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Manufacturing costs in whole-milk creameries

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NOTE TO USERS

MANUFACTURING COSTS IN WHOLE-MILK CREAMERIES

by

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I. INTRODUCTION

This thesis concerns itself with the determination of the costs of manufacturing butter in creameries processing whole milk. This determination of creamery costs forms a part of Project 1169 of the Iowa Agricultural Experiment Station, under the auspices of the Research Marketing Act. The title of the project is "Reorganization of the Dairy Industry in Iowa." The project statement, as submitted to Research Marketing Act officials in Washington, D. C. by the Iowa Agricultural Experiment Station on December 27, 1948, contains in part the following:

> Description of work:
> (a) Problem and Need for Work
> 1. Problem: To readjust numbers, sizes, locations, and types of dairy plants in Iowa in accordance with economic allocation of resources and in the light of present and expected future requirements for dairy products.
> 2. Need for the Research: Iowa is the fourth largest dairy state, and occasionally moves into first place in butter production, but its dairy manufacturing industry has been slow to adjust to changing conditions. In spite of improved roads and transportation facilities, about as many plants have remained in production as in the period before World War I. Instead of plant consolidation or the demise of inefficient plants, much overlapping and duplication of routes for farm-to-plant assembly has developed.
> Although studies have shown clearly that considerable advantages in efficiency go with butter manufacturing operations of medium to

large scale, small creameries have persisted in Iowa.

Work on this project began in 1949, and, as a result of this work, Research Bulletin 389, of the Iowa Agricultural Experiment Station, was published in June, 1952. This bulletin developed the relationship between butter manufacturing costs and volume of production in gathered-cream creameries. It also showed strong evidence of the desirability of consolidation as a cost-reduction measure in many small Iowa creameries.

In 1951 and 1952, members of the Iowa Agricultural Experiment Station staff, as a part of Project 1169, did the groundwork for proposed consolidations in one specific Iowa area, in order to get a working knowledge of the problems that would be encountered in effecting a consolidation. It soon became evident that information about cost-volume relationships in gathered-cream creameries was insufficient. The question continually arose as to whether it would be more profitable to change from a gathered-cream operation to a whole-milk creamery at the time of consolidation, and, if so, what volume of production was desirable from a cost viewpoint in whole-milk creamery.

The increasing interest in whole-milk operations may be due to a number of factors. Some of these factors are:

1) An increasing awareness of the value of the non-fat

portion of the milk.

2) Availability of substitutes for skim milk for feeding purposes.

3) Dislike for performing the separation function on the farm.

4) Prevalence of large whole-milk plants in some large dairy areas.

5) Anticipation of high returns for the skim milk.

Regardless of the reason, an increasing interest does exist in switching from (a) separating the milk on the farm, with the skim milk remaining on the farm while the cream is shipped to the creamery for manufacture into butter, to (b) sending the whole milk to the creamery, with the creamery separating the milk, making butter with the cream and disposing of the skim milk in some form (such as processing it into non-fat dry milk powder.)

The extent to which it would be profitable to make this shift depends, to a large degree, upon the following:

1) The efficiency of separation on the farm, as compared with the efficiency of separation at the creamery.

2) The market value of the skim milk.

3) The value of the skim milk to the farmer for feed purposes.

4) The cost of hauling whole milk as compared with the cost of hauling cream.

5) The cost of manufacturing butter from whole milk as compared with the cost of manufacturing butter from cream.

This thesis concerns itself entirely with the cost of manufacturing butter from whole milk, and the relationship of this cost to volume of production. Specifically, costs are determined for operations from the receiving of the whole milk to the manufacture and packaging of the butter for sale as bulk butter, and the processing of the skim milk into storage for sale as such, or for further manufacturing operations.

Other studies are currently being made as part of Project 1169 to determine the costs of hauling both cream and whole milk for various volumes of production, and the costs of drying the skim milk into non-fat dry milk solids, and the returns that may be secured therefrom. Compilation of the results of these studies should provide the answers to the questions of whether it would be profitable to switch from gathered-cream to whole-milk operations, and what volume of production would be desirable from a cost viewpoint in a whole-milk creamery.

II. REVIEW OF LITERATURE

Most of the studies of costs in dairy plant operations made in the past have been studies made of plant records, rather than intensive study of plant operations.

Tinley and others (11) in 1935 made such a study of whole-milk creameries. The records of 20 creameries in California ranging in volume of output from ½ million to 7 million pounds annually were examined. These were, in the main, whole-milk creameries with the manufacture of butter as the primary enterprise and the drying of skim milk and buttermilk or the manufacture of casein as secondary activities. In this study, the manufacture of butter was charged with all expenses which would have been incurred if butter only were made, while the by-products were charged only with the additional expenses which could be attributed directly to their manufacture. Tinley found that labor costs, excluding hauling, cutting and wrapping, ranged from $7.45 to $17.55 per 1000 pounds of butter manufactured. Labor costs declined rapidly as volume increased from ½ million to 1½ million pounds and somewhat less rapidly from 1½ million to 2½ million pounds. One creamery with a volume of 4 million pounds had higher labor costs than the creameries

in the 2 million to 2½ million pound range, and two creameries manufacturing 6½ million pounds had still higher labor costs. These studies indicated that the optimum size with respect to labor utilization would be about 3½ million pounds annually.

Other such studies of different dairy plant operations have been reviewed in Research Bulletin 389 of the Iowa Agricultural Experiment Station.

In recent years most of the studies have been intensive studies of dairy plant operations. In June, 1948, Henry, Bressler, and Frick (8) published a study on economies of scale in market-milk plants. In this study, plants were constructed on paper and assigned outputs equal to their respective capacities. These capacities were computed from technical data and opinions. Inasmuch as each case presented was similar to all others in respect to the utilization of plant capacity, the economies indicated by the results were considered to be the true economies of scale for this type of operation.

A study in 1952 of similar operations by Bartlett and Bothard (1) used as the basis two plants that were considered to be efficient. These plants processed 3,250 and 12,750 gallons of milk per day respectively. The labor, space, equipment, electric power, and steam power used in these plants was studied in detail. These data were

presented largely to serve as a basis for comparison by other plants.

French (6) in 1952 described the research procedure used in the evaluating of the milk receiving labor in Indiana. The use of motion and time study techniques was described and time standards for receiving operations were established.

Hall (7) in 1953 published a talk given in 1952 in which receiving room efficiency and the causes of inefficiencies were discussed in detail. Hall also established time standards for receiving operations.

In 1952, Frazer, Nielsen, and Nord (5) published a study of butter manufacturing costs in gathered-cream creameries. Costs in sample plants were analyzed and compared with costs determined from plants constructed on paper. Close agreement between the costs determined by both methods was found.

III. METHOD OF PROCEDURE

The procedure followed in gathering the data for this thesis was built around the experience gained and data accumulated in the study of 13 gathered-cream creameries used as sample plants for Research Bulletin 389 of the Iowa Agricultural Experiment Station. All available data from these plants that could be applied to this study were used, and some of the standards that appear in this thesis were first developed for and published in Bulletin 389. For example, no attempt was made in this study to develop new time standards for churning operations, as these time standards were adequately determined for, and published in, Bulletin 389.

A. Sample Plants

In addition to this background information, 10 whole-milk plants were visited and their operations analyzed for this study. These plants performed a variety of operations and many of the plants provided only specific pieces of information, rather than being typical in entirety of the sort of operation being considered in this study. For example, both Grade A market milk plants and manufacturing

milk plants processing the milk by methods other than those requiring separation were studied, primarily to secure information on the receiving operation.

Most of the plants studied performed some operations in addition to those specifically ascribed to plants in this thesis. As a result, it was not feasible to present in this thesis a section on the costs in these sample plants, as the costs would encompass such a variety of operations that they would be rendered meaningless. Neither was it possible to locate sufficient plants performing only the desired functions and covering the desired volume range to permit such a sample plant section to be developed. However, sufficient information was secured in these plants to develop, on paper, plants capable of performing the desired functions. Bulletin 389 illustrated that plants developed in this manner provided cost figures very closely approximating the average of sample plant figures, and in many cases providing more and better information than that available from the sample plants. Thus data were gathered in a wide variety of plants and from these data typical plants were developed on paper covering the volume range and having costs typical of those that would be achieved if such plants were constructed.

B. Methods Used in Gathering Data

In gathering information for this study and other studies forming a part of Project 1169, a team of three or four men visited each plant for the combined purposes of gathering data needed for each individual study and of securing general impressions of problems confronting the dairy industry. Although not all the information was available at each plant, these procedures were followed at most plants:

1) The overall operation was inspected to observe the integration of work force, equipment, and functions performed.

2) Pertinent operations were timed with a stop watch.

3) Pertinent equipment in the plant was listed and described as to make, capacity, and function.

4) Cost data were secured from the plant's records.

5) Haulers were interviewed about their operation, and their problems were discussed.

6) The plant manager, plant superintendent, and key workers were interviewed, and problems of each were discussed.

An attempt was made to have all the people participating in the overall project become aware of the general problems in the dairy industry and of the problems involved in each facet of the project. This was done to provide lively

discussion of the methods to be used in each particular study, and group participation in making the basic decisions necessary in determining certain costs.

C. Basic Decisions

Some costs vary considerably among plants, due to a great many factors over which the individual plant managements have little or no control. In developing a study of this sort, it is necessary to standardize these many variables by selecting values typical of the industry as a whole. Establishment of these standards involves making basic decisions, the validity of which is very difficult to prove. Therefore, all such basic decisions have been made by the group as a whole rather than by the individual primarily concerned, in an attempt to keep arbitrariness in the decisions to a minimum, and to insure that the plants developed in this thesis represent as well as possible typical situations. Other standards, such as the time standards for various operations, and equipment necessary for various functions, have been established on the basis of intensive research and are not classified as basic decisions.

The following basic decisions concern the operation of the plant:

1. Average butterfat test in flush 3.5%
2. Average production per day per producer. 240 pounds
3. Average cans per day per producer..... 3.5 cans
4. Average cans per load..... 123 cans
5. Average patrons per load..... 35 patrons
6. Number of loads per churning..... 5
7. Average overrun..... 21.5%
8. Twice monthly testing of composite samples.
9. Production per churning..... 1800 lbs.
10. Operating days per week..... 7
11. Peak month's production represents 11% of annual production.

D. Methods of Determining Costs

Using the above standards, costs were developed for each of four levels of production. Plants I, II, III, and IV were constructed to produce one, two, three, and four full churnings per day in the peak season. The seasonal nature of the dairy business requires that some method of determining annual volume be arrived at, and it appeared logical to base the volume ranges on daily productions in the peak, calculating annual volumes from these fitures. Based on the peak month's production representing 11 per cent of annual production, and assuming a seven-day week--common in milk plants--these plants represent annual volumes

of 500,000; 1,000,000; 1,500,000; and 2,000,000 pounds of butter per year. All costs were similarly calculated on an annual basis. Sufficient labor and equipment were assigned to each plant to handle the peak load, and annual costs then assigned to this labor force and equipment.

1. Labor costs

In determining labor costs for the four plants, it was necessary to determine both the amount and type of labor required and also to determine the cost of the labor force in terms of wage rates. The amount and type of labor required was determined through exhaustive time studies of all phases of plant operations, and the recapitulation of these various times into time standards for the various plant operations. A complete list of the time standards is given in Appendix D. These time standards are typical of times taken to perform the operations in the plants studied, and do not represent any particular optimum or desired standard.

Recognizing the fact that organization of the work in a dairy plant is a complex problem, with peak loads making the allocation of the work difficult, work organization charts have been developed for a day's production in the peak season for each plant. The charts for each plant may be found in Appendix E. These work organizations itemize

the work to be done during the day as part of the daily routine, and, in addition, provide "idle time" for such irregular duties as loading butter, which, as it occurs irregularly, cannot be assigned a specific time on the work organization chart. Not shown on the charts are the work schedules of the manager, clerical help, testers, or additional men needed to provide a day off each week for the operating personnel.

Most creameries employ their men on an annual salary basis, and, with few exceptions, keep a constant work force throughout the year. Thus, no seasonal employees have been provided for in this study. Rather, it has been assumed that such functions as painting of buildings and equipment, the installation of new equipment, etc., will be performed during the slack season of the year.

Wage rates have, therefore, been established on an annual basis, and the following standard wage rates, typical of those being paid, have been established by group decision:

Manager (Plants I and II).....	$6500 per year
Manager (Plants III and IV).....	$7000 per year
Plant Superintendent.....	$4500 per year
Buttermaker.....	$4000 per year
Helper.....	$3000 per year
Tester.....	$2500 per year

Chief office clerk..... $2500 per year

Other office help..... $2000 per year

These standard wage rates were then applied to the employees of each plant, as determined by the work organization charts, in order to determine labor cost.

2. Building costs

Building costs were assessed by determining the space requirements for each general function in the plant, and determining the cost of providing that space. In every case, the space allocations provide enough room for the plant to be easily kept clean and presentable and also permit efficient operation. Space requirements are listed in Appendix F.

The cost of providing the necessary space was determined by calculating the present cost of constructing an adequate building. This cost was determined through the use of "Boeckh's Manual of Appraisals" (2) and the "Boeckh Index Calculator Tables" (3). A sample calculation of building replacement cost may be found in Appendix A. The values listed are for single-story brick and concrete construction, adjusted by a current Des Moines index of 2.444. For each plant, the adjusted cost was increased by $11,000 as an allowance for special items in creamery construction, such as cold storage facilities and tiled walls.

The annual cost of the building was then found by taking 4 per cent of this present cost as the cost of depreciation and maintenance on the building. The amount of money spent on maintenance materially affects the life, and therefore the rate of depreciation, of the building, with depreciation costs and maintenance costs tending to vary inversely. As no attempt has been made to evaluate how much money should be spent on maintenance, the depreciation and maintenance costs have been grouped as one. This is not presented as a generally applicable treatment of depreciation, but only as a satisfactory one in this instance.

In addition to the cost for depreciation and maintenance, an interest cost of 5 per cent of the average investment is charged, with the average investment considered to be one-half of the original investment. Thus, the annual cost of the building is the sum of the depreciation, maintenance, and interest costs, or an amount equal to 6.5 per cent of the present cost.

3. Equipment costs

Equipment costs were determined in a manner very similar to building costs. The necessary equipment to do the job efficiently and well was first determined. This was done after listing equipment in the various sample plants

and discussing the problems involved with plant managers and operating personnel, as well as representatives of manufacturers of dairy equipment. Present costs of the equipment were secured from manufacturers and suppliers of dairy equipment. A complete list of equipment installations and costs may be found in Appendix B.

The annual cost of the equipment was found by grouping depreciation and maintenance costs as one percentage, with the percentage applied to the original cost of the individual piece of equipment. These two costs have been grouped following the same reasoning as discussed in determining building costs. The choice of the percentage charge for depreciation and maintenance comes from estimates of the life of the equipment and of the maintenance cost of that equipment. The selection of appropriate depreciation and maintenance rates was considered a basic decision, and, as such, represents the consensus of opinion of the group working on Project 1169. Bulletin "F" of the U. S. Treasury Department, Bureau of Internal Revenue, entitled "Income Tax, Depreciation and Obsolescence, Estimated Useful Lives and Depreciation Rates" (12), "The Market-Milk Industry" by C. L. Roadhouse and J. L. Henderson (10), and "Dairy Engineering" by A. W. Farrall (4), were used as references. A complete list of the depreciation and maintenance rates used is given in Appendix C.

In addition to the depreciation and maintenance costs, interest is charged at 5 per cent of the average investment in equipment, with the average investment taken as one-half of the original investment. Thus, the annual cost of the equipment is the sum of the depreciation, maintenance and interest costs, all calculated as a percentage of the investment in equipment. Appendix I lists the total investment in building and equipment for each of the plants.

4. Other costs

Labor, building, and equipment are responsible for about two-thirds of the total cost involved in this type of plant. These costs have, therefore, received a large share of the attention in developing costs for this thesis. Other items of cost, such as packaging materials, are very easy to determine for various sized plants, while still others, such as power, will vary considerably, depending upon local conditions. In general, the costs of fuel, power, materials used in processing, packaging materials, general plant supplies, office supplies, and general administrative expense, were determined by using the figures available from both the ten plants visited for this study, and the 13 sample plants of Bulletin 389. In most cases, it was necessary to alter the actual figures of the plants to fit the functions of the plants developed here, and an

average of these values was then selected. All of these calculations were considered basic decisions and subjected to the scrutiny of the entire group. While these figures are subject to greater percentage error than the others, the absolute error is not considered to be overly severe.

The costs of insurance, local taxes, and payroll taxes were computed for each plant at standardized rates. Insurance was computed at $1.35 per $100 of coverage on the building and $1.45 per $100 of coverage on the contents of the building. These rates were furnished by the Iowa Inspection Bureau, Des Moines, Iowa, as being representative rates for insuring butter plants. The rates were applied to a coverage representing 80 per cent of average investment. Local taxes were charged at the rate of 30 mills per dollar of average investment. Payroll taxes were charged at a rate of 2 per cent of the wages paid.

In some instances costs have been departmentalized for ease in presentation and for comparison between plants. However, departmental costs have not been calculated in total, as such cost figures have not been found to have any particular value.

IV. RESULTS

Using the methods discussed in the preceding section, costs have been established for Plants I, II, III, and IV as 9.42, 7.18, 6.26, and 5.62 cents per pound of butter manufactured respectively. A complete summary of total costs in these plants may be found in Appendix G. These figures represent the plant costs of receiving the whole milk, separating, pasteurizing, and churning the cream into butter, packaging the butter for sale in bulk, and storing the bulk butter for shipment. In addition, the costs of cooling and storing the skim milk are included. The costs of assembling the milk from the farm to the creamery, and further processing the skim milk are not included, but are being separately studied as a part of Project 1169.

A. Plant I

Plant I, with a production of 500,000 pounds of butter per year, has a unit cost of 9.42 cents per pound. Table 1 shows the primary costs in cents per pound of butter manufactured for Plant I. During the peak day Plant I manufactures 1,800 pounds of butter, requiring that it take in 1,480 pounds of fat--based on a 21.5 per cent overrun--and

Table 1

Primary Costs for Plant I in Cents Per Pound of Butter Manufactured
(Annual Production - 500,000 pounds)

Labor	3.25
Fuel	.70
Power	.45
Materials used in processing	.05
Packaging materials	.23
Building cost	.69
Equipment cost	2.63
Insurance	.18
Taxes	.48
Payroll taxes	.07
General plant supplies	.35
Office supplies	.05
General administrative expense	.29
Total cost per pound	9.42

42,300 pounds of milk of 3.5 per cent milk. This 42,300 pounds of milk is separated into approximately 4,300 pounds of cream and 38,000 pounds of skim milk.

Milk is received in Plant I by one person at the rate of 20,000 pounds per hour. In order to handle this quantity, the receiving room is equipped with a 1,000 pound scale, complete with printomatic attachment and automatic sampler, a 750 pound weigh tank, and a 1,000 pound receiving vat. The milk is pumped to separation through 2-inch sanitary pipe by a 3 horsepower centrifugal pump.

The milk is stored before separation in a 2,000 gallon (16,000 pound) surge tank at a temperature of approximately 55° F. From here the milk is pumped through a preheater, preheating it to 100° F. before separation in two separators, each having a capacity of 11,000 pounds per hour. The cream then goes to one of two 600 gallon round processors for pasteurizing and cooling and overnight storage. This cream is churned into butter the following morning in one 2,000 pound churn. Following separation, the skim milk is cooled from 100° F. to 40° F. in a plate cooler with a capacity of 20,000 pounds per hour, and is then stored in a 5,000 gallon (40,000 pound) cold wall storage tank.

A complete list of the equipment installed in Plant I is given in Appendix B. The equipment in every case, has sufficient capacity to handle the product as fast as the

plant personnel could be expected to perform the operations. Although often seen, it does not make sense from an economic viewpoint to have, for example, the receiving operation slowed down due to too small a pump removing the milk from the receiving tank. In addition to providing equipment of sufficient capacity, labor-saving equipment has been installed wherever feasible. For example, although the installation of a printomatic attachment and automatic sampler do not appreciably improve the receiving rate, they do make the job of receiving milk easier to perform and thereby are considered to more than justify their annual cost (excluding interest) of $110.

The labor force in Plant I consists of a manager, a combination buttermaker-plant superintendent, 1 helper, 1 half-time tester, and 1 half-time office clerk. This results in a total annual labor cost of $16,250, made up as follows:

Manager	$6500
Buttermaker-Superintendent	$4500
Helper	$3000
Half-time tester	$1000
Half-time office clerk	$1250
Total	$16,250

The use of a half-time tester and a half-time office clerk is based on the assumption that these duties will be

performed by female employees. Observation in the field indicates that half-time female help is generally available while half-time male help is not.

The work organization chart for Plant I, showing the daily duties of the buttermaker and the helper, can be found in Appendix E. The duties of the manager, the half-time tester and the half-time office clerk are not shown. An office clerk, working half-days only, should be able to handle the necessary clerical duties for a plant this size, while one person should be able to do the necessary testing by working two full days each week. The duties of the manager encompass a great many functions, at least some of which may call for his being away from the creamery at some times. Therefore, the manager has not been assigned any specific plant duties on a daily basis. However, in this size plant, the management functions are not as complex as in the larger plants, and the manager is expected to relieve the buttermaker and the helper on their day off. Thus the manager is expected to work two days a week in the plant, thereby keeping the plant operating seven days a week, with no employee working more than six days a week.

The work organization of Plant I shows the buttermaker working approximately seven hours a day, and the helper working seven and a half hours a day. The buttermaker begins work at 7:00 a.m. and performs most of the functions

associated with churning. He also supervises the operation of the equipment used in separating, pasteurizing, and cooling the milk, and he cleans the churn at the same time. In addition, he does some cleaning later in the day. The helper begins work at 9:00 a.m., helps tub and weigh the butter, and does all the receiving. Receiving takes place over a period of two and a half hours. In addition, he does the majority of the cleaning in the plant. Very little idle time is available during this period for such irregular duties as receiving supplies. These duties are not as time-consuming in this size plant as they are in the larger plants, however, and it is anticipated that the manager will be available to perform such functions at least part of the time. Otherwise, the length of the working day for these personnel in this plant would have to be increased, although it is not anticipated that a working day of more than eight hours would often be necessary.

B. Plant II

Plant II, with a production of 1,000,000 pounds of butter per year, has a unit cost of 7.18 cents per pound. Table 2 shows the primary costs in cents per pound of butter manufactured for Plant II.

Table 2

Primary Costs for Plant II in Cents Per Pound of Butter Manufactured (Annual Production - 1,000,000 pounds)

Labor	2.65
Fuel	.55
Power	.45
Materials used in processing	.05
Packaging materials	.23
Building cost	.39
Equipment cost	1.76
Insurance	.12
Taxes	.31
Payroll taxes	.05
General plant supplies	.35
Office supplies	.05
General administrative expense	.22
Total cost per pound	7.18

The chief reasons for the reduction in cost of 2.24 cents per pound from Plant I to Plant II lie in the reduction of labor, building, and equipment costs. Labor costs are reduced by .60 cent, building costs are reduced by .30 cent, and equipment costs are reduced by .87 cent. All of these costs increase in total but do not increase proportionately to the increase in production.

During the peak day, Plant II manufactures 3,600 pounds of butter, requiring that it take in 2,960 pounds of fat--based on a 21.5 per cent overrun--and 84,600 pounds of 3.5 per cent milk. This 84,600 pounds of milk is separated into approximately 8,600 pounds of cream and 76,000 pounds of skim milk.

Milk is received in Plant II by two men at the rate of 33,000 pounds per hour. In order to handle this quantity, the receiving room is equipped with a 1,000 pound scale, complete with printomatic attachment and automatic sampler, a 750 pound weigh tank, and a 1,500 pound receiving vat. The milk is pumped to separation through 2-inch sanitary pipe by a 3 horsepower centrifugal pump.

The milk is stored before separation in a 3,000 gallon surge tank at a temperature of approximately 55° F. From here the milk is pumped through a preheater, preheating it to 100° F. before separation in three separators, each having a capacity of 11,000 pounds per hour. The cream then

goes to two of three 600 gallon round processors for pasteurizing and cooling and overnight storage. This cream is churned into butter the following morning in one 2,000 pound churn. Following separation, the skim milk is cooled from 100° F. to 40° F. in a plate cooler with a capacity of 33,000 pounds per hour, and then stored in two 5,000 gallon cold wall storage tanks. A complete list of the equipment installed in Plant II is given in Appendix B.

The labor force in Plant II consists of a manager, a plant superintendent, a buttermaker, two helpers, a combination helper-tester, and a full-time office clerk. This results in a total annual labor cost of $26,500, made up as follows:

Manager	$6500
Plant Superintendent	$4500
Buttermaker	$4000
Helper	$3000
Helper	$3000
Helper-tester	$3000
Office clerk	$2500
Total	$26,500

The work organization chart for Plant II, showing the daily duties of the buttermaker, the plant superintendent and two helpers can be found in Appendix E. The duties of

the manager, the combination helper-tester and the office clerk are not shown. The manager in this plant is not expected to perform any plant duties. The combination helper-tester is used four days a week providing a day off for the other four men, and, in addition, does the testing for four days every two weeks.

The work organization chart shows the buttermaker beginning work at 7:00 a.m. and turning out two churnings by himself, completing these at noon. He then returns for two and a half hours in the afternoon and does some cleanup, but is generally available for miscellaneous duties. The plant superintendent works approximately a seven-hour day, with his chief function being the supervision of separating, pasteurizing, and cooling operations. He also does some cleaning in the afternoon. The two helpers also put in approximately seven-hour days, and do all the receiving and the bulk of the cleaning. By working an eight-hour day considerable time would be available for miscellaneous duties.

C. Plant III

Plant III, with a production of 1,500,000 pounds of butter per year, has a unit cost of 6.26 cents per pound. Table 3 shows the primary costs in cents per pound of butter

Table 3

Primary Costs for Plant III in Cents Per Pound of Butter Manufactured (Annual Production - 1,500,000 pounds)

Labor	2.40
Fuel	.50
Power	.45
Materials used in processing	.05
Packaging materials	.23
Building cost	.30
Equipment cost	1.36
Insurance	.09
Taxes	.24
Payroll taxes	.05
General plant supplies	.35
Office supplies	.05
General administrative expense	.19
Total cost per pound	6.26

manufactured for Plant III. The chief reasons for the reduction in cost of .92 cent from Plant II to Plant III lie in the reduction in equipment and labor costs. Equipment costs are reduced .40 cent, largely because relatively little extra equipment is needed in Plant III. Labor costs are reduced .25 cent, not due to a proportionate decrease in the number of employees, but due to the additional employees all being in the lower wage brackets.

During the peak day, Plant III manufactures 5,400 pounds of butter, requiring that it take in 4440 pounds of fat--based on a 21.5 per cent overrun--and 126,900 pounds of 3.5 per cent milk. This 126,900 pounds of milk is separated into approximately 12,900 pounds of cream and 114,000 pounds of skim milk. The receiving facilities and method of operation in Plant III are the same as those in Plant II. The principal additional pieces of equipment in Plant III not found in Plant II are an additional round processor, more storage capacity, another churn, and more refrigeration and steam capacity. A complete list of the equipment installed in Plant III is given in Appendix B.

The labor force in Plant III consists of a manager, a plant superintendent, a buttermaker, five helpers, a tester and one full-time and one half-time office clerk. This results in a total annual labor cost of $36,000, made up as follows:

Manager	$7000
Plant Superintendent	$4500
Buttermaker	$4000
Helper	$3000
Helper	$3000
Helper	$3000
Helper	$3000
Helper	$3000
Tester	$2000
Office clerk	$2500
Half-time office clerk	$1000
Total	$36,000

The work organization chart for Plant III, showing the daily duties of the buttermaker, the plant superintendent and four helpers can be found in Appendix E. The duties of the manager, the office help, the tester and one helper are not shown. The manager in this plant is not expected to perform any plant duties. The tester will be kept busy six days every two weeks. The extra helper works six days a week providing a day off for the other six men.

In this plant, the buttermaker and one helper do the majority of the work connected with churning. In addition, they give lunch hour relief to the plant superintendent and the man in receiving, and also do some cleaning. The plant superintendent primarily supervises the separating,

pasteurizing, and cooling functions. Two helpers do the majority of the receiving and a good share of the cleaning. The other helper assists in all operations at various times. Considerable time is available for miscellaneous duties, and no one works longer than an eight-hour day.

D. Plant IV

Plant IV, with a production of 2,000,000 pounds of butter per year, has a unit cost of 5.62 cents per pound. Table 4 shows the primary costs in cents per pound of butter manufactured for Plant IV. The cost reduction of .64 cent is the smallest difference between plants found in this study, and is chiefly composed of a .25 cent reduction in labor cost and a .22 cent reduction in equipment cost. Labor costs are reduced chiefly because of the economies in work organization realized by hiring a special cleanup crew, and also because all additional employees are in the lower wage bracket. Some expensive additional equipment is required in Plant IV, causing the reduction in equipment cost to be relatively small. Increased production with much of the equipment remaining unchanged still leaves an appreciable cost reduction, however.

During the peak day, Plant IV manufactures 7,200 pounds of butter, requiring that it take in 5,920 pounds of fat--

Table 4

Primary Costs for Plant IV in Cents Per Pound of Butter Manufactured (Annual Production - 2,000,000 pounds)

Labor	2.15
Fuel	.47
Power	.45
Materials used in processing	.05
Packaging materials	.23
Building cost	.24
Equipment cost	1.14
Insurance	.07
Taxes	.20
Payroll taxes	.04
General plant supplies	.35
Office supplies	.05
General administrative expense	.18
Total cost per pound	5.62

based on a 21.5 per cent overrun--and 169,200 pounds of 3.5 per cent milk. This 169,200 pounds of milk is separated into approximately 17,200 pounds of cream and 152,000 pounds of skim milk. The receiving facilities and method of operation in Plant IV are the same as those in Plants II and III. Pasteurizing and cooling of the cream in Plant IV is done in a short-time-high-temperature pasteurizer, rather than in round processors. This method of pasteurization could have been used in Plant III at only very little additional cost; it is a more economical method of performing this function in Plant IV. Other major items of additional equipment in Plant IV are more storage and refrigeration capacity, as well as a composition control unit for the buttermaking process. A complete list of the equipment installed in Plant IV is given in Appendix B.

The labor force in Plant IV consists of a manager, a plant superintendent, a buttermaker, seven helpers, a tester, and two full-time office clerks. This results in a total annual labor cost of $43,000, made up as follows:

Manager	$7000
Plant Superintendent	$4500
Buttermaker	$4000
Helper	$3000
Helper	$3000
Helper	$3000

Helper.....	$3000
Helper.....	$3000
Helper.....	$3000
Helper.....	$3000
Tester.....	$2000
Office clerk.....	$2500
Office clerk.....	$2000
Total	$43,000

The work organization chart for Plant IV, showing the daily duties of the buttermaker, the plant superintendent and four helpers, can be found in Appendix E. The duties of the manager, the office help, the tester, and three helpers are not shown. The manager in this plant is not expected to perform any plant duties. The tester will be kept busy eight days every two weeks. One of the extra helpers is available to provide one day off a week for the other men. The other two helpers are cleaning men, and do the cleaning for the entire plant after the day's operations are completed. This cleaning requires a total of 10½ man-hours per day. The use of a night cleanup crew is subject to some criticism as being unlikely to result in an adequate cleaning job being done. However, night cleanup crews are being used in some places and are necessary in a plant of this size, unless two separate receiving lines are set up.

In this plant the buttermaker and one helper perform the churning function. In addition, they give lunch-hour relief to the plant superintendent and men in receiving, as well as being available for miscellaneous duties. The plant superintendent supervises the separating, pasteurizing, and cooling functions. The other three helpers split up the functions of receiving and being available for miscellaneous plant duties. In this plant, except for the 12:30 to 1:30 lunch hour, one man is always available for irregular duties of a general nature.

V. DISCUSSION

The results obtained in this study show costs of 9.42, 7.18, 6.26, and 5.62 cents per pound of butter manufactured for whole-milk creameries producing 500,000; 1,000,000; 1,500,000; and 2,000,000 pounds respectively. These figures represent the costs that could be expected under the stated conditions if new plants were constructed and equipped for whole-milk operation. In general, it is felt that the conditions imposed in developing the costs are typical of those prevalent in the dairy industry, and that the costs can fairly be said to be typical of the costs that can be expected for plants of this sort.

Unit costs decrease continuously at a decreasing rate throughout the volume range of this study. The lowest unit costs are found at an annual volume of 2,000,000 pounds, which represents the largest volume analyzed. Larger volumes have not been studied for several reasons. One reason is that the cost curve is beginning to level out and it is not anticipated that very substantial reductions in cost would be realized at greater volumes. In Plant IV the labor force is highly specialized throughout the working day, and the equipment is used to capacity throughout the

normal working period. Another reason is that it would not be possible to attain a greater volume without materially changing the method of operation. Either the milk would have to be received for a longer period than normal (requiring a change in hauling practices), or additional receiving lines would have to be set up either in the plant or at another location. Such a duplication of facilities would be unlikely to result in lower costs. A third reason is that the cost figures for relatively small plants are of more value to this study, in that changes to whole-milk operations in Iowa are far more likely to occur at relatively small volumes.

Even at the volume of Plant IV, some question arises as to the workability of the work organization. Many plant managers consider the use of night cleanup crews to be a completely unsatisfactory method of operation. However, they are in use in some places and have been used in Plant IV, as such an arrangement is necessary if 169,000 pounds of milk are to be received and processed in a day.

The cost curve for these whole-milk plants is considered to be more of a continuous function than the cost curve for gathered-cream creameries. The relatively large quantities of labor and equipment in all of these plants reduces the necessity for operating at a fixed volume, as the addition of a piece of equipment or the acquisition or separation of

a helper less seriously affects the overall cost picture. It is expected, therefore, that production midway between Plants I and II, or between Plants II and III, would result in cost figures approximately midway between the values determined for these plants.

The plants developed in this thesis produce both butter and skim milk, although costs have been developed in terms of cents per pound of butter manufactured. These costs can also be expressed in cents per hundred pounds of whole milk received, and a summary of costs in this unit may be found in Appendix H. These figures are presented because they are of value in comparing these costs with other whole-milk operations. However, the unit of cents per pound of butter manufactured has been generally used to permit comparison of these figures with those developed for creameries producing butter from gathered cream.

It should be recognized that in calculating costs in terms of cents per pound of butter manufactured, all of the costs have been charged against the butter, and none allocated to the skim milk. The butter and the skim milk are joint products and an allocation of costs between the two on any physical basis would necessarily be arbitrary and meaningless, as much of the cost is incurred before the two are separated. The pertinent costs here are the extra costs of manufacturing butter from whole milk as compared with

manufacturing butter from gathered cream. These costs can realistically be charged to the skim milk in deciding whether a switch to whole milk would be advisable.

Bulletin 389 of the Iowa Agricultural Experiment Station shows the costs of manufacturing butter from gathered cream to be from three to five cents per pound of butter manufactured in reasonably efficient plants, with the variation due to volume of production. Some adjustment of these figures should be made to take care of price level changes from the time they were developed until now, but it is not expected that such changes would increase the costs by more than 0.5 cent per pound. At an annual production of 2,000,000 pounds of butter, the extra costs in the whole-milk plants as compared with the gathered-cream plants amount to approximately two cents per pound of butter, while at an annual production of 1,000,000 pounds of butter, the extra costs are approximately three cents per pound of butter. A cost difference of three cents per pound of butter is equivalent to a cost of 14.22 cents per hundred pounds of skim milk. The skim milk must be of sufficient value to absorb these costs if a switch to whole milk is to be advisable.

The methods used in this thesis, and generally being used in Project 1169, are considered to be the best methods available for the determination of cost-volume relationships.

In addition, however, they provide a variety of other information of value to people working in the dairy industry. The equipment installations in these plants could very profitably be studied by many plant managers for comparison with the equipment they are now using. Many instances were observed where scrimping on equipment resulted in unnecessary extra costs due to slowing down the operation or requiring additional employees. The previously mentioned case where the pump is the bottleneck in the receiving operation is a good example of this. Study of the time standards and the work organization charts should also provide information about possible inefficient operations in individual plants. Some rather wide variations from these standards were observed in some cases, and these variations could well form the basis of critical evaluation by those in charge of, or those performing, the various operations.

In summary, these costs provide a large part of the answer to the questions of how large a whole-milk creamery should be, and whether a switch to whole milk from gathered cream would be advisable. Addition of these figures to those being determined for hauling costs and drying costs (if the skim milk is to be dried) will provide a basis for determining the most economical size for a whole-milk creamery. Comparison of these costs with costs in gathered-cream operations will provide the cost data necessary for

an evaluation of the advisability of switching to whole milk.

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VIII. APPENDICES

A. Sample Calculation of Replacement Cost of Creamery Building (Plant I)

Perimeter of building.....		300 ft.
Area of building.....	5441	sq. feet
Base price per sq. foot of ground area.		$ 3.18
Adjusted base price per sq. foot of ground area $3.18 x 2.444.....		$ 7.78
Estimate of replacement cost 5441 x $7.78		$42,300
Adjustment for additional facilities...		$11,000
Total estimate of replacement cost.....		$53,300

B. Equipment Installations and Costs

1. Administration

a. Plant I

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Calculator	800.00	10	80.00
Desk and chairs	100.00	10	10.00
Typewriter	100.00	10	10.00
Files	150.00	10	15.00
Safe	200.00	10	20.00
Miscellaneous	50.00	10	5.00
Total	1,400.00		140.00
Interest			35.00
TOTAL			175.00

b. Plant II

Equipment	Investment (dollars	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Calculator	800.00	10	80.00
Desk and chairs	200.00	10	20.00
Typewriter	100.00	10	10.00
Files	200.00	10	20.00
Safe	200.00	10	20.00
Adding machine	300.00	10	30.00
Total	1,800.00		180.00
Interest			45.00
TOTAL			225.00

c. Plant III

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Calculator	800.00	10	80.00
Desk and chairs	300.00	10	30.00
Typewriter	100.00	10	10.00
Files	300.00	10	30.00
Safe	200.00	10	20.00
Adding machine	300.00	10	30.00
Total	2,000.00		200.00
Interest			50.00
TOTAL			250.00

d. Plant IV

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Bookkeeping machine	3,500.00	10	350.00
Typewriter	100.00	10	10.00
Adding machines	600.00	10	60.00
Check writer	250.00	10	25.00
Desks, chairs, etc.	400.00	10	40.00
Files	300.00	10	30.00
Safe	300.00	10	30.00
Check sorter	150.00	10	15.00
Total	5,600.00		560.00
Interest			140.00
TOTAL			700.00

2. Receiving and testing

a. Plant I

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Suspension scales (1,000 lbs.)	900.00	10	90.00
Printomatic attachment	600.00	10	60.00
Weigh tank (750 lbs.)	1,500.00	10	150.00
Receiving tank (1,000 lbs.)	1,200.00	10	120.00
Automatic sampler	500.00	10	50.00
Milk pump (3 h.p.)	420.00	10	42.00
Can washer (10-13 cans/min.)	6,000.00	12	720.00
Conveyor installation	6,500.00	10	650.00
Sanitary pipe and fittings	500.00	12	60.00
Babcock centrifuge	270.00	10	27.00
Test bottle racks	50.00	10	5.00
Test bottle shaker	120.00	10	12.00
Table, sinks and stools	150.00	10	15.00
Storage for sample bottles	50.00	10	5.00
Sediment and methylene blue testing equipment	600.00	12	72.00
Installation	2,000.00	10	200.00
Total	21,360.00		2,278.00
Interest			534.00
TOTAL			2,812.00

b. Plants II, III, and IV

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Suspension scales (1,000 lbs.)	900.00	10	90.00
Printomatic attachment	600.00	10	60.00
Weigh tank (750 lbs.)	1,500.00	10	150.00
Receiving tank (1,500 lbs.)	1,300.00	10	130.00
Automatic sampler (2 compartment)	550.00	10	55.00
Milk pump (3 h.p.)	420.00	10	42.00
Can washer (10-13 cans/min.)	6,000.00	12	720.00
Conveyor installation	6,500.00	10	650.00
Sanitary pipe and fittings	500.00	12	60.00
Babcock centrifuge	270.00	10	27.00
Test bottle racks	70.00	10	7.00
Test bottle shaker	120.00	10	12.00
Table, sinks and stools	150.00	10	15.00
Storage for sample bottles	100.00	10	10.00
Sediment and methylene blue testing equipment	600.00	12	72.00
Installation	2,000.00	10	200.00
Total	21,580.00		2,300.00
Interest			540.00
TOTAL			2,840.00

3. Separation, pasteurization, and cooling

a. Plant I

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Storage tank (2,000 gal.)	4,300.00	8	344.00
Variable speed pump	1,250.00	10	125.00
Preheater (20,000 lbs./min.)	4,500.00	10	450.00
Separators (2-11,000 lbs./hr. each)	10,800.00	10	1,080.00
Separator bowl, table, and crane	400.00	10	40.00
Plate cooler	4,000.00	10	400.00
Storage tank (5,000 gal.)	9,000.00	8	720.00
Round processors (2-600 gal.)	9,000.00	10	900.00
Recording thermometers (2)	300.00	10	30.00
Indicating thermometers (3)	120.00	10	12.00
Sanitary pipe and fittings	3,500.00	12	420.00
Wash tank and pipe washer	800.00	10	80.00
Pipe racks and tables for fittings	400.00	10	40.00
Installation	2,500.00	10	250.00
Total	50,870.00		4,891.00
Interest			1,272.00
TOTAL			6,162.00

b. Plant II

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Storage tank (3,000 gal.)	6,000.00	8	480.00
Variable speed pumps (3)	3,000.00	10	300.00
Preheaters (3-11,000 lbs./hr. each)	6,000.00	10	600.00
Separators (3-11,000 lbs./hr. each)	16,200.00	10	1,620.00
Separator bowl, table, and crane	400.00	10	40.00
Plate cooler	6,000.00	10	600.00
Storage tanks (2-5,000 gal.)	18,000.00	8	1,440.00
Round processors (3-600 gal.)	13,500.00	10	1,350.00
Recording thermometers (3)	450.00	10	45.00
Indicating thermometers (5)	200.00	10	20.00
Sanitary pipe and fittings	4,500.00	12	540.00
Wash tank and pipe washer	800.00	10	80.00
Pipe racks and tables for fittings	500.00	10	50.00
Installation	3,500.00	10	350.00
Total	79,050.00		7,515.00
Interest			1,976.00
TOTAL			9,491.00

c. Plant III

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Storage tank (3,000 gal.)	6,000.00	8	480.00
Variable speed pumps (3)	3,000.00	10	300.00
Preheaters (3-11,000 lbs./hr. each)	6,000.00	10	600.00
Separators (3-11,000 lbs./hr. each)	16,200.00	10	1,620.00
Separator bowl, table, and crane	400.00	10	40.00
Plate cooler	6,000.00	10	600.00
Storage tanks (2-7,000 gal.)	22,000.00	8	1,760.00
Round processors (4-600 gal.)	18,000.00	10	1,800.00
Recording thermometers (4)	600.00	10	60.00
Indicating thermometers (6)	240.00	10	24.00
Sanitary pipe and fittings	4,500.00	12	540.00
Wash tank and pipe washer	800.00	10	80.00
Pipe racks and tables for fittings	500.00	10	50.00
Installation	3,500.00	10	350.00
Total	87,740.00		8,304.00
Interest			2,194.00
TOTAL			10,498.00

d. Plant IV

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Storage tank (3,000 gal.)	6,000.00	8	480.00
Variable speed pumps (3)	3,000.00	10	300.00
Preheaters (3-11,000 lbs./hr. each)	6,000.00	10	600.00
Separators (3-11,000 lbs./hr. each)	16,200.00	10	1,620.00
Separator bowl, table, and crane	400.00	10	40.00
Plate cooler	6,000.00	10	600.00
Storage tanks (3-7,000 gal.)	33,000.00	8	2,640.00
Cream pasteurizer and cooler	8,000.00	10	800.00
Storage tank (2,500 gal.)	6,500.00	8	520.00
Round processor	4,500.00	10	450.00
Recording thermometer	150.00	10	15.00
Indicating thermometers (5)	200.00	10	20.00
Sanitary pipe and fittings	4,500.00	12	540.00
Wash tank and pipe washer	800.00	10	80.00
Pipe racks and tables for fittings	500.00	10	50.00
Installation	4,000.00	10	400.00
Total	99,750.00		9,155.00
Interest			2,494.00
TOTAL			11,649.00

4. Churning

a. Plant I

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Churn (1-2,000 lb.)	3,850.00	15	578.00
Platform scales	550.00	10	55.00
Water filter	120.00	10	12.00
Conveyor	150.00	10	15.00
Buttermilk pump	350.00	10	35.00
Moisture balance	100.00	10	10.00
Tape dispenser	40.00	10	4.00
Buttermilk tank	200.00	8	16.00
Miscellaneous	150.00	10	15.00
Total	5,510.00		740.00
Interest			138.00
TOTAL			878.00

b. Plant II

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Churn (1-2,000 lb.)	3,850.00	15	578.00
Platform scales	550.00	10	55.00
Water filter	120.00	10	12.00
Conveyor	150.00	10	15.00
Buttermilk pump	350.00	10	35.00
Moisture balance	100.00	10	10.00
Tape dispenser	40.00	10	4.00
Buttermilk tank	300.00	8	24.00
Miscellaneous	150.00	10	15.00
Total	5,610.00		748.00
Interest			140.00
TOTAL			888.00

c. Plant III

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Churns (2-2,000 lb.)	7,700.00	15	1,155.00
Platform scales	550.00	10	55.00
Water filter	180.00	10	18.00
Conveyor	150.00	10	15.00
Buttermilk pump	350.00	10	35.00
Moisture balance	100.00	10	10.00
Tape dispenser	40.00	10	4.00
Buttermilk tank	400.00	8	32.00
Miscellaneous	150.00	10	15.00
Total	9,620.00		1,339.00
Interest			240.00
TOTAL			1,579.00

d. Plant IV

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Churns (2-2,000 lb.)	7,700.00	15	1,155.00
Platform scales	550.00	10	55.00
Water filter	180.00	10	18.00
Conveyor	150.00	10	15.00
Buttermilk pump	350.00	10	35.00
Moisture balance	100.00	10	10.00
Tape dispenser	40.00	10	4.00
Buttermilk tank	500.00	8	40.00
Composition control unit	600.00	6	36.00
Miscellaneous	150.00	10	15.00
Total	10,320.00		1,383.00
Interest			258.00
TOTAL			1,641.00

5. General plant (refrigeration)

a. Plant I

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Compressor Condenser	3,700.00	8	296.00
Ice builder	4,400.00	8	352.00
Compressor	350.00	8	28.00
Cooling unit	500.00	10	50.00
Sweet water pumps (2)	600.00	10	60.00
Installation	1,500.00	8	120.00
Total	11,050.00		906.00
Interest			276.00
TOTAL			1,182.00

b. Plant II

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Compressor Condenser	5,130.00	8	410.00
Ice builders	8,800.00	8	704.00
Compressor	350.00	8	28.00
Cooling unit	500.00	10	50.00
Sweet water pumps (2)	600.00	10	60.00
Installation	2,000.00	8	160.00
Total	17,380.00		1,412.00
Interest			434.00
TOTAL			1,846.00

c. Plant III

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Compressor Condenser	6,780.00	8	542.00
Ice builders	13,200.00	8	1,056.00
Compressor	450.00	8	36.00
Cooling unit	500.00	10	50.00
Sweet water pumps (2)	600.00	10	60.00
Installation	2,500.00	8	200.00
Total	24,030.00		1,944.00
Interest			601.00
TOTAL			2,545.00

d. Plant IV

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Compressor Condenser	8,290.00	8	663.00
Ice builders	17,600.00	8	1,408.00
Compressor	450.00	8	36.00
Cooling unit	500.00	10	50.00
Sweet water pumps (2)	600.00	10	60.00
Installation	3,000.00	8	240.00
Total	30,440.00		2,457.00
Interest			761.00
TOTAL			3,218.00

6. General plant (steam, water, etc.)

a. Plant I

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Steam generator	6,600.00	8	528.00
Feed water pump	700.00	12	84.00
Fuel oil tank	1,500.00	8	120.00
Fuel pump	500.00	10	50.00
Steam header	600.00	8	48.00
Installation	2,000.00	8	160.00
Water well	2,000.00	8	160.00
Water pump and pressure tank	1,000.00	8	80.00
Heating units (6)	600.00	10	60.00
Lockers	100.00	8	8.00
Miscellaneous	2,000.00	10	200.00
Total	17,600.00		1,498.00
Interest			440.00
TOTAL			1,938.00

b. Plant II

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Steam generator (125 h.p.)	8,500.00	8	680.00
Feed water pump	800.00	12	96.00
Fuel oil tank	1,500.00	8	120.00
Fuel pump	500.00	10	50.00
Steam header	600.00	8	48.00
Installation	2,500.00	8	200.00
Water well	2,000.00	8	160.00
Water pump and pressure tank	1,200.00	8	96.00
Heating units (6)	600.00	10	60.00
Lockers	200.00	8	16.00
Miscellaneous	2,500.00	10	250.00
Total	20,900.00		1,776.00
Interest			522.00
TOTAL			2,298.00

c. Plant III

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Steam generator (150 h.p.)	9,500.00	8	760.00
Feed water pump	850.00	12	102.00
Fuel oil tank	2,000.00	8	160.00
Fuel pump	500.00	10	50.00
Steam header	600.00	8	48.00
Installation	3,000.00	8	240.00
Water well	2,000.00	8	160.00
Water pump and pressure tank	1,400.00	8	112.00
Heating units (8)	800.00	10	80.00
Lockers	300.00	8	24.00
Miscellaneous	3,000.00	10	300.00
Total	23,950.00		2,036.00
Interest			599.00
TOTAL			2,635.00

d. Plant IV

Equipment	Investment (dollars)	Depreciation and maintenance rate (per cent)	Yearly cost (dollars)
Steam generator (150 h.p.)	9,500.00	8	760.00
Feed water pump	850.00	12	102.00
Fuel oil tank	2,000.00	8	160.00
Fuel pump	500.00	10	50.00
Steam header	600.00	8	48.00
Installation	3,000.00	8	240.00
Water well	2,000.00	8	160.00
Water pump and pressure tank	1,400.00	8	112.00
Heating units (8)	800.00	10	80.00
Lockers	400.00	8	32.00
Miscellaneous	3,500.00	10	350.00
Total	24,550.00		2,094.00
Interest			614.00
TOTAL			2,708.00

C. Depreciation and Maintenance Rates for Various Types of Equipment

Type of Equipment	Depreciation and maintenance rate (per cent)
Steam generators, water pumps, water wells, pressure tanks, buttermilk tanks, compressors and ice builders.....	8
Office equipment, cream and butter scales, dump tanks, cream and butter testing equipment, conveyor installations, cream and buttermilk pumps, recording and indicating thermometers, cooling and heating units, separators, round processors, miscellaneous equipment and tools.....	10
Can washers, sanitary pipes and fittings, sediment testing equipment and feed water pumps.....	12
Churns.....	15
Cream filters.....	20

D. Time Standards for Creamery Operations

1. Churning

Rinse churn	5 min.
Run cream into churn	15 min.
Run churn	45 min.
Drain buttermilk	10 min.
Wash butter	10 min.
Drain wash water	10 min.
Add salt and run churn	5 min.
Run test, add water, run churn	15 min.

After rinsing churn, one man would be substantially free for next hour, busy 15 of the next 30 minutes, and fully occupied the next 20 minutes.

Tub 1,800 lbs. butter (1 man)	20 min.
Tub 1,800 lbs. butter (2 men)	10 min.
Weigh, package and remove 1,800 lbs. of butter (1 man)	25 min.
Weigh, package and remove 1,800 lbs. of butter (2 men)	15 min.
Make boxes for 1,800 lbs. of butter (1 man)	10 min.
Line boxes for 1,800 lbs. of butter (1 man)	15 min.
Clean churn	60 min.
Time required of 1 man on cleaning churn	10 min.
Make records	15 min. per churning

2. Receiving

Receiving rate (1 man).....	5 cans per min.
Receiving rate (2 men).....	8 cans per min.
(Allow 5 minutes between loads)	
Total receiving time (Plant I).....	143 min.
Total receiving time (Plant II).....	199 min.
Total receiving time (Plant III).....	300 min.
Total receiving time (Plant IV).....	403 min.
Prepare receiving room.....	10 min.

3. Pasteurizing, separating, and cooling

Although not kept busy 100 per cent of the time, the full-time attention of one man is required to supervise the operation of the equipment used in separating the whole milk and preparing the cream for churning and the skim milk for storage.

4. Cleaning

a. Plant I

Clean receiving room.....	60 min.
Clean separators (45 min. each).....	90 min.
Clean storage vats (30 min. each).....	60 min.
Clean round processor.....	30 min.
Clean plate cooler.....	30 min.
Clean pipes.....	30 min.
General plant cleanup.....	60 min.
Total man-minutes cleaning time.....	360 min.

b. Plant II

Clean receiving room	60 min.
Clean separators (45 min. each)	135 min.
Clean storage vats (30 min. each)	90 min.
Clean round processors (30 min. each)	60 min.
Clean plate cooler	45 min.
Clean pipes	30 min.
General plant cleanup	90 min.
Total man-minutes cleaning time	510 min.

c. Plant III

Clean receiving room	60 min.
Clean separators (45 min. each)	135 min.
Clean storage vats (30 min. each)	90 min.
Clean round processors (30 min. each)	90 min.
Clean plate cooler	45 min.
Clean pipes	30 min.
General plant cleanup	90 min.
Total man-minutes cleaning time	540 min.

d. Plant IV

Clean receiving room	60 min.
Clean separators (45 min. each)	135 min.
Clean storage vats (30 min. each)	150 min.
Clean round processor	30 min.
Clean plate cooler	45 min.

Clean cream pasteurizer and cooler.....	45 min.
Clean pipes.....	45 min.
General plant cleanup.....	120 min.
Total man-minutes cleaning time.....	630 min.

E. Work Organizations

APPENDIX E.
WORK ORGANIZATIONS
PLANT I

Time	Buttermaker	Helper
7:00 A.M.		
	Rinse churn	
	Attend boiler	
	Make boxes	
7:30 A.M.		
	Clean Round Processor	
8:00 A.M.	Line boxes	
	Busy churning	
8:30 A.M.	Idle 15 min.	
	Busy churning	
9:00 A.M.		
	Tub butter	Tub butter
	Weigh butter	Weigh butter
		Prepare receiving room
9:30 A.M.	Idle 40 min.	
	Eat	Idle 30 min.
10:00 A.M.		
	Assemble pipes	
10:30 A.M.		
	Tend Pasteurization, Separation, etc.	Receive
11:00 A.M.		
11:30 A.M.		
12:00 Noon		

Figure 1 (continued).

APPENDIX E. (continued)
PLANT I (continued)

Time	Buttermaker	Helper
12:00 Noon		
		Receive
12:30 P.M.	Tend Pasteurization, Separation, etc.	
1:00 P.M.		Eat
1:30 P.M.	Eat	
2:00 P.M.		Clean receiving room
2:30 P.M.	Clean two separators	
		Clean plate cooler
3:00 P.M.		
		Clean pipes
3:30 P.M.		
	Records	
		Clean storage vat
4:00 P.M.		
		Clean storage vat (skim)
4:30 P.M.		
5:00 P.M.		General plant cleanup
5:30 P.M.		

Figure 2. Plant II.

APPENDIX E. (continued)
PLANT II

Time	Buttermaker	Plant Superintendent	Helper	Helper
7:00 A.M.	Rinse churn Attend boiler			
	Make boxes			
7:30 A.M.	Clean Round Processor			
8:00 A.M.	Line boxes			
	Busy churning			
8:30 A.M.	Idle 15 min.			
	Busy churning			
9:00 A.M.	Tub butter	Assemble pipes	Prepare receiving room	Prepare receiving room
9:30 A.M.	Weigh butter	Idle 45 min.	Idle 50 min.	Idle 50 min.
	Make boxes			
10:00 A.M.	Line boxes			
	Idle 10 min.			
10:30 A.M.	Busy churning			
	Idle 15 min.			
11:00 A.M.	Busy churning	Tend Pasteurization, Separation, etc.	Receive	Receive
	Tub butter			
11:30 A.M.	Weigh butter			
12:00 Noon	Idle 10 min.			

Figure 2 (continued)

APPENDIX E. (continued)
PLANT II (continued)

Time	Buttermaker	Plant Superintendent	Helper	Helper
12:00 Noon				
12:30 P.M.	Idle 60 min.			
	Eat		Receive	Receive
1:00 P.M.		Tend Pasteurization, Separation, etc.		
	Clean churns			
1:30 P.M.	Clean Round Processor			
			Eat	Eat
2:00 P.M.	Idle 50 min.			
2:30 P.M.		Idle 60 min.		
		Eat		
	General plant cleanup		Clean storage vat	
3:00 P.M.				Clean receiving room
	Records		Clean pipes	
3:30 P.M.		Clean two separators		
			Clean plate cooler	Clean separator
4:00 P.M.				
4:30 P.M.			Clean storage vat (skim)	Clean storage vat (skim)
		General plant cleanup	General plant cleanup	General plant cleanup
5:00 P.M.				
5:30 P.M.				

Figure 3. Plant III

APPENDIX E. (continued)
PLANT III

Time	Buttermaker	Helper	Plant Superintendent	Helper	Helper	Helper
7:00 A.M.	Rinse churn Attend boiler					
	Make boxes					
7:30 A.M.	Line boxes					
	Idle 25 min.					
8:00 A.M.	Rinse churn					
	Busy churning	Clean Round Processor				
8:30 A.M.	Idle 15 min.					
	Busy churning	Make boxes Idle 15 min.				
9:00 A.M.	Tub butter	Tub butter		Prepare receiving room	Prepare receiving room	Clean Round Processor
	Busy churning and weighing butter	Weigh butter Line boxes	Assemble pipes			
9:30 A.M.			Idle 40 min.	Idle 50 min.	Idle 50 min.	
	Busy churning	Idle 20 min.				Idle 25 min.
10:00 A.M.	Idle 10 min.	Tub butter				Tub butter
	Busy churning	Weigh butter				Weigh butter
10:30 A.M.	Idle 15 min.	Make boxes				Clean Round Processor
	Busy churning	Line boxes	Tend Pasteurization, Separation, etc.	Receive	Receive	
		Idle 10 min.				Idle 5 min.
11:00 A.M.		Tub butter				Tub butter
		Weigh butter				Weigh butter
	Idle 65 min.					
11:30 A.M.	Eat	Idle 40 min.				Idle 40 min.
12:00 Noon						

Figure 3 (continued)

APPENDIX E. (continued)
PLANT III (continued)

Time	Buttermaker	Helper	Plant Superintendent	Helper	Helper	Helper
12:00 Noon						
12:30 P.M.	Tend Pasteurization, Separation, etc.	Idle 60 min. Eat	Idle 60 min. Eat	Idle 60 min. Eat	Receive	Receive
1:00 P.M.						
1:30 P.M.	Clean churns Idle 50 min.	Receive			Idle 60 min. Eat	Idle 60 min. Eat
2:00 P.M.			Tend Pasteurization, Separation, etc.	Receive		
2:30 P.M.	General plant cleanup Records	Idle 90 min.			Receive	Idle 90 min.
3:00 P.M.				Clean receiving room	Clean receiving room	
3:30 P.M.						
4:00 P.M.		Clean two separators	Records	Idle 30 min. Clean pipes	Idle 30 min. Clean storage vat	Clean separator
4:30 P.M.						Clean plate cooler
5:00 P.M.			General plant cleanup	Clean storage vat (skim)	Clean storage vat (skim)	
5:30 P.M.				General plant cleanup	General plant cleanup	General plant cleanup

Figure 4. Plant IV.

APPENDIX E. (continued)
PLANT IV

Time	Buttermaker	Helper	Plant Superintendent	Helper	Helper	Helper
6:00 A.M.		Rinse churn				
		Make boxes				
		Line boxes				
6:30 A.M.						
		Make boxes				
		Line boxes				
7:00 A.M.		Idle 5 min.				
		Rinse churn				
		Busy churning				
7:30 A.M.		Idle 15 min.				
	Busy churning	Make boxes				
		Idle 10 min.				
8:00 A.M.						
	Tub butter	Tub butter				
	Busy churning and weighing butter	Weigh butter				
8:30 A.M.		Line boxes				
	Busy churning	Idle 20 min.				
9:00 A.M.						
	Tub butter	Tub butter	Assemble pipes	Prepare receiving room	Prepare receiving room	
	Busy churning and weighing butter	Weigh butter				
9:30 A.M.		Make boxes				
		Line boxes	Idle 40 min.	Idle 50 min.	Idle 50 min.	
	Busy churning					
		Idle 10 min.				
10:00 A.M.						
	Tub butter	Tub butter				Idle 210 min.
	Busy churning and weighing butter	Weigh butter				General plant duties
10:30 A.M.		Idle 35 min.				
	Busy churning		Tend Pasteurization, Separation, etc.	Receive	Receive	
11:00 A.M.						
	Tub butter	Tub butter				
	Weigh butter	Weigh butter				
11:30 A.M.						
	Idle 70 min.	Idle 70 min.				
	Eat	Eat				
12:00 Noon						

Figure 4 (continued)

APPENDIX E. (continued)
PLANT IV (continued)

Time	Buttermaker	Helper	Plant Superintendent	Helper	Helper	Helper
12:00 Noon						
	Idle 70 min.	Idle 70 min.	Tend Pasteurization, Separation, etc.	Receive		Idle 210 min.
12:30 P.M.	Eat	Eat				General plant duties
					Receive	
1:00 P.M.	Tend Pasteurization, Separation, etc.	Receive	Idle 60 min.	Idle 60 min.		Idle 60 min.
			Eat	Eat		Eat
1:30 P.M.						
		Idle 60 min.			Idle 60 min.	
2:00 P.M.	Clean churns	General plant duties			Eat	
2:30 P.M.	Records					
			Tend Pasteurization, Separation, etc.	Receive		Receive
3:00 P.M.	General plant cleanup					
					Idle 150 min.	
3:30 P.M.					General plant duties	
4:00 P.M.						
4:30 P.M.						
5:00 P.M.						
5:30 P.M.						

F. Space Requirements

	Plant I	Plant II	Plant III	Plant IV
		square feet		
Administration	240	240	336	336
Receiving	700	700	700	700
Testing	225	225	225	225
Pasteurizing, etc.	1600	2500	3000	3000
Churning	420	420	900	900
Refrigeration	300	400	500	600
Steam and water	800	920	1000	1000
Supplies	800	1000	1200	1400
Cooler	256	288	320	360
Rest rooms, etc.	100	150	200	200
Total	5441	6843	8381	8721

G. Cost Summary

	Plant I	Plant II	Plant III	Plant IV
	dollars			
Labor	16250	26500	36000	43000
Fuel	3500	5500	7500	9500
Power	2250	4500	6750	9000
Materials used in processing	258	515	772	1030
Packaging materials	1150	2302	3455	4610
Building cost	3464	3965	4556	4712
Equipment cost	13147	17588	20347	22756
Insurance	912	1178	1358	1507
Taxes	2410	3100	3580	3970
Payroll taxes	325	530	720	860
General plant supplies	1740	3480	5220	6960
Office supplies	234	468	702	936
General administrative expense	1440	2170	2910	3650
Total	47080	71796	93870	112491

H. Cost Summary

	Plant I	Plant II	Plant III	Plant IV
	cents per cwt. of milk			
Labor	13.85	11.29	10.21	9.16
Fuel	2.98	2.34	2.13	2.02
Power	1.92	1.92	1.92	1.92
Materials used in processing	0.22	0.22	0.22	0.22
Packaging materials	0.98	0.98	0.98	0.98
Building cost	2.95	1.69	1.30	1.00
Equipment cost	11.20	7.50	5.77	4.84
Insurance	0.78	0.50	0.38	0.32
Taxes	2.05	1.32	1.02	0.85
Payroll taxes	0.28	0.23	0.20	0.18
General plant supplies	1.48	1.48	1.48	1.48
Office supplies	0.20	0.20	0.20	0.20
General administrative expense	1.23	0.93	0.83	0.78
Total	40.12	30.60	26.64	23.95

I. Total Investments in Building and Equipment

Plant	Building (dollars)	Equipment (dollars)	Total (dollars)
I	53300	107790	161090
II	61000	146320	207320
III	70100	168920	239020
IV	72500	192240	264740