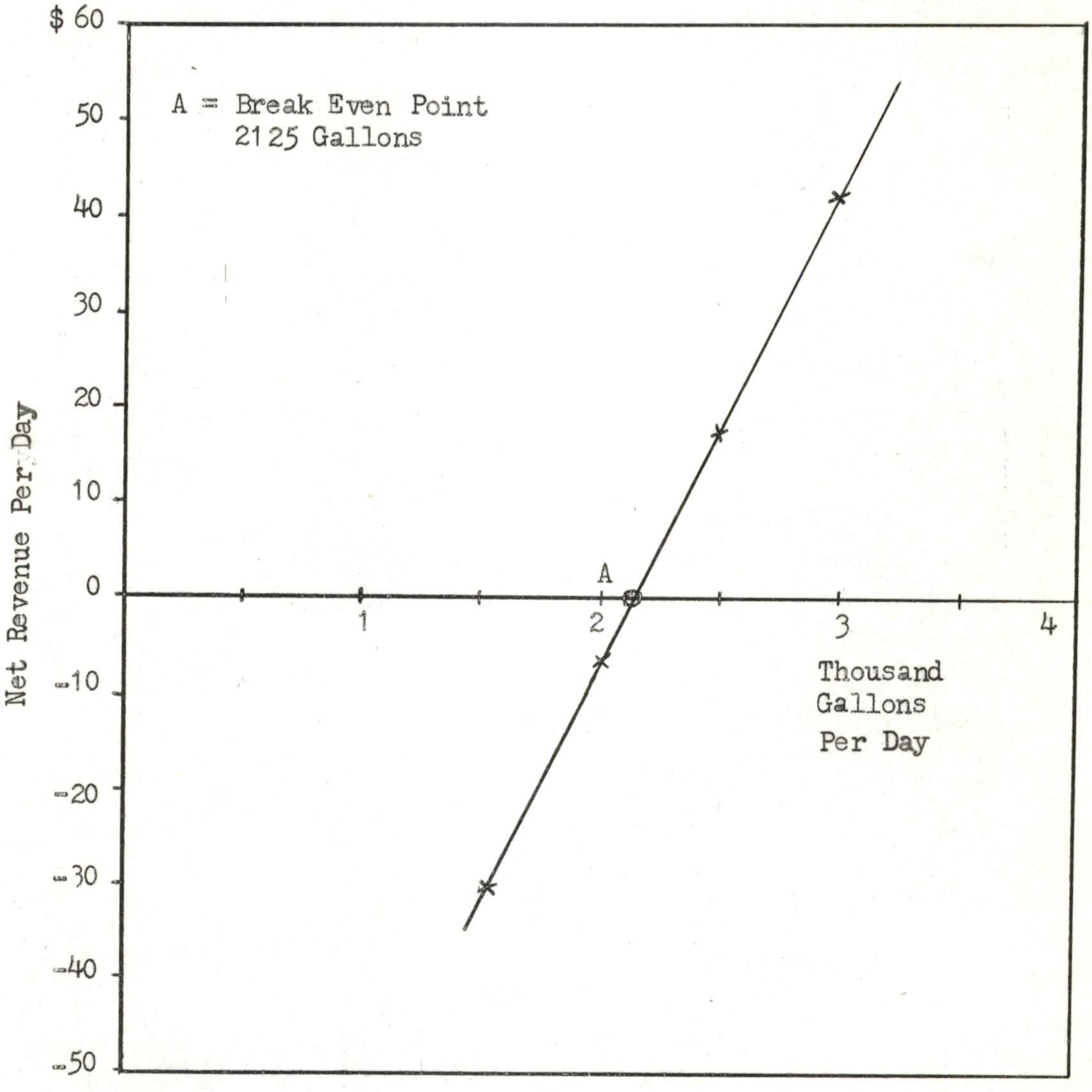

Figure 1. Net revenue associated with alternative volumes of milk received at the plant. (Based on processing cost)

Membership

In order to have a voting right in the policies of the cooperative, each producer should become a member by paying the proposed nominal membership fee of $1.05. From the 8,300 producers in the district with a sizeable number in the Trichur town, it is expected that at least 500 producers will become members realizing $525.00. But whatever the number of members might be, this amount does not enter into any cost estimates as no interest is charged on membership fee of cooperative organizations.

Stocks

Preferred stocks carrying an interest of 6 per cent per annum, in the demoninations of $21.00, $10.50 and $2.10 are proposed to be sold at the rate of 500, 4,000 and 8,000 each, respectively, which contributes $69,300 to the capital.

Government

As explained earlier, given the outlook of the Government towards cooperatives, a subsidy of $63,000 and a loan of $72,450 can be expected. The loan is assumed to be interest free and long term. It is returnable at an increasing rate of 1 per cent per annum of the original amount, 1 per cent to be paid at the end of the first year, 2 per cent at the end of the second year, and so on. At this rate, the amortization period lasts for 14 years.

Bank

Local cooperative banks usually extend substantial amounts on loans to cooperative associations at low rates of interest. An amount of $31,500 returnable within 10 years and carrying an interest of 5 per cent per annum is expected from this source.

The various sources may be summed up as follows realizing a total of $236,775.

		$	Rs.
Membership Fee (each $1.05--500 members)		525	2,500
Preferred Stock	$21.00--500	10,500	50,000
	10.50--4,000	42,000	200,000
	2.10--8,000	16,800	80,000
Bank Loan		31,500	150,000
Government--subsidy		63,000	300,000
loan		72,450	345,000
Total		236,775	1,127,500

CHAPTER IV

DISTRIBUTION OF PASTEURIZED MILK

Milk distribution is a function of the number of consumers to whom milk is delivered and the volume of milk delivered. (The model cooperative milk plant will initially confine selling activities to urban consumers,) that is, to those in the five-square-mile area of Trichur town, which has a population of 117,800 or 23,560 persons per square mile. According to Government of India report,[1] in the early 1950's the average family size consisted of 5.21 persons. Excluding about 5,000 people not living with their families, (this urban population can be grouped into approximately 21,650 families. Based on the income distribution of middle class families[2] in urban areas,) there are about 3,400 families with a monthly income of $63.00 and above, who are considered here as potential consumers. For computing delivery cost, the households were assumed to be scattered throughout the town, resulting in an average of 680 such households per square mile. (As the model plant is proposed to be centrally located, the one-way distance to the farthermost house in the town will be about three miles from the plant.)

Labor and equipment requirements are computed from the engineers')

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[1] India 1961--A Reference Annual (New Delhi: Publications Division, Ministry of Information and Broadcasting, Government of India), p. 177.

[2] Ibid., p. 181.

time standards published by Babb and Butz[3] and modified wherever necessary to suit the local conditions. Distribution processes consist of elements that are fixed with the volume of milk delivered and those that are variable. Fixed elements comprise those activities such as checking load, plant delays, servicing vehicle, and waiting for personnel, while the variable elements are those associated with number of stops, volume of milk handled, geographical location of delivery points, arranging cases of milk during loading and unloading, "to door" and "return" elements at customer's place, customer service and delay, and bookkeeping. Using the time standards indicated, the total time required for house-to-house delivery is estimated. As there are no refrigeration facilities in homes, milk has to be delivered daily, and early in the morning. The climate being tropical, the high temperature will spoil the milk if kept outside cold storage too long. So the pasteurized milk must be delivered between 5:30 and 8:30 a.m. Including time for fixed elements, each deliveryman will have to work for only five hours a day.

Due to the high concentration of households in the area and the frequent stops to deliver a small amount of milk per customer, it was found that delivery by bicycles is more economical than by trucks. Cheap labor and low maintenance cost contribute to the low distribution cost by bicycles. It is estimated that within the specified time, a deliveryman can, on the average, supply 180 pints (6 cases) of milk, in two trips,

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[3]E. M. Babb, and W. T. Butz, "Improving Fluid Milk Distribution Practices Through Economic Engineering Techniques," Northeast Regional Marketing Project No. 13, Bulletin No. 622, (University Park: The Pennsylvania State University, June, 1957).

to 72 households at the rate of 2.5 pints per point. This is the optimum volume that can be distributed by one man.

(In the town area, there are colleges, hospitals, restaurants and other institutions, about 65 in all, requiring milk in large quantities. These centers are considered as bulk delivery points for which a truck has to be maintained.) Based on an average of three cases per point, the delivery of 195 cases of 30 pints each to these 65 points requires a 1.5 ton truck to be operated by a driver-deliveryman.

The distribution of the basic volume of 16,000 pints to 4,060 households and 65 institutions, therefore, requires a labor force of 58 men every day, made up of one driver and 57 bicycle riders, and does not include any relief men. The initial capital investment on vehicles amounts to $6,862.50, made up of a 1.5 ton truck costing $4,500 and 50 bicycles, each costing $47.25.

The daily operating expenses for bulk delivery, computed on the procedures followed by Bressler,[4] by the truck is shown in Table IX. Table X shows the daily operating cost for retail delivery of milk.

The data used for estimating distribution costs are mostly furnished by the distributors of the vehicles. Taking the number of stops and average distance of stops from the plant, it is estimated that the truck may have to travel a distance of twenty miles a day, and at the rate of seven miles per gallon requires $1.56 worth of gasoline a day.

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[4]D. A. Clarke, Jr. and R. G. Bressler, Jr., "Truck Costs and Labor Requirements on Milk Delivery Routes," Efficiency of Milk Marketing In Connecticut, (Storrs: Agricultural Experiment Station, Connecticut, June 1943), Bulletin 148.

TABLE IX

DAILY OPERATING COST FOR BULK DELIVERY OF MILK
(ONE 1.5 TON TRUCK)

Item	Cost Per Day--Dollars			Total Daily Cost Dollars
	Overhead	Operating		
		Fixed	Variable	
Gasoline	--	0.25	1.31	1.56
Oil	--	--	0.05	0.05
Tire[1]	--	--	--	--
Repairs[2]	--	--	0.58	0.58
General Garage and Storage[3]	0.50	--	--	0.50
Depreciation[4]	1.67	--	--	1.67
Insurance[5]	0.21	--	--	0.21
License[6]	0.33	--	--	0.33
Labor	--	1.05	--	1.05
Total	2.71	1.30	1.94	5.95

[1]No change of tires within the first year.

[2]$0.0291 per mile

[3]$0.50 per day

[4]Life period 7 years and scrap value 5 per cent of original investment.

[5]State Farm Insurance (Knoxville) rate of $38.70 every 6 months.

[6]Tennessee state rate $120.00 per year.

TABLE X

DAILY COST FOR RETAIL DELIVERY OF MILK
(50 BICYCLES)

Item	Operating Cost--Dollars		Total Daily Cost Dollars
	Overhead	Variable	
Repair[1]	--	2.63	2.63
Depreciation[2]	2.10	--	2.10
License[3]	0.09	--	0.09
Tire[4]	--	0.72	0.72
Labor	--	35.91	35.91
Total	2.19	39.26	41.45

[1] At the rate of $1.05 for every 200 miles travelled

[2] Life period of 3 years with scrap value 5 per cent of original cost.

[3] Current rate of $0.63 per bicycle per year

[4] Based on one change every year

Oil is required at the rate of five quarts per 1,000 miles and at the price of $2.20 per gallon the daily cost amounts to 5 cents.

According to Bressler,[5] repair cost average about $0.0291 per mile and general garage and storage cost about $0.50 per day for 1.5 ton trucks. General garage expenses consist for items such as washing, servicing and painting. At this rate the operating expenses amount to $0.58 for repairs and $0.50 for general garage and storage cost per day.

For bicycles an approximate service and repair cost of $1.05 for every 200 miles travelled was taken, resulting in a daily expense of $2.63 for the 50 bicycles. Depreciation on the vehicles was estimated on a life period of seven years for the truck and three years for the bicycles with a scrap value of five per cent[6] of the original purchase price. This gives depreciation cost per day of $1.67 for the truck and $2.10 for the 50 bicycles. The license fee of $120 per year charged in the state of Tennessee is used as an estimate for the 1.5 ton truck used for bulk delivery of milk. This amounts to a daily cost of $0.33. The current license fee for bicycles in the Trichur town is $0.63 per bicycle per year which amounts to an overhead cost of $0.09 per day for the 50 bicycles. The State Farm Insurance (Knoxville) rate of $38.70 every six months for liability insurance is taken as the best estimate of insurance coverage for trucks in Trichur area, which amounts to about $0.21 per day. Based on the present wage rate of $18.90 per bicycle rider and $31.50 for the truck operator per month, the total daily labor

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[5] _Ibid_., p. 11.

[6] _Ibid_., p. 12.

cost amounts to $35.91 and $1.05 for retail and milk delivery respectively. No interest is charged on the capital investment on vehicles, as it is a cooperative organization. The source for the capital of $6,860.70, required for the purchase of truck and bicycles, is proposed to be raised through a nominal deposit from the customers of $1.05 for every pint of milk delivered. Milk plants customarily obtain deposits from consumers for "to door" delivery of pasteurized milk as a safety against breakage of bottles and payment for milk.

In the operation of the truck there is a total daily fixed cost of $4.01 (overhead and fixed) and a daily variable cost of $1.94 that varies with the distance travelled and number of stops made per day. On the average, the distribution cost per pint amounts to $0.0041 per pint for retail delivery and $0.00019 per pint plus $4.01 for bulk deliveries. Based on these unit costs, the distribution cost for alternative volumes of pasteurized milk estimates are given in Table XI.

Assuming that all customers are charged an additional $0.0042 per pint for "to door" delivery of milk, the price of cows' milk will be 10.1¢ and for buffaloes' milk 10.5¢ per pint. If the total daily output is delivered at customers' place the total cost including both processing and transportation and associated revenue for alternative volumes will be given in Table XII. The net revenue of Table XII when transposed on to Figure 2 indicates the minimum volume of about 1,750 gallons that should be processed as well as distributed in order to break even in the current economic conditions and the various assumptions made in the study.

TABLE XI

DAILY DISTRIBUTION COST FOR ALTERNATIVE VOLUMES DELIVERED

Pints Delivered A Day	Pints Delivered A Day		Daily Delivery Cost Dollars		Total Daily Distribution Cost—Dollars
	Retail	Bulk	Retail	Bulk	
8,000	2,150	5,850	8.82	5.95	14.77
12,000	6,150	5,850	25.22	5.95	31.17
16,000*	10,150	5,850	41.62	5.95	47.57
20,000	14,150	5,850	58.02	5.95	63.97
24,000	18,150	5,850	74.41	5.95	80.37
28,000	22,150	5,850	90.82	5.95	96.77
32,000	26,150	5,850	107.22	5.95	113.17

*Volume on which calculations are based.

TABLE XII

TOTAL DAILY COST (PURCHASE, PROCESSING AND DISTRIBUTION) FOR DIFFERENT VOLUMES OF MILK

Daily[1] Volume	Cost Per Day				Revenue Per Day[5]	
	Purchase[2]	Plant[3]	Delivery[4]	Total	Total	Net
(Pints)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
8,000	704.34	135.84	14.77	854.95	823.20	-31.75
12,000	1,056.51	158.12	31.17	1,245.80	1,234.80	-11.00
16,000*	1,408.68	177.13	47.57	1,633.38	1,646.40	+13.02
20,000	2,760.85	198.12	63.97	2,022.94	2,058.00	35.06
24,000	2,113.02	213.46	80.37	2,406.85	2,469.60	62.75
28,000	2,465.19	238.54	96.77	2,800.50	2,881.20	80.70
32,000	2,817.36	260.13	113.17	3,190.84	3,191.80	101.96

*Volume on which calculations are based.

[1]Fifty per cent each cow and buffalo milk per day.

[2]To producers @ $0.0798 per pound for cow and $0.084 per pound for buffalo milk.

[3]Processing cost as per Table VI.

[4]Delivery of the total output at customers place.

[5]Based on selling price of $0.101 per pint for cow and $0.105 per pint for buffalo milk.

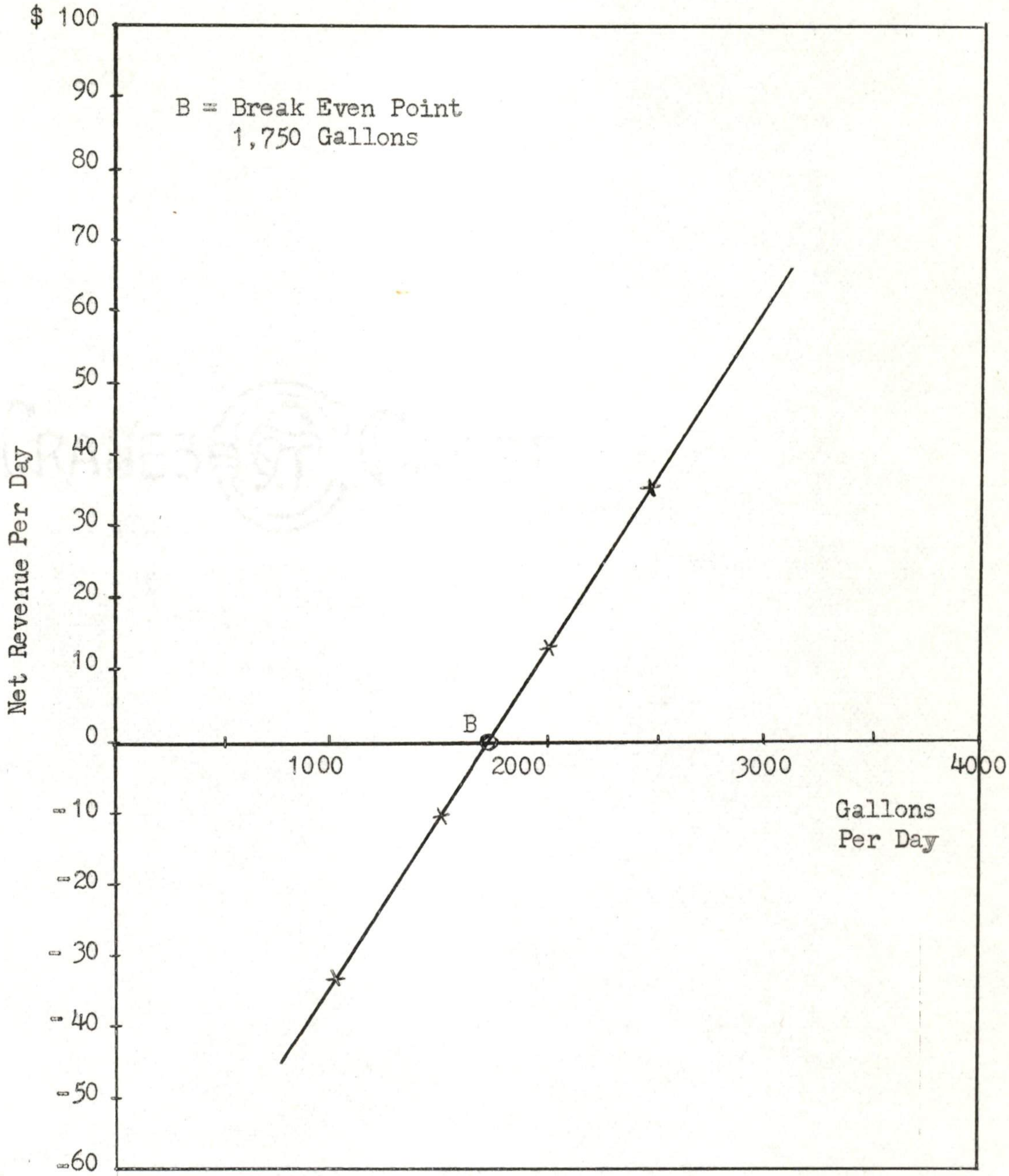

Figure 2. Net revenue associated with alternative volumes of milk received at the plant. (Based on processing and distribution costs)

CHAPTER V

ANALYSIS OF FUTURE POSSIBILITIES

The analysis of expansion possibilities in the future for the model cooperative milk plant chiefly consist of the evaluation of demand and supply position by the year 1971. This is essential, as it helps in obtaining a better perception of the feasibility for the establishment of such a cooperative milk plant and its possible effect on milk production in the area. The potential demand and supply of milk will reveal whether, even with an initial loss, the plant will be able to operate profitably for a considerable part of its life time, which is about 17 years. The factors taken into account in analyzing the demand situation are:

1. Trend in population of the district
2. Trend in urbanization
3. Trend in per capita income deflated by consumer price index
4. Trend in milk consumption associated with its variables such as income elasticity, educational level of consumers and availability of pure wholesome milk.

While the urban population was considered as potential consumers in addition to those in the district the supply situation was analyzed taking the whole district as potential source of supply of milk, to which the anticipated percentage increase in all India milk production was applied.

According to the Government of India population growth rate[1] projection an increase of 21.4 per thousand persons per annum during 1960-1966 and 19 per thousand persons per annum during 1966-1971 is anticipated. This growth rate takes into account the birth rate as well as the rate of mortality. At this rate the population in the Trichur district is expected to rise from 1,634,251 in 1961 to 1,994,919 in 1971. This does not take into account migration as the fluctuation in population due to that is assumed to be not significant. The simple linear urbanization trend[2] in India can be explained by the equation $Yu = 9.8 + 1.95x$, which gives 20.50 per cent of the population or 402,974 as urban in the district of Trichur by the year 1971.

The all India trend in per capita real income (money income deflated by consumer price index) shows an average increase of about 4 per cent per annum over the period 1956-1961. The deflated per capita income in Trichur in 1961 was $42.34 (Rs. 201.60). Assuming that the per capita real income of the district increases at the same rate per annum as that of all India average then by 1971 the real income per capita in the district will be $59.27 (Rs. 282.24). As mentioned earlier the consumers are at present spending about 64.1 per cent of the income on food articles, the total quantity of which still falls far short of the absolute requirements. Further, milk is being considered, especially

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[1] Third Five Year Plan--A Draft Outline, (New Delhi: Planning Commission, Government of India, June 1960), p. 5.

[2] India 1961--A Reference Annual (New Delhi: Publications Division, Ministry of Information and Broadcasting, Government of India), p. 171.

by those in the lower income category, as a luxury item of food. So during the developmental stages of a nation as the consumers' income, educational and standard of living levels gradually rise the food items considered luxurious will become necessities and the quantities of these items demanded will increase. Considering for the present analysis unitary income elasticity for milk the per capita consumption is expected to rise to 2.56 ounces by 1971 from 1.83 ounces in 1961. Thus with an anticipated population of 1,994,919 in the district and at the rate of 2.56 ounces the total quantity of milk likely to be demanded by 1971 is 37,115 gallons per day. While this amount is more realistic under the present conditions it is much lower than the target of the Government of India[3] to raise the milk consumption level to 6 ounces per head per day by 1965-1966. Extending this rate to 1971 the amount of milk likely to be demanded is 86,988 gallons per day.

Analyzing the supply situation it is seen that at present, including the milk from goats the average daily output in the district of Trichur is about 14,200 gallons. No information is available regarding the increase in the milk production in the past few years for the district. But during 1951-1956 milk production in the state of Kerala increased, on an average, at about 4.7 per cent per annum from 42,462,090 gallons to 52,548,870 gallons.[4] The all India milk production trend[5] indicates an increase of

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[3] Problems in the Third Plan, A Critical Miscellany, (Delhi: The Publications Division, Government of India, January 1961), p. 144.

[4] Agricultural Situation in India, 1959, 13 (10), Indian Dairyman, April 1959, Vol. XI, No. 4 (Bangalore, India: Indian Dairy Science Association, 1959), pp. 82-83.

[5] Third Five Year Plan, op. cit., p. 38.

19 per cent from about 4,466.55 million gallons produced during the 1950-1951 to 5,750.93 million gallons in 1960-1961 and the anticipated target is about 6,613.57 million gallons by 1965-1966, an increase of 15 per cent over the 1960-1961 production. The amount of milk produced in the state of Kerala is generally very low when compared to other states in India. So, assuming that the 15 per cent increase is expected by 1971, which is more probable under the prevailing marketing conditions, the amount of milk available will be only 16,330 gallons per day, whereas if the 1951-1956 rate is maintained the amount available daily is likely to be 20,874 gallons.

Thus, it is evident that under the present production and marketing conditions the supply falls far short of the anticipated demand. The proposed cooperative milk processing plant has a peak capacity of 528 gallons per hour and with slight modification can pasteurize 792 gallons (3,000 litres) per hour. Operating one shift of 8 hours a day the plant, at an average of 95 per cent capacity of 500 gallons per hour can economically pasteurize 2,500 gallons of milk a day. In the event of large scale increase in milk receipt, the plant can be operated in two or three shifts in which case the optimum volume will be about 5,000 and 7,500 gallons respectively. As the plant is continuously operated with additional shifts one to two thousand gallons more milk can be pasteurized with no additional cost. After modifications the corresponding volumes for one, two, and three shifts may be 3,750, 7,500 and 11,250 gallons, respectively, with a possible increase up to 13,500 gallons of milk with three shifts a day.

Banerjee[6] reporting on the impact of city milk projects on the dairy industry in general, states that due to the lack of proper outlets for marketing milk the rural producers are losing interest in the production of milk and suggests that cooperative marketing associations could be of great help in creating incentive for expanding milk production. He further outlines the following benefits achieved by established cooperative associations.

1. Land Transformation. Waste lands brought under fodder cultivation.
2. Veterinary Aid. Timely prevention and proper treatment of diseases.
3. Transport Facilities. Transportation of milk from rural to urban areas necessitates the improvement of existing roads and construction of new ones.
4. Central Milking Shed. Construction of central milking sheds have greatly helped the milking of animals under hygenic conditions and thus the procurement of milk with high sanitary standard.
5. Silo Towers. For ensiling the fodder produced locally.
6. Prizes. Rewards for better management and improvements have created incentive among producers.
7. Bonus and Loan. Income besides the direct payment received for milk supplied, through the sharing of profits of the

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[6] Ganesh Chandra Banerjee, "Role of Various City Milk Schemes in the Development of Dairy Industry in India," Indian Dairyman, Volume XI, May 1959, (Bangalore, India: Indian Dairy Science Association), p. 122.

association and facilities for loans on easy terms for needed improvements have stimulated the expansion of milk production.[7]

A report by the Director General of F. A. O. states that within eight years (1950-1958) the Kaira District Cooperative Milk Producers' Union in Anand have raised their yearly supply of milk to the city of Bombay ten times, from 6,000,000 pounds to 60,000,000 pounds through increased production in the area served by the cooperative association.[8] The report[9] further states that even though the quantity of milk delivered by producers at collection centres is as low as 1 to 5 pounds the bonus paid to them increased by 13 times from $5,222 in 1950 to $68,250 in 1958.

This clearly indicates the benefits possible by the establishment of milk processing plant and milk distribution through cooperative effort, for ensuring a permanent continuous outlet for the milk produced and its effect on the dairy industry in the area. The proposed plant is capable of handling a sizable proportion of the total milk produced in the district. This marketing channel can be used to the utmost advantage by the producers and increase the production at the rate of 16 per cent of the 1961 production per year to meet the anticipated demand of 37,115 gallons or 51 per cent per annum to achieve the target of 86,988 gallons per day by 1971.

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[7]Ibid., p. 123.

[8]Director General of F. A. O. of United Nations, "Freedom from Hunger Campaign," Indian Dairyman, September 1960, Volume XII, No. 9, p. 243.

[9]Ibid., p. 244.

CHAPTER VI

SUMMARY

As explained earlier, the study is essentially a synthetic cost estimate of pasteurizing and bottling milk plant, in order to find the feasibility of establishing such a plant in the Trichur town (Kerala State, India). Under the present marketing conditions it is seen that producers of milk are lacking incentive to expand production and consumers lacking trust in the milk purchased. Milk production is carried on by a large number of small producers mostly unorganized and unaware of profitable market outlets and potential demand for milk. It is expected that through the organization of a cooperative association of producers, a pasteurization and bottling plant can be set up and the pooled milk pasteurized, bottled and sold. This will form a year-round marketing channel and the steady returns will act as an incentive for the expansion of milk production. On the consumers' side it is expected to instill more confidence in them regarding the quality of milk and so encourage their buying from the cooperative association.

The various sources outlined for obtaining capital for the model plant are assumed to be feasible. It is seen that if the proposed plant is to break even under the present conditions it should process no less than 2,125 gallons of milk a day. Economies due to large scale processing in the future is anticipated. For distribution of pasteurized milk bicycles are found to be more economical than trucks due to the frequent stops necessary and smaller volume of milk per household. Estimation

of break even point shows the minimum volume of 1,750 gallons to be pasteurized and distributed a day. It is proposed to charge the consumers the additional cost for "to door" delivery of milk and a small additional revenue is expected this way. No collection costs are estimated as, in the initial stages, it is presumed that the producers will deliver the milk at the plant.

The analysis of future possibilities show encouraging results for the cooperative organization. The current trend indicates a gradual increase in the quantity of milk consumed and demanded, but supply has not increased proportionately. The per capita consumption in the Trichur area is expected to increase to 2.56 ounces by 1971 from the present 1.83 ounces, with the assumption of unitary income elasticity. To meet the anticipated demand in 1971 through increase in population and income the present production will have to be trebled, while to meet the Government objective of raising the per capita consumption level to 6 ounces the current production will have to expand more than 6 times.

The provision of an organized market outlet is, therefore, expected to create change in the dairy industry of the area by expansion of milk production through incentive to producers by way of greater returns.

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APPENDIX

TABLE XIII

EQUIPMENT LIST

Sl. No.	Name	Price	
		Dollars	Rupees
I.	MILK RECEIVING SECTION	22,411	106.720
	Weighing scale Tripping bar Drip saver Dump tank (264 gals.--1,000 ltrs) Raw milk pump (528 gph --2,000 1 ph) Can washer (3-4 c.p.m.) Raw milk tanks (cap. 1,584 gals.--6,000 ltrs) Steaming blocks		
II.	PASTEURIZATION AND PROCESSING SECTION	33,411	159,100
	H.T.S.T. Unit 528 gph (2,000 L.p.h.) Balance tank 26.4 gals. Milk pump 528 gph (2,000 1 ph) Plate pasteurizer 528 gph Filter 1,056 gph Tri-process unit 528 gph Hot water pump 2,112 gph (8,000 1 ph) Well water pump Sweet water pump Storage tank 1,584 gals. (6,000 ltrs) Homogenizer 528 gph. Other auxilaries		
III.	BOTTLING SECTION	24,877	118,363
	Bottle washer 48 bpm (1 pint--0.5 ltr) Bottle filler (100 bpm) (1 pint--0.5 ltr) Conveyors		
IV.	REFRIGERATION SECTION	25,946	123,550
	Compressor Condenser Oil separators Ice building tank Ice building coils Insulation for ice builders Liquid separators		

TABLE XIII (continued)

Sl. No.	Name	Price Dollars	Price Rupees
	Agitator Ammonia pipes and fittings Air diffusers Insulation materials for cold store room Water pumps for condenser Ammonia valves Refrigeration controls Insulation for all parts First charge of oil and ammonia Spray pipe system Other accessories		
V.	STEAM SECTION	17,535	83,500
	Boilers--2 (each capacity 1,320 lbs.) (600 Kgms) per hour Other auxiliaries		
VI.a	WASHING, SERVICE AND OTHER CONNECTIONS	21,405	101.930
	Crate rinsing Sanitary fittings Insulations Processing unit Steam generating unit Water supply unit Sweet water unit Electric panel unit		
VI.b	MISCELLANEOUS SUPPLIES		
	(chemical cleaning sets, hoses, buckets, trolleys, equipment chest, plungers and related accessories)		
VII.	LABORATORY EQUIPMENT	1,260	6,000
TOTAL		146,846	699,264

TABLE XIII (continued)

Name		Cost
OFFICE SUPPLIES		$ 1,050
Filing cabinets	1	
Desk	2	
Chairs	8	
Tables	4	
Typewriter and Stand	1	
Safe	1	
Posting trays	4	
Other (stationaires)		

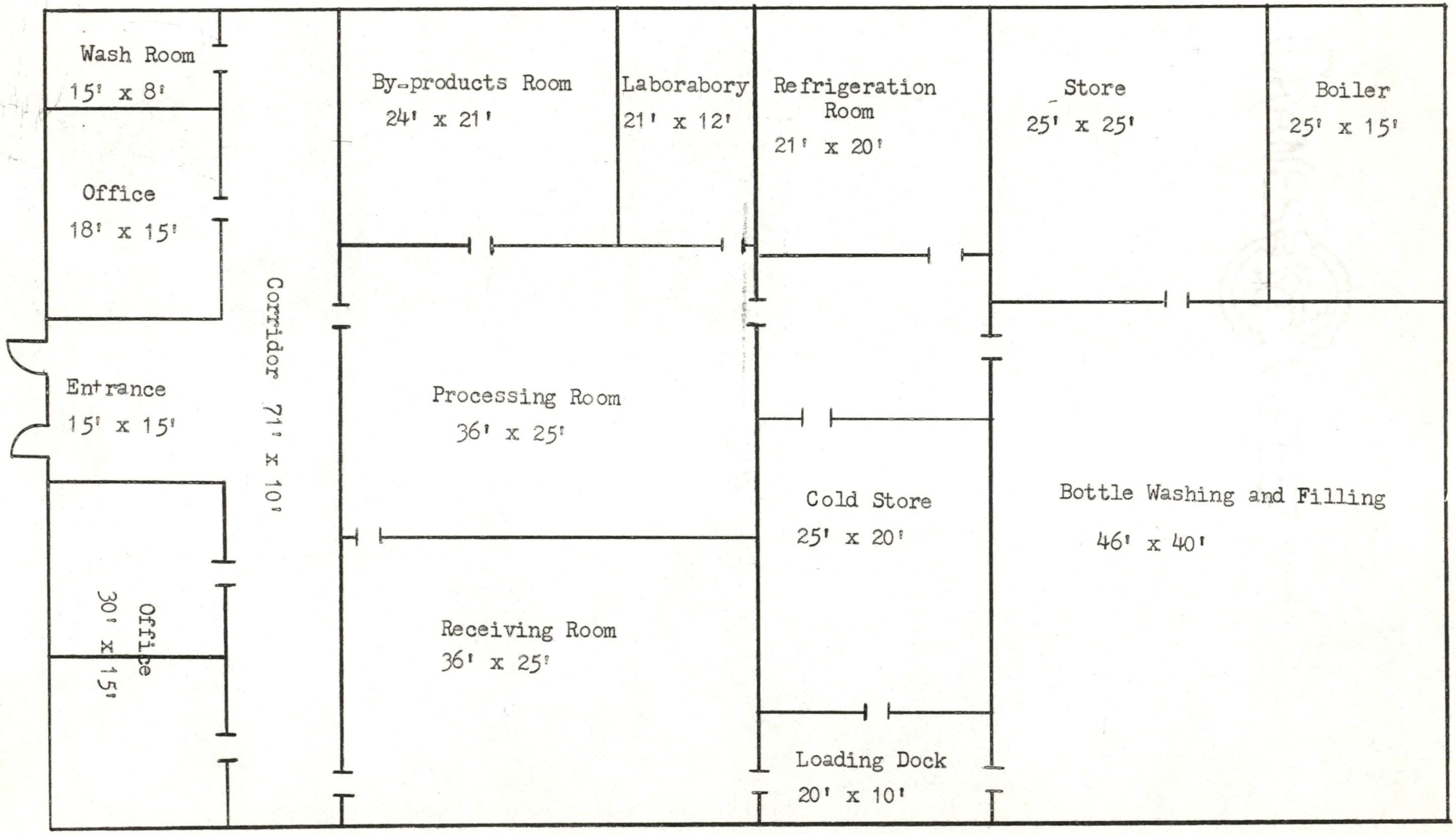

Figure 3. Floor Plan

TABLE XIV

FORMULAS

I. B.T.U. ESTIMATES, ELECTRICITY REQUIREMENTS

1. Cooling Some Material

Weight of material in pounds x(t - t')x Specific heat of the material = Total B.T.U.

(where t = Initial temperature in Fahrenheit of the material

and t' = Temperature in Fahrenheit to which the material is to be cooled.)

2. Cooling Room

R = fn (t - t') B.T.U.

(where R = Number of B.T.U.'s lost through walls every 24 hours

f = Total square feet of insulating surface

n = Number of B.T.U. heat transmitted through that surface every 24 hours per square foot per degree Fahrenheit difference between inside and outside the the room.

t = Average temperature (^{o}F.) outside the wall

t' = Temperature (^{o}F.) to be maintained

(Standard used: Heat transmission across the walls with insulation thickness 4" and cement concrete walls = 0.064 BTU/Sq. ft./^{o}F. difference/hour

3. Cooling Blower Motor

Horse Power of Motor X B.T.U. per horse power (1 H.P. = 2,545 B.T.U./Hour)

4. Capacity of Compressor

= B.T.U.'s per hour

$$\frac{\text{B.T.U. per hour}}{12,000} = \text{tons of refrigeration per hour}$$

TABLE XIV (continued)

II. LIGHTS

Standard Used:

Location	Operating Foot-Candles
Entrance	10
Corridor	10
Offices--1	40
Offices--2	40
Locker room	10
Receiving room	20
Processing	20
Bottle filling and washing	70
Cold store	10
Loading dock	10
By-products room	20
Laboratory	50
Refrigeration room	10
Store room	10
Boiler room	10

$$\text{Total Lamp Lumens required} = \frac{\text{Operating Foot-Candles} \times \text{Area of Room}}{\text{Coefficient of utilization} \times \text{Maintenance Factor}} \quad \text{(All rooms)}$$

$$\frac{\text{Total Lamp Lumens}}{\text{Number of lamps per luminaire} \times \text{Lumens per lamp}} = \text{Number of Luminaires required}$$

TABLE XIV (continued)

STEAM REQUIREMENTS

1. Total heat of 95% steam = Total heat of liquid + latent heat of 95% steam

2. Heat obtained per pound of 95% steam = Total heat of 95% steam - total heat of condensate.

3. Heating Materials.

$$\frac{\text{Total weight of material in pounds} \times \text{Specific heat of material} \times (t - t')}{\text{Boiler Efficiency}} = \text{total B.T.U.'s required}$$

Where t = Final temperature of material (Fahrenheit)

t' = Initial temperature of material (Fahrenheit)

4. Total pounds of steam = $\frac{\text{Total heat required}}{\text{Heat per pound of steam}}$

5. Fuel Requirement

i. $$\frac{\text{B.T.U. required to evaporate one pound of water at operating pressure}}{\text{Heat valve in B.T.U. per pound of fuel} \times \text{Boiler Efficiency}} = \text{Pounds of fuel per pound of steam}$$

ii. $$\text{Total pounds of fuel required per day} = \frac{\text{Output of steam per hour} \times \text{Duration of operation}}{\text{Amount of steam per pound of fuel}}$$

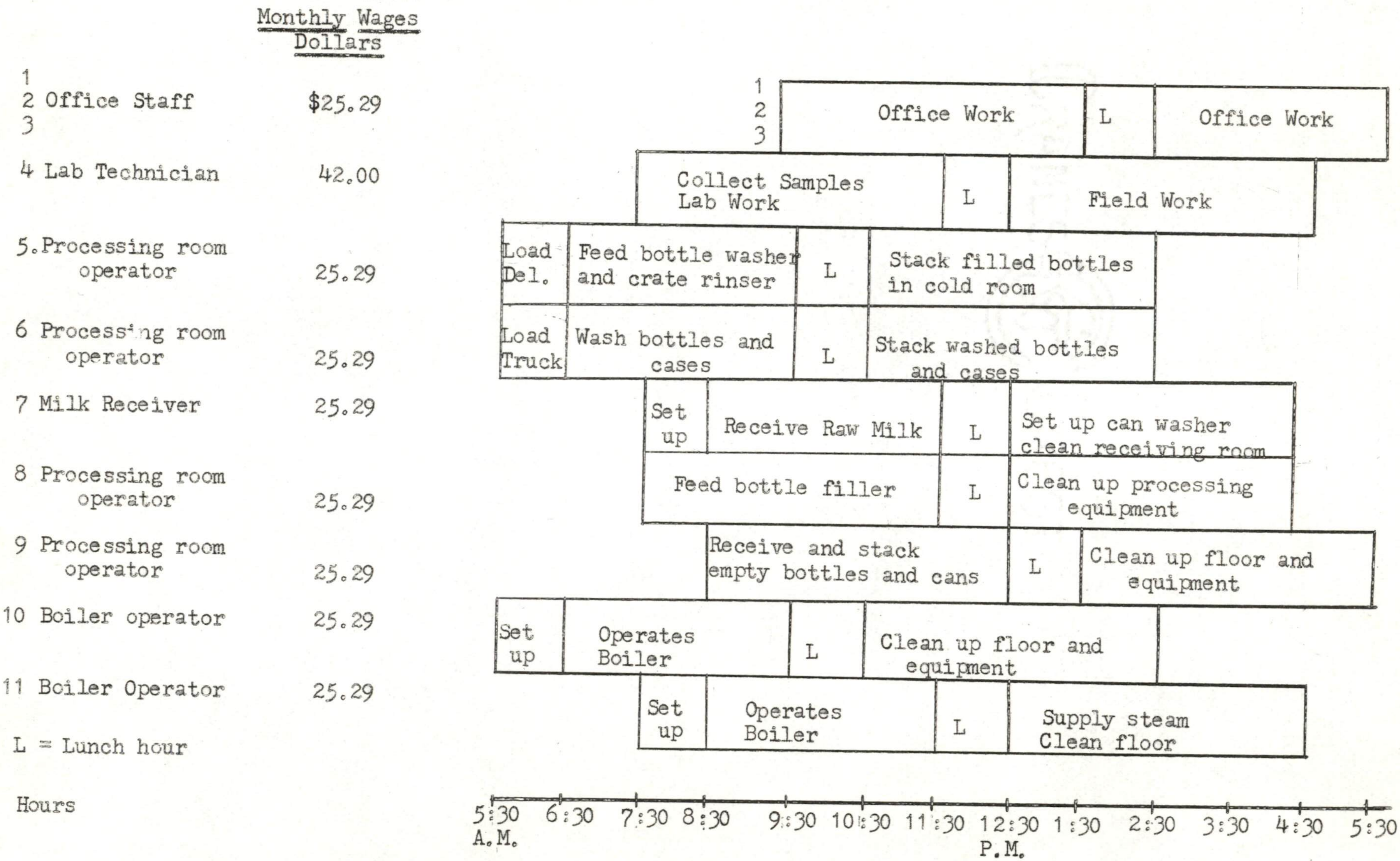

Figure 4. Plant Crew and Major Tasks.

TABLE XV

(2,000 GALLONS OF MILK PER DAY)

DAILY REFRIGERATION LOAD

Item	B.T.U.'s Per Day	Peak Requirement Per Hour
Pasteurization (cooling)	295,050	73,763
Cold storage (heat loss through walls)	122,573	5,107
Cooling milk in cold storage	335,916	13,996
Cooling cases and dollies	9,109	380
Cooling cans and bottles	35,680	1,487
Blower motor heat	45,810	2,545
Line losses	44,428	1,851
Total Refrigeration Load	888,566	99,129

DAILY STEAM REQUIREMENTS

Item	Pounds of Steam Per Day
Pasteurization[1]	1,246
Can Washing[2]	263
Bottle and Case Washing[3]	1,086
General Cleaning[4]	2,764
Loss	282
Total	5,641

[1] Heating water to 176° F. to raise the temperature of milk from 147.2° F. to 167° F.

[2] Can washer requires 250 pounds of steam per hour

[3] Two pound per case of bottles

[4] One pound for every three square feet

TABLE XV (continued)

DAILY WATER REQUIREMENTS

Item	Gallons Per Day
Compressor cooling	952
Can Washing	177
Pasteurization	120
Boilers	2,000
Bottle Washing	1,150
Personnel Use	375
General Use	860
Total	5,634