UNIVERSITY OF IDAHO
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AN ECONOMIC STUDY of SMALL FLUID MILK PLANT PROBLEMS in Northern Idaho

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This report develops an economic framework for solving various problems confronting small fluid milk plant operators. Although a small number of plants were used in the study and the time studied was short, the principles used in this analysis have wide application. A survey of 40 dairy plants in Idaho during February 1955, indicated that the costs derived in this study have applicability to Idaho conditions during 1954.

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Alaska Agricultural Experiment Station, California Agricultural Experiment Station, Colorado Agricultural Experiment Station, Idaho Agricultural Experiment Station, Montana Agricultural Experiment Station, Oregon Agricultural Experiment Station, Utah Agriculutral Experiment Station, Washington Agricultural Experiment Station, and Agricultural Marketing Service, U.S. Department of Agriculture.

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An Economic Study of Small Fluid Milk Plant Problems

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Introduction

Modern transportation and production techniques have greatly affected fluid milk distribution. Modern road systems make it possible to distribute milk over increasingly wider areas with regularly scheduled milk routes. Some plants deliver milk several hundred miles on these routes three to four times a week. In addition to better roads, improvement in quality of dairy products makes possible the hauling of milk longer distances. Modern packaging techniques have increased the quantities of milk delivered per route and have reduced the haul-back weight of cases and milk containers. Some routes are able to have pay loads on the back-haul, which substantially reduces the transportation costs borne by milk.

Some plants previously operating in relatively isolated markets have found an increased amount of competition from larger plants located in the metropolitan areas. Initially, this competition was quite severe because the larger plants generally had better quality and they carried a wider variety of dairy products.

Recently, small plants have improved the quality of their products, but they have encountered another competitive obstacle. Larger plants have been in a position to adopt modern processing and packaging techniques and to keep their unit costs low. Small plants cannot. Each new technique which is introduced seems to put the small plants at a greater competitive disadvantage. Homogenized milk, for example, found favor among consumers. This reduced the market potential of producer-distributors. They could not afford to add the expensive equipment for homogenization nor could they afford to continue operations with the reduced market. As a result, many producers discontinued their distribution operation.

Small operators were confronted with a similar competitive problem by the introduction of paper cartons. Grocery store managers preferred paper cartons to glass bottles. Small plants were forced either to lose a portion of their market or to introduce paper. Either alternative placed them at a cost disadvantage in comparison with the larger distributors.

Small plants have made various adjustments to better withstand the increased competition. These include improved quality through

[1]Formerly a cooperative agent, Agricultural Marketing Service, U.S.D.A. and Assistant Agricultural Economist, University of Idaho, respectively. In addition to the support given by the dairies and equipment dealers cooperating on the project, special contributions have been made by Dr. W. E. Folz and D. A. Clarke, Jr. through their economic and editorial criticism.

stricter enforcements of quality standards at the farm and at the plant. Some small plants have offered additional products, products either processed by the small plant or jobbed from larger plants. A few operators have increased emphasis on retail route sales. Many consumers will accept milk in glass on house deliveries when they would prefer paper containers at grocery stores. Some plants promote the idea of locally produced products, and emphasize that their milk has been produced locally for local consumption. A few operators have partially integrated their plants with the major wholesale outlets. They accomplished this by selling stock in the dairy to the major wholesale outlets. In this manner the dairy's business interest becomes also the wholesale buyers' interest. Other plants have reduced payments to milk producers in order to stay in business. This can be done, however, only when the producers have no other outlet to which they could ship milk.

There are limits to the adjustments that can be made by the smaller plants. Modern production techniques, consumer wants, and sanitation requirements clearly define the limits of adjustments. For example, consumers want a specific product such as homogenized milk; sanitation and legal definitions specify the general type of equipment required. This equipment is expensive and results in higher unit costs for this process in small plants than in large ones.

This whole area of conflict between smaller plants located in small communities and larger plants located in larger communities is important to producers, processors, and consumers in the western region. If a small processor is forced to discontinue his operation, the market for the producers is disrupted. The producers must either find a new market for their milk or change to alternative farm enterprises. Consumers are also affected in their choice of brands of milk and in the services offered. This is especially true in outlying areas.

The Problem

This study uses data from a limited area and time to show the limits of economic adjustments that small plants might make and it directs attention to the following five problem areas:[2]

1. Under present operating conditions, what volume is necessary to cover long-run costs?
2. Under different volume conditions, what product combinations have the greater probability of economic success?
3. Under small volume conditions, what adjustment may be necessary in producer milk prices to maintain and replace local plant facilities?
4. Under what product-price relationship would one make long-run shifts in product combinations?
5. At a given volume of operations, what is the value to a plant of an expanded volume?

[2]The information for this study was obtained from six plants. However, these data have been checked on specific counts such as advertising, fuel, expenses, and average hauling cost per mile, in 44 Idaho plants during February, 1955. Significant variations from the data in this report were adequately explained by the plant managers. Therefore, the authors feel that, though this study has been based on a small number of plants, the present report has considerable general application to current industry problems.

Sources of Data and Method of Study

The problems treated in this report have involved the analysis of three sets of data. The first is the observed data obtained from six relatively small processing plants located in the Clearwater Valley and on the Camas Prairie in northern Idaho in an area that has only minor external market influences.[3] This area, approximately 150 miles long, has several geographical barriers to outside shipments of milk. It has approximately 50,000 non-rural population, which is equally divided between a larger metropolitan area and outlying small towns. Seven dairy firms distributed dairy products in this area. Six of the firms processed as well as distributed dairy products. The present analysis, of course, was limited to these six plants.

Three plants, two of which both processed and distributed dairy products and the third only distributed dairy products, were located in the larger metropolitan area, Lewiston, Idaho, and Clarkston, Washington. The four other plants were located in Orofino, Kamiah, Grangeville, and Cottonwood, Idaho. All plants were connected by hard surfaced roads, which form a loop of 220 miles. The plants varied in size from about 12,000 to about 125,000 pounds processed per week. The total milk receipts of all plants was 291,000 pounds in one week. Five of the processing plants bottled milk in both glass and paper. All plants but one handled ice cream and all but one processing plant made butter, most of which was churned from sour cream.

The six plants were visited in November, 1953. Annual data were obtained from the plants' records regarding volume; insurance costs; taxes; repair and maintenance costs; various factory supplies, such as cleaning supplies, sugar and flavors for ice cream, cartons, etc.; truck costs, including interest, licenses, insurance, gasoline, oil, batteries, chains, tires and repairs; and general costs such as donations, advertising and management. Water, fuel, and power costs were analyzed on a monthly basis to determine adjustments which might be necessary in adjusting utilization information to an annual plan. A description of the building and equipment, building and equipment costs, purchase dates and estimated life were secured as a basis for developing depreciation schedules. The prevailing rate of interest was noted.

In addition, during one week a complete labor utilization study was made in the plant to afford a basis for allocating labor costs among the joint operations.

The use of labor observations for a short time, such as that for which observations were taken in the plants scheduled for the study, has the advantages of allowing adequate attention to the adjustments in labor and other resource use to meet day-to-day variations in plant conditions and products. Such details would be buried in the summarized cost records for longer periods. While it would be preferable to take day-to-day records and make personal observations of plant operations over long periods of time, this would be a task beyond the resources usually available for research.

[3]Originally these data were used to develop a method for an area analysis of fluid-milk distribution costs under varying types of organization. Due to the inadequacy of transportation data a report will not be made on the full analysis of the original pilot study. This report was made to the Western Regional Dairy Technical Committee at the time of completion of the analysis.

This study takes into account production conditions relative to the volumes of the various products made by the plants during the short time these plants were under observation. However, over a longer period, with changing receipts of raw milk and changing market conditions, volumes of the various products could be expected to change.

Therefore, one limitation of the present data and methodology is that it may not include conditions related to the wider adjustments in receipts and products that necessarily occur over a long period in a joint-product operation with seasonal variations in raw milk receipts and changing market conditions.

A second limitation in the analysis arises from the fact that no attempt was made to determine whether the plants were operating at efficient volumes for the combinations of equipment in use. The observed costs used in synthesizing the hypothetical model plants therefore represent the low level of costs prevailing under existing operating conditions without standardizing equipment. Alternatively, it is possible to determine the combination of plant and equipment which would result in the lowest cost for each size of plant studied.

Observed costs for existing circumstances were used because: (1) Joint-product plants normally operate at various proportions of capacity and seldom at the ideal level, since market prices dictate the level of production as well as do costs. Therefore, it is more realistic to approximate the operating levels usually found rather than the ideal level. (2) Capacity is difficult to define in multi-product plants where, at a given time, production of an individual product is geared to the immediate short-run demand.

The observed data varied widely from plant to plant, particularly in the time equipment was purchased, local wage rates, and management situations. In order to study the effects of different volumes and product combinations on costs, it was necessary to develop basic models in which such cost factors were held constant.

The second set of data were derived from the observed conditions and combined by synthesis into basic model plants. The basic model plant data were synthesized from observed operating conditions with all factor prices standardized. The product combinations in these model plants include the fluid milk in cartons and glass containers, butter, and ice cream. Most observed plants had this product combination. The basic model plants were developed on the assumption of the application of the lowest cost operating practices observed in the area.[4] The models thus constructed provided the data for a complete analysis of differences of unit costs with different volumes of output, of the value of additional volume, and of the net farm value of milk produced under varied volume and product combinations.

The third set of data involved a modification of the input-output data of the basic model plants. Certain products were eliminated from the basic models. For example, instead of processing fluid milk in both paper and glass containers, together with butter and ice cream as in the basic models, one or more products were eliminated and the effects

[4]See Appendix, pp. 28-43, for more complete statement of assumption and methods used in developing the model plants.

on costs were analyzed. Five different product combinations were synthesized from the so-called basic model plant data. The purpose of the analysis using this type of data is to determine the combination of products that will provide the greatest returns over costs at different levels of output. These data were also used to develop an analysis of product price variations that would justify changes in the production combination.

In all, 30 model plants were synthesized. They reflect variations in size from 9,080 pounds of 4.08 percent milk, or its equivalent, per week in the smallest model to 145,230 pounds per week in the largest model.

The number of plants in each product combination is as follows: (1) Five model plants processed and bottled fluid milk products in both paper and glass containers, and also processed butter and ice cream. (2) Five model plants processed fluid milk in glass containers but did did not process butter or ice cream. (3) Five models processed and bottled fluid milk in glass containers only and processed butter and ice cream. (4) Five model plants processed fluid milk products in paper containers only, and processed butter and ice cream. (5) Five model plants processed fluid milk products, in both paper and glass containers, and also butter, but did not process ice cream. (6) Five model plants processed fluid milk products in paper and glass containers, and also ice cream, but had no butter operation.

The costs were divided into the following seven classifications: Capital, labor, container, non-dairy products supply, general expense, truck, and raw material costs.[5]

Observed Conditions

The costs obtained or observed in the six plants studied were allocated to processes and products wherever possible.

The average range of allocated costs are shown by products and functions in Table 1.

Wide ranges in allocated unit costs existed among the six plants. The major causes of these ranges were differences in capital investment and the efficiency of labor usage among the plants. For example, Plant Y with about 13 times the volume of Plant X had only about 1½ times Plant X's investment in homogenizing equipment. Labor required for the operation was chiefly that of setting up the homogenizer and pipelines and taking them apart and cleaning them. The total labor in the operation used differed little regardless of volume. Therefore, when unit costs were computed, the large difference in volume applied to fairly uniform total costs resulted in a very wide difference in the unit costs of homogenizing for the two plants.

Costs which could not be assigned to specific products or processes were grouped under the following cost headings: Capital, labor, general expenses, and management (Table 2). The unallocated costs per unit also varied considerably from plant to plant.

[5]See Appendix, pp. 31-43, for explanation of these categories.

Table 1.—Average and range of allocated processing and distribution costs in the six observed dairy plants, by functions.

Function	Unit	Weighted Average cost per unit	Range of unit costs
		dollars	dollars
Fluid milk	1,000 lbs. milk	3.53	2.52 - 5.68
Homogenization	1,000 lbs. milk	.74	.29 - 4.47
Bottling:			
Paper	unit*	.0050	.0028- .0125
Glass	unit*	.0070	.0043- .0125
Chocolate drink	gal.	.0250	.0120- .0995
Cultured milk	gal.	.0362	.0210- .1121
Cream:			
Whip	gal.	.0458	.0192- .1937
Coffee	gal.	.0448	.0304- .2010
Cereal	gal.	.0414	.0212- .2024
Skim	1,000 lbs.	2.49	2.44 - 3.03
Ice cream	1,000 lbs. mix	100.18	16.73 -194.98
Butter:			
Buttermaking	1,000 lbs.	34.26	16.47 - 56.28
Butter wrapping	1,000 lbs.	19.25	7.48 - 39.83
Cottage cheese	16-oz. pkg.	.0460	.0375- .0579
Sales:			
Wholesale	1,000 lbs. milk	4.56	
Retail	1,000 lbs. milk	3.79	

*Quart equivalents.

Unallocated management costs varied widely between low and high volume plants on one hand, and medium-sized plants on the other. Management personnel in small volume plants spent most of its time as plant labor, and management decisions required little time. The large plants in the study had sufficient volume to also obtain low unallocated management costs per 1,000 pounds of milk received from specialized management personnel. On the other hand, the middle-sized plants in the study required approximately the same total management costs as the large plants. As a result, with only medium volume, their management costs were high.

Unallocated labor costs per 1,000 pounds of milk received varied inversely with volume, but general expenses and capital costs showed a smaller relationship to output.

Total costs were grouped under the same headings as unallocated costs with the addition of a new category, supply costs. Each category is discussed below.

Table 2.—Average and range of unallocated processing and distribution costs in the six observed dairy plants. (Unit is 1,000 pounds of milk received.)

Cost	Weighted average cost per unit	Range of unit costs
Capital costs	$2.57	$1.88-$4.98
Labor costs	1.86	0.42- 5.46
General costs	4.47	1.96- 8.72
Management	1.74	0.15- 4.73

Total Capital Costs.—Capital costs included depreciation, interest, repair and maintenance, insurance and taxes.

The annual depreciation rate of the six plants averaged 6.44 percent of initial investment and ranged from 5.2 percent to 8.77 percent of the initial purchase cost. The average estimated investment of the plants was 75.09 percent of the original purchase price and ranged from 63.16 percent to 84.17 percent. Differences in the amount of investment were found to be due to the size of the plant and age of equipment.[6]

Depreciation (34 percent) and interest (29 percent) were the largest components of total capital costs. Repair and maintenance accounted for 21 percent of total capital costs; insurance and taxes for 21 percent and 7 percent, respectively. Total capital costs (including both allocated and unallocated costs) averaged $6.17 per 1,000 pounds of milk received and ranged from $4.97 to $11.78.

With the exception of the smallest plant, the unit capital costs of the observed plants varied inversely with volume. In fact, three plants had practically the same total capital costs although their volumes differed widely. As a result, their unit capital costs varied from $2.69 to $4.19 per 1,000 pounds of milk received.

The smallest plant studied was a simple plant with a limited number of products, and plant and equipment investment held to a minimum. These factors resulted in low unit costs.[7]

Total Labor Costs.—Total labor costs included the direct labor which could be allocated to a product or process and unallocated labor, such as cleaning plant and equipment, janitor services and labor delays. Total labor for the six plants averaged $14.62 per 1000 pounds of milk received. The allocated labor for all products and processes averaged $12.76 per 1000 pounds of milk received and ranged from $10.01 to $17.70 in the different plants. The average cost of unallocated labor was $1.86 per 1000 pounds of milk received and the range was $0.42 to $5.46.[8]

The two plants with the highest unit labor costs also had the highest capital costs and had the lowest volume of production. High labor costs per unit of product were associated with a small volume of processing.

General Expenses.—General expenses include items such as fuel, lights, cleaners, advertising and donations which cannot be allocated readily to products and processes. Such costs averaged $4.47 per 1000 pounds of milk received and ranged from $1.96 to $8.72. Such items as fuel, lights, and cleaners were related directly with volume.

Supply Costs.—The cost of supplies such as ice cream flavors, glass bottles, paper cartons, etc., could be allocated directly to products or processes. These costs averaged 34 cents per 1000 pounds of milk received and ranged from 33 to 77 cents. Though certain supplies can

[6]With type of operation held constant.

[7]This plant is an example of the type of operation which is shown by this study to have the lowest plant costs (pp. 17-18).

[8]Part of these ranges are accounted for by the degree to which labor could be allocated to specific functions in the individual plants or had to be thrown into unallocated labor.

be purchased with quantity discounts, such discounts were not a significant factor for these six plants; therefore, the unit cost of supplies was fairly constant among plants handling the same products.

Management Costs.—Management costs as defined in this study do not include time which management personnel spent in the plant as plant labor. Total management costs tended to be related inversely to volume in those plants which had specialized management personnel. Small plants had practically no management function which could be isolated Personnel worked as plant labor, and decision-making seldom could be isolated from direct labor.

Data from the six plants surveyed show that a definite inverse relationship existed between their unit costs and volume. The major causes of this relationship were the high capital and labor costs per 1000 pounds occurring in all but one of the smaller plants.

The low unit costs observed in the smallest plant indicate that smaller plants with high costs could reduce costs substantially and thereby improve their competitive position by avoiding unnecessary capital expenditures, improving plant organization, and simplifying their operations.[9] Such possibilities will be at least partially explored in the section of this report on "Best Product Combination for Plants of Different Sizes."

Basic Model Plants

The basic plants in this analysis are the models showing processing costs for all products, fluid milk in paper and glass, butter, and ice cream. In addition, the model plants carry delivery costs for local distribution only.[10] It is from these basic models that the other groups of plant models are derived.

Capital Costs

Capital expense is made up of depreciation, repair, insurance, taxes, and interest, Table 3. The larger plants have lower capital costs per 1,000 pounds of milk than the smaller plants. The effect of volume on capital costs is greater in the smaller plants than in the larger plants.

Labor Costs

The basic model plant analysis indicates that plants processing 9,080 pounds of milk per week have unit labor costs over 80 percent higher than plants processing 145,280 pounds per week, Table 4. The model plant processing the smaller volume has labor costs of $22.75 per 1,000 pounds of milk processed when the wage rate averages $1.47 per hour for plant labor. The sales labor cost per 1,000 pounds of milk does not vary with the size of the plant because it has been computed

[9]Previous work carried on at the Utah Agricultural Experiment Station, under the direction of the Western Regional Dairy Marketing Research committee confirms this conclusion (ALLRED, WELLS M. and WILLIS, JOHN L., *Can Small Plants Process Every Other Day*, American Milk Review, August, 1954).

[10]See Appendix Table 1 for a detailed breakdown of costs. Methods and assumption used in developing these model plants are given in the Appendix, pp. 28-43.

Table 3.—Annual capital expenses per 1,000 pounds of milk of basic model dairy plants, by size.

Plant designate	Plant size	Depreciation	Repair	Insurance, tax, and interest
	pounds	dollars	dollars	dollars
X	9,080	7.44	6.49	12.68
2X	18,160	4.01	3.47	6.95
4X	36,320	2.99	2.39	4.91
8X	72,640	1.70	1.37	2.96
16X	145,280	0.97	0.82	1.94

on a commission basis. However, the plant labor cost does show considerable effect of scale. In fact nearly $9.00 of the difference in costs between the two plant sizes can be explained by the difference in the plant labor costs. Most of the rest of the differences in unit labor costs between the various sizes of plants can be explained by the costs of the office labor. Table 4 also shows that plants of different sizes operating under the same wage rates have substantially different unit labor costs. In order for the smaller plants to compete, external economies of the market must be realized by small plants to make up the basic differences in plant labor costs.

Container Costs

The container costs per unit are shown in Table 5. The costs of paper containers are calculated for two types of machines. One type bottles milk in preformed containers and the other bottles it in containers that are shaped during the bottling process. The preformed cartons cost about 1 cent per quart more than the other type. Prices of containers of other sizes have the same general relationship between the two types.

This table shows that the plant bottling milk in cartons that are formed during the bottling process has quite a cost advantage for containers over a plant that is bottling in preformed cartons. Most smaller plants use the preformed cartons because of the lower equipment costs while the larger plants use the other type. The equipment used in the basic model plants has been selected on the basis of the lowest total costs, equipment, labor, and carton costs. This results in the selection of the preformed carton in the two smaller plants. At 36,320 pounds

Table 4.—Weekly labor and management expenses of the basic model dairy plants, by size.

Plant designate	Per 1,000 pounds of milk received				
	Plant labor	Office labor	Sales labor	Management	Total per 1,000 pounds
	dollars	dollars	dollars	dollars	dollars
X	11.66	2.20	7.06	1.83	22.75*
2X	7.77	2.56	7.06	1.67	19.06
4X	5.83	2.56	7.06	1.58	17.03
8X	3.89	1.92	7.06	1.54	14.41
16X	2.91	.96	7.06	1.52	12.45

*Includes cost of hiring CPA to keep books in lieu of office force.

Table 5.—Container costs of basic model dairy plants, by type of container.

Container type		Preformed per unit cost	Formed per unit cost
	dollars	dollars	dollars
Glass bootles, qt.	.0060	.....	.....
Glass bottles, ½-pt.	.0054	.....	.....
Paper containers, qt.	.....	.0250	.0154
Paper containers, pt.	.....	.0210	.0099
Paper containers, ½-pt.	.....	.0180	.0091
Butter parchments, 1-lb.	.0030	.....	.....
Butter cartons, 1-lb.	.0160	.....	.....
Butter boxes, 60-lb.	.1095	.....	.....
Butter box liner	.0300	.....	.....
Butter shipping box	.2340	.....	.....
Ice cream containers, gallon	.1580	.....	.....
Cottage cheese containers, 16-oz.	.0244	.....	.....

per week the costs of the two types were about the same with a slight advantage in favor of the formed carton.

Non-dairy Product Supply Costs

The total non-dairy supply cost for a product is determined by the unit price times the number of units used in the plant, Table 6. These costs were determined by a formula and all sizes of plants used the same product ingredients. There is no advantage of scale as far as the cost of the non-dairy products supplies are concerned.

Table 6.—Cost of non-dairy product supplies per unit of product for basic model dairy plants, by supply item.

Supply item	Product use	Unit of product	Amount
			dollars
Chocolate flavoring	Chocolate drink	Quart	.0295
Culture	Cultured milk	Quart	.0076
Salt	Butter	Pound	.0010
Salt	Cottage Cheese	Pound	.0008
Sugar	Ice cream	Gallon	.0791
Powdered skim	Ice Cream	Gallon	.0460
Stabilizer	Ice Cream	Gallon	.0035
*Flavors	Ice Cream	Gallon	.0735

*This is a weighted average flavor cost.

General Expenses

General expense, which includes such items as factory cleaning supplies, fuel, light, and power, are determined for the model plants by using an estimating formula based on observed data.[11] Some are figured directly in dollars while others are determined in physical units.

Truck Costs

The fixed and variable truck costs are shown in Table 7. The costs are computed for four types of trucks. These types or sizes are the ones

[11]The formulas are shown in the Appendix, page 40.

customarily used in this area. The cost estimates may be considered as approximations of normal costs for these types of trucks. The costs of a ¾-ton route van as shown in Table 7 do not necessarily fit any one make of truck. It is only an average cost for a ¾-ton route van. The fixed costs per week vary among the types of trucks, the larger truck having the higher fixed cost. The same variable costs, however, were used for all sizes of trucks in setting up the model plants.

Table 7.—Truck costs per week, fixed and variable costs per mile for basic model dairy plants, by type of truck.

Type of truck	Fixed cost per week	Variable costs per mile
	dollars	dollars
¾-ton route van (retail)	11.98	.0917
2-ton refrigerated van (wholesale)	14.10	.0917
2-ton refrigerated van (ice cream)	17.26	.0917
2-ton dual temp van	23.09	.0917

There was not a sufficient number of observations to obtain the variable costs, including gasoline, tires, oil, etc., by different types and sizes of trucks. Therefore, the data on variable costs have been synthesized for a ¾-ton retail route van.[12] Thus, in the models, variations in total costs among different types and sizes of trucks are due to differences in fixed costs. Variable costs have been stated on a "per mile" basis because cost per mile is a more applicable incremental unit to consider in deciding whether to extend a route than cost per 1000 pounds of milk received.[13]

The difference in fixed costs between the ice cream van and the wholesale milk van is due to the type of refrigerated box required for the ice cream truck. The more elaborate refrigeration required for ice cream makes ice cream vans more expensive than those used for wholesale milk delivery. The higher cost for the dual-temp truck is likewise due to the more expensive body.

Milk and Cream Costs

In estimating the cost of marketing milk and cream in the basic models it was assumed that the price of milk delivered to the dairy was $6.05 per 100 pounds of 4 percent milk and that of cream was $0.60 per pound of butterfat. This was the current price paid during November, 1953. The cream purchased was sour cream used wholly in butter production.

[12]Additional information obtained from a Boise, Idaho, dairy indicates that smaller trucks have lower costs than larger trucks operating under the same conditions. Under the operating conditions of the plants studied, the wholesale trucks had longer hauls with relatively fewer stops than the retail trucks and the variable costs per mile were approximately the same.

[13]In the market area analysis, the transportation information was not adequate to determine the additional costs of added delivery in terms both of distances and of volume of sales. One should be able to add the incremental cost of processing to incremental costs of delivering. This total increment cost should be compared to the incremental revenues of a given stop, town, or volume. This comparison will determine the economic feasibility of including such a market in the centralized plant system. Also included should be information on physical sizes and the characteristics of the trucks. These data should describe the number of units of glass or paper that could be handled. The original data were especially lacking in capacity information on dual and tri-temp trucks. The quantity these trucks can hold does not give the basic working relationship. For example, a truck may hold 500 gallons of ice cream, but because he has imperfect knowledge of store needs, the driver will not be able to sell 500 gallons without reloading his truck.

Total Costs

The two total major cost elements in total costs are capital and labor. The total costs are shown per 1000 pounds of milk received for the six sizes of plants, in Table 8. The capital cost per unit in the smallest plant was greater than labor cost per unit; as the plant size increased the capital cost became less per unit relative to the total labor cost. The differences between capital and labor costs are more significant as the plants become larger. A plant processing 9,080 pounds of milk per week has capital and labor costs per unit of about $33 more than a plant processing 145,280 pounds per week. The differences in cost elements other than capital and labor are minor. The total unit capital and labor cost difference between the smallest and largest plant is about $36. Capital accounts for over $26 per 1000 pounds of milk or 37 percent of total unit cost in the smallest plant, whereas it amounts to only $2.65 per 1000 pounds or about 13 percent of total unit cost in the largest plant. On the other hand, the labor cost is nearly $23 per 1000 or 31 percent of the total in the smallest plant compared with less than $11.00 or 43 percent in the larger plant.

The increase in labor cost as a percent of total cost in the larger plant was caused by the increased relative importance of selling and management to larger plants. Plant and office labor cost per unit decreased rapidly as plant size increased, whereas selling costs remained constant and management costs decreased only slightly.

The other cost elements—container, non-dairy products supply, and

Table 8.—Cost per 1,000 pounds of milk by size of basic model dairy plants, by cost element.

Cost element	Cost per 1,000 pounds of milk				
	Pounds of milk received per week				
	9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
Capital	26.61	14.43	10.29	6.03	3.73
Labor:					
Plant	11.66	7.77	5.83	3.89	2.91
Office	2.20	2.56	2.56	1.92	.96
Sales	7.06	7.06	7.06	7.06	7.06
Management	1.83	1.66	1.58	1.54	1.52
Total	22.75	19.05	17.03	14.41	12.45
Container:					
Fluid products	7.72	7.72	4.66	4.67	4.67
Butter	.20	.20	.20	.19	.19
Ice cream	1.32	1.32	1.32	1.32	1.32
Cottage cheese	.06	.06	.06	.06	.06
Total	9.30	9.30	6.24	6.24	6.24
Non-dairy product supplies	2.22	2.12	2.12	2.12	2.12
General supplies	8.75	5.43	3.78	2.93	2.50
Truck expenses:					
¾-ton van	1.92	1.11	.96	.87	.93
2-ton van (wholesale milk)	.....	1.04	.56	.59	.85
2-ton van (ice cream)	.....	.....	....	.30	.16
2-ton van (dual-temp)	.....	.....	.93	.36	.18
Total	1.92	2.15	2.45	2.12	2.12
TOTAL	71.55	52.48	41.91	33.85	29.16

truck expenses—increase as a percentage of total cost as plant size increases. General expenses, on the other hand, decrease as a percent of the total cost as plant size increases.

Other Product Combinations

In the previous section we constructed basic model plants, in which the plant sizes and product combinations were similar to those encountered in the survey area. In this section an analysis will be made of costs in which different product combinations from those included in the basic model plants will be studied. The purpose of this analysis is to answer the question: How much more or less will it cost per unit for different sizes of plants to produce different product combinations?

The cost of the other product combinations is determined from the basic models. If it is desired to determine the cost of producing milk in a plant which bottles milk in glass bottles only, this cost is discovered by deducting the cost of processing milk bottled in paper from the total costs in the appropriate model plant. The paper bottling equipment also is deducted from the basic models as is also the cost of supplies associated with paper bottling. In a similar manner costs of a plant that is bottling milk in paper and glass and processing all products with the exception of butter are determined by deducting the processing costs of butter, which include equipment, supplies, and labor, from total costs in the basic model plants.

The comparison of costs by elements for the different-sized plants and the different process combinations are shown in Tables 9 to 13. The costs thus presented are only a part of the picture. This section concentrates on the unit costs of different-sized plants. Differences in levels of costs in comparison with revenues of the various combinations are considered later.

Plants Processing Fluid Milk Products in Glass Containers

Costs of plants processing milk in glass only and processing neither ice cream nor butter are shown in Table 9. This table shows that the relationship between the cost elements remains the same as those in the basic model. However, the cost per 1000 pounds of milk for this type of plant is considerably lower than that of the basic models. This is due to the deductions of the costs of manufacturing ice cream, butter, and paper cartoned milk. These reductions include building facilities, equipment, labor, containers, and manufacturing supplies. The difference in the total cost between a plant processing 9,080 pounds and one processing 145,280 pounds is about $32.00. This difference is made up of two major factors, the differences in capital cost of about $19.00 and in the labor cost of about $8.00 per unit. The general expenses account for about $6.00 difference in unit costs. However, truck expenses are greater per 1000 pounds of milk received in the larger plants than in the smaller plants. The small plant operator can deliver all of his products with one small truck.

Table 9.—Processing costs per 1,000 pounds of milk received by different sized plants bottling milk in glass containers, by cost elements.

Cost elements	Processing costs per 1,000 pounds of milk received				
	Plant size in pounds of milk per week				
	9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
Capital	21.25	11.54	7.28	4.74	2.85
Labor	20.46	17.74	15.79	14.05	12.11
Containers	2.48	2.48	2.48	2.48	2.48
Non-dairy processing supplies	.....	.....	.....	.....	.....
General supplies	8.31	5.16	3.58	2.79	2.37
Truck expenses	1.93	2.74	2.74	2.82	2.59
TOTAL	54.43	39.66	31.87	26.88	22.40

Larger plants have a greater degree of specialization in their truck fleet. Only a portion of the capacity of each kind of truck may be used, and considerable duplication of routes may occur because different kinds of trucks may have to deliver at the same stops.

A more pronounced reduction in unit costs with increased volume occurs in plants bottling less than 50,000 pounds of fluid milk in glass per week than in larger plants.

Container costs per unit of these plants remain the same regardless of size because the larger observed plants did not realize substantial quantity discounts in purchasing these containers.

Plants Processing Fluid Milk in Glass, Butter, and Ice Cream

The cost elements for each plant processing milk in glass only and processing ice cream and butter are shown in Table 10. The costs per 1000 pounds of milk received are greater for these plants than for those just discussed. This is due to the addition of the costs of the ice cream and butter equipment and supplies to the product combination. There is a difference of about $36 in total costs between the smallest and the largest plant in this group. Capital and labor unit costs show the greatest reduction as the plant size increases. There is a difference of $23 in

Table 10.—Processing costs per 1,000 pounds of milk received by different sized plants bottling milk in glass only and processing ice cream and butter, by cost elements.

Cost element	Processing costs per 1,000 pounds of milk received				
	Plant size in pounds of milk per week				
	9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
Capital	26.33	14.13	8.86	5.55	3.33
Labor	22.05	19.33	19.25	16.63	14.67
Containers	4.06	4.06	4.06	4.06	4.06
Non-dairy processing supplies	2.12	2.12	2.12	2.12	2.12
General supplies	8.75	5.43	3.77	2.93	2.50
Truck expenses	1.93	2.74	2.74	3.12	2.75
TOTAL	65.24	47.81	40.80	34.41	29.43

capital unit costs and about $8 in labor between the largest and smallest plants. The smaller plants that have ice cream and butter cannot use their labor as efficiently as the larger plants. A certain amount of idle labor is necessary when processing ice cream or butter. As the volume of the product increases, there is less idle labor per unit of output. The larger plants also employ larger equipment which has a greater hourly output. This requires less labor per unit of output. These two factors are the major reasons for lower unit labor costs for the larger producers of ice cream and butter.

The non-dairy processing supplies are the same per 1000 pounds of milk for all sizes of plants. In this combination, as in the others, the product supplies are computed on a formula basis.

Plants Processing Fluid Milk in Paper, Butter, and Ice Cream

The costs per element for plants processing milk in paper and processing ice cream and butter are shown in Table 11. The difference in total costs between the largest and the smallest plant is about $40 per unit. The smallest plant had a cost of $69.56 per 1000 pounds of milk received, whereas the largest had total costs of $29.42. The difference in capital costs between the smallest and largest plant is about $22 per unit. The small plant had capital costs of $25.37 per 1000 pounds while the large plant had costs of $3.86 per unit. The difference in labor cost between the two sizes of plants was about $7.40. The small plant had a labor cost of $19.20 and the large plant had a cost of $11.82 per 1000 pounds of milk received. The difference between the capital and labor costs of the large and small plants accounts for most of the difference in the total cost. The differences in the container costs are due to the type of equipment used. In each case the type of container equipment assumed to be employed was that which resulted in the lower total costs for each size of plant.

Plants Processing Fluid Milk in Glass and Paper Containers, and Butter

The costs for a plant processing milk in glass and paper containers

Table 11.—Processing costs per 1,000 pounds of milk received by different sized plants bottling milk in paper and processing ice cream and butter, by cost elements.

Cost elements	Processing costs per 1,000 pounds of milk received				
	Plant size in pounds of milk per week				
	9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
Capital	25.37	13.64	9.93	6.18	3.86
Labor	19.20	16.48	16.39	12.80	11.82
Containers	12.20	12.20	7.59	7.59	7.59
Non-dairy processing supplies	2.12	2.12	2.12	2.12	2.12
General supplies	8.75	5.43	3.77	2.93	2.50
Truck expenses	1.92	1.89	1.93	1.75	1.53
TOTAL	69.56	51.76	41.73	33.37	29.42

and processing butter are shown in Table 12. The total cost for a plant with a volume output of 9080 pounds per week is $66.18 per 1000 pounds. The total cost for a plant processing 145,280 pounds per week is $24.45, or about $42 per 1000 pounds less than the unit cost in the small plant. Again the major difference in costs is in capital and labor, primarily capital. This difference is about $22 per 1000 pounds of milk received.

Table 12.—Processing costs per 1,000 pounds of milk received by different sized plants bottling milk in glass and paper and processing butter, by cost elements.

Cost elements	Processing costs per 1,000 pounds of milk received — Plant size in pounds of milk per week				
	9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
Capital	25.10	13.42	9.83	5.81	3.55
Labor	22.23	18.54	16.52	13.89	11.46
Containers	8.01	8.01	4.95	4.95	4.95
Non-dairy processing supplies	.17	.17	.17	.17	.17
General supplies	8.75	5.43	3.77	2.93	2.50
Truck expenses	1.92	2.04	2.12	1.65	1.82
TOTAL	66.18	47.61	37.36	29.40	24.45

Plants Processing Fluid Milk in Glass and Paper, and Ice Cream

The costs for plants processing in glass and paper and processing ice cream are shown in Table 13. The difference in total costs between the largest and smallest plant processing these products is about $41 per 1000 pounds of milk received. There is a difference in capital cost between the small and the large plant of about $21. The difference in the labor cost between the small and large plant is about $11. The differences in labor costs among all the combinations between the large and small plants are about the same, about $11 per 1000 pounds of milk received. However, the level of the labor costs between the various combinations are different.

Table 13.—Processing costs per 1,000 pounds of milk received by different sized plants bottling milk in glass and paper and processing ice cream, by cost elements.

Cost elements	Processing costs per 1,000 pounds of milk received — Plant size in pounds of milk per week				
	9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
Capital	24.78	13.19	9.55	5.66	3.54
Labor	21.79	18.10	16.97	13.45	11.01
Container	9.10	9.10	6.04	6.04	6.04
Non-dairy processing supplies	2.09	2.09	2.09	2.09	2.09
General supplies	8.75	5.43	3.77	2.93	2.50
Truck expenses	1.92	2.04	2.41	2.07	2.04
TOTAL	68.43	49.95	40.83	32.24	27.22

Total Costs Variations for Model Plants

The total costs for the different sized plants and for the different product combinations are shown in Table 14. When a change is made in the product combinations, changes in costs occur. The cost change is measured from the basic plants which process all products. In all but three cases, this change is a reduction in total costs due to reductions in equipment and labor force with fewer products. In the 72,640-pound plant size where the combination of fluid milk in glass containers, butter, and ice cream are processed, there is an increase in cost of $44.61 per week over the basic model plants. The other two cases are at the size of 145,280 pounds of milk per week where the combination includes milk bottled in glass, butter, and ice cream; the total cost increased $52.68. When this size plant processed milk in paper cartons, ice cream, and butter, the cost increased $50.09 over the basic model plant of the same size. These increases are caused by the need for purchasing larger bottling equipment when the total output is processed in one type of container.

At all volumes of output the plant processing milk in glass bottles without processing ice cream and butter has the lowest processing costs, Table 14.

Table 14.—The effect on total costs of various sized model dairy plants, by different production combinations.

Pounds of milk received per week	9,080		18,160		36,320		72,640		145,280	
Production combination*	Totals	Changes over I	Totals	Changes over I	Totals	Changes over I	Totals	Changes over I	Totals	Changes over I
	(Dollars)		(Dollars)		(Dollars)		(Dollars)		(Dollars)	
I(GPIB)	648.76	......	954.03	......	1,520.51	......	2,455.17	......	4,224.11	......
II (G)	494.16	−154.60	723.14	−230.89	1,157.86	−362.65	1,952.91	−502.26	3,254.42	−969.69
III (GIB)	592.41	− 56.35	871.31	− 82.72	1,481.96	− 38.55	2,499.78	+ 44.61	4,276.79	+ 52.68
IV (PIB)	631.57	− 17.19	943.04	− 10.99	1,515.63	− 4.88	2,424.01	− 31.16	4,274.20	+ 50.09
V (GPB)	600.92	− 47.84	867.69	− 86.34	1,356.91	−163.60	2,135.35	−319.82	3,552.24	−671.87
VI (GPI)	621.31	− 27.45	910.20	− 43.83	1,450.55	− 69.96	2,342.38	−112.79	3,954.98	−269.13

* G refers to glass bottled milk.
P refers to paper cartoned milk.
I refers to ice cream.
B refers to butter.

Plant Revenues

Costs are only one side of the problem that must be considered when looking at the plant as a whole. The other side is revenue. A plant that lowers cost by dropping some products will at the same time lower the revenues by the amount resulting from the sale of these items. The loss in income may be greater than the reduction in costs. Therefore, in determining what combination of products will result in the greatest net returns to the producers and handlers, one must consider costs in relation to revenues. The assumed revenues for the various size plants and combinations are shown in Table 15.[14] The revenues for a plant

[14]Appendix Table 10 shows the volumes of each product processed, its selling price, and the revenues from the basic model plant processing 9,080 pounds of milk per week.

Table 15.—Total revenues of model dairy plants processing 9,080 pounds of milk, by production combination.

Plant group*	Revenues Wholesale	Retail	Total
	dollars	dollars	dollars
I (GPIB)	796.31	249.99	1,046.30
II (G)	210.02	518.37	728.39
III (GIB)	520.50	525.87	1,046.37
IV (PIB)	872.82	172.10	1,044.92
V (GPB)	726.29	247.99	974.28
VI (GPI)	602.17	248.49	850.66

* G refers to glass bottled milk.
P refers to paper cartoned milk.
I refers to ice cream.
B refers to butter.

that does not process butter, for example, would not include the butter revenues of the basic plant. The revenues for a plant with 18,160 pounds of milk per week would be double those which are shown in Table 15.

Net Plant Value of Milk for Plants of Different Sizes

The net plant value of milk for the basic model plants and the five other production combinations are shown in Table 16. This value is the value of milk to the plant after paying all costs other than milk costs and varies with the production combination and size of plant.[15] This table shows that in all cases larger plants can pay producers more for milk. If a small plant is a necessary part of the marketing system and must be maintained over a long period of time, producers will not be able to receive as much for milk delivered to small plants as can be obtained from larger plants if other plant costs per unit, such as labor rates per hour, are the same. On the other hand, producers that have

Table 16.—Net plant value of milk testing 4.085 percent butterfat delivered to different sized dairy plants, by different production combinations.

Production combination*	Net plant value per hundredweight milk — Pounds of milk received per week: 9,080	18,160	36,320	72,640	145,280
	dollars	dollars	dollars	dollars	dollars
I (GPIB)	2.73	4.64	5.68	6.48	6.94
II (G)	2.58	4.06	4.83	5.33	5.78
III (GIB)	3.36	5.09	5.79	6.42	6.91
IV (PIB)	2.91	4.68	5.68	6.51	6.89
V (GPB)	2.47	4.22	5.34	6.12	6.61
VI (GPI)	2.53	4.37	5.37	6.14	6.65

* G refers to glass bottled milk.
P refers to paper cartoned milk.
I refers to ice cream.
B refers to butter.

[15]When the supply and demand conditions warrant it, small plant operators often forego a part of their interest and management returns in order to pay a higher value for needed milk.

no alternative markets or have production alternatives that return substantially lower income may consider a lower producer price at the small plant justified.

Best Product Combination for Plants of Different Sizes

The combination of products that are processed, as well as size of output, affects returns to the handlers and producers. Figure 1 indi-

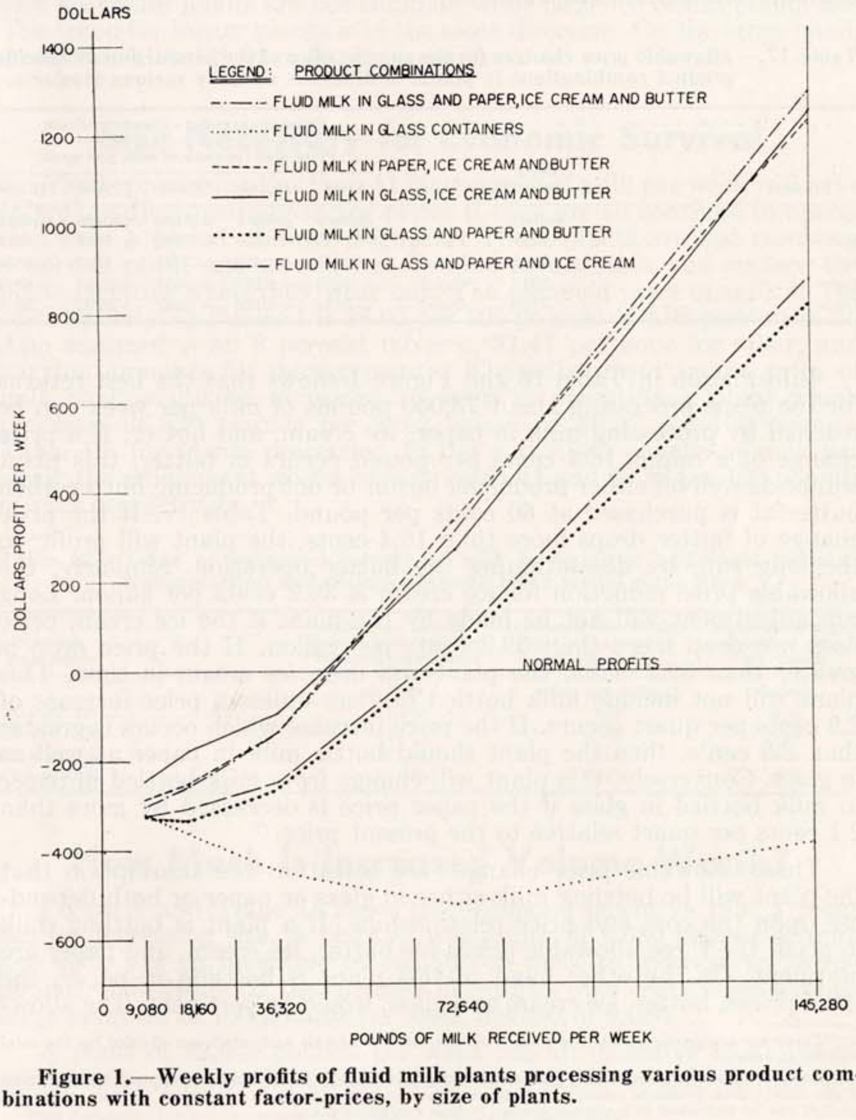

Figure 1.—Weekly profits of fluid milk plants processing various product combinations with constant factor-prices, by size of plants.

cates the weekly profits of various sized plants processing different product combinations when the prices paid within a given sized plant for labor, milk, management, and interest, etc., are the same.

The economic selections of best product combinations have been based on the following assumed prices: Butter—66 cents per pound; ice cream—$1.26 per gallon; and milk—20 cents per quart.[16] If the prices change on any one of these four products, this may change the product combination that will bring the greatest net returns. At each plant size there is an allowable price change before a change in product combination is justified, Table 17.

Table 17.—Allowable price changes for the continuation of the production of specific product combinations in plants of different sizes by various products.

Product	Price per unit	Unit	Price changes on various products — Plant size (pounds of milk per week)				
			9,080	18,160	36,320	72,640	145,280
	dollars		dollars	dollars	dollars	dollars	dollars
Butter	.6565	Pound	−.1136	−.1376	−.1524	−.1638	−.1547
Ice Cream	1.2585	Gallon	−.2910	−.3487	−.3761	−.3917	−.3630
Paper	.2017	Quart	+.0230	+.0169	+.0039	−.0207	−.0014
Glass	.1996	Quart	−.0131	−.0120	−.0032	+.0292	−.0070

Information in Table 16 and Figure 1 shows that the best returns for the plant processing about 73,000 pounds of milk per week can be reached by processing milk in paper, ice cream, and butter. If a price change of a minus 16.4 cents per pound occurs in butter, this plant will be as well off either producing butter or not producing butter when butterfat is purchased at 60 cents per pound, Table 17. If the price change of butter drops more than 16.4 cents, the plant will profit, in the long run, by discontinuing the butter operation. Similarly, the allowable price reduction for ice cream is 39.2 cents per gallon. Long run adjustment will not be made by the plant if the ice cream price does not drop more than 39.2 cents per gallon. If the price drop is greater than 39.2 cents, the plant will drop ice cream in time. This plant will not include milk bottled in glass unless a price increase of 2.9 cents per quart occurs. If the price increase which occurs is greater than 2.9 cents, then the plant should bottle milk in paper as well as in glass. Conversely, this plant will change from milk bottled in paper to milk bottled in glass if the paper price is decreased by more than 2.1 cents per quart relative to the present price.[17]

These allowable price changes are based on the assumption that the plant will be bottling milk either in glass or paper or both depending upon the cost and price relationships. If a plant is bottling milk in glass, the three allowable prices for butter, ice cream, and paper are pertinent. On the other hand, if this plant is bottling in paper, the three prices, butter, ice cream and glass, would be pertinent. The allow-

[16]These are composite prices; the total revenues, both wholesale and retail, are divided by the total number of units.

[17]Each of the above solutions are partial solutions. The values given in Table 16 apply when the prices of the other three products remain unchanged. Simultaneous changes in the prices of more than one product can be appraised in a manner similar to that explained above.

able price changes do not mean that this plant will discontinue operations on all products. The allowable price changes are based on the assumption that fluid milk will continue to be processed.

The allowable price changes are determined for five sizes of plants, Table 17. This table indicates that the small plants will continue processing a given production combination with wider changes of fluid milk prices than the larger plants. On the other hand, the larger plants can stay in ice cream and butter with wider price reductions than can the small plants. This seems to be in accord with experience. Small specialized ice cream plants are not common while large ice cream plants are. The trend for butter plants is in the same direction. On the other hand, small specialized fluid milk plants exist.

Size Necessary for Economic Survival

Plants processing less than 41,000 pounds of milk per week will have to make adjustments in factor prices if they are to continue in operation over a period of time, Figure 1. These plants are not receiving a normal profit and so will not be able to maintain and replace the plant facilities when they wear out. The assumed price of milk in the costs underlying Figure 1 is \$6.05 per 100 pounds of 4.08 percent milk. Also assumed is an 8 percent interest, \$1.47 per hour for labor, and varying amounts for management.[18] The adjustment in the price of milk that would be necessary to keep in operation a plant which processes 36,320 pounds per week would be \$0.37 per 100 pounds, Table 16; for plants processing 18,160 and 9,080 pounds of milk per week, the adjustment would have to be \$1.41 and \$3.32 per 100 pounds of milk respectively.

Table 18.—Value of increased volume of milk in terms of additional miles of transportation and dollars between basic model plant sizes.

Between plant sizes	Difference in total revenue and total cost between plant sizes	Increased distribution route mileage at 10 cents per mile	Value per quart of maintained volume purchased
	dollars	miles per week	dollars
X and 2X	61.86	618	.018
2X and 4X	158.78	1,588	.023
4X and 8X	521.86	5,219	.038
8X and 16X	1,144.05	11,441	.042

How Much Is Increased Volume Worth?

Figure 1 and Table 18 show the economic incentive that a plant has for increasing size. A plant of a capacity of 9,080 pounds of milk per week has an incentive of \$61.86 per week to increase to 18,160 pounds. The \$61.86 is the increase in returns over costs when operating a plant at 18,160 pounds per week instead of 9,080.

A plant of 72,640 pounds per week has an incentive of \$1,144.05 per week to increase its plant volume to 145,280 pounds of milk per

[18]See Appendix Table 1 on management costs by basic model plant sizes.

week.[19] The plant can spend the $61.86 per week, in the case of the small plant, or the $1,144.05 per week in the case of the large plant, in various ways to increase volume.

Small plants have two obvious alternatives in trying to meet the competition of larger plants. The first is to reduce unit costs while retaining their present volume; the second is to reduce unit costs by increasing volume. Each plant must find its own way to take care of its problems. Regardless of which method or combinations of methods a plant manager may select to improve his plant's competitive position, he must have a reasonable expectation that the increase in volume (or drop in costs) will be sufficient to justify his expenditures.

Reducing Costs Without Increasing Volume

The analysis shows that normally plants receiving 41,000 pounds of milk or less per week cannot meet expected long-run costs, including the producer prices of milk used in the study. Obviously, therefore, only under circumstances extremely favorable to survival could a smaller plant endure over a long-run period.

In instances where producers have no other outlets for milk or cream except a small local plant, they may find it to their advantage to accept a lower price for their farm milk or cream, rather than change to some other farm enterprise.

Similarly, where the local opportunities for labor are limited, labor costs might be reduced by using part-time labor, or family labor, or by some other device.

Equipment costs often can be reduced by buying used equipment.

A study in Utah indicates that some opportunity for lowering costs may be possible by every-other-day processing of milk.

Adjustments in the combination of products may make it possible to compete with larger plants. A plant that could not compete with large plants in paper-cartoned milk might be able to do so by bottling in glass.

Retail sales may be stressed over wholesale sales. Emphasis may be placed on service or quality, rather than retail price.

In cases where the plant processes by-products at such a small volume that costs per unit are high, the plant might be better off to discontinue the processing and purchase the by-products. This course is feasible only if by-products can be purchased at a lower cost than the cost of processing.

Lowering Costs by Increasing Sales Volume

This study indicates that a more certain way than merely lowering costs is to increase volume of sales to obtain the cost advantages inherent in obtaining more efficient utilization of labor and more complete utilization of the plant's capacity.

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[19]The degree to which a plant's management will respond to this incentive can be expected to depend on its expectations that sales can be increased, and on the plant's ability to finance the expenditures necessary to obtain the increase in sales.

A merger of small plants is one way that sales volume can be increased. Such mergers may result in specialized operations in each of the existing plants. For example, one plant may process all of the fluid milk products, while the other may produce manufactured products; or one may package milk in paper, the other in glass. Alternatively, the entire operation may be concentrated in one of the plants.

A plant may expand its sales territory. Based on the model plant data, a plant handling 9,080 pounds of milk weekly could expand its route mileage 618 miles per week at a variable cost of 10 cents per mile, or could afford to pay 1.8 cents per maintained quart per week when buying a route, if this expansion could be expected to double its sales. These expenditures would leave it in the same economic position as before the expansion. If it could obtain the same increase in sales at a lower cost, its position would be improved.

Advertising and aggressive sales campaigns offer another possibility for increasing the size of dairy operations. Such campaigns may increase the one plant's sales at the expense of a non-advertising plant. In such instances the suffering plant can be expected to retaliate in kind. The resultant struggle for sales may actually result in a rise in unit costs, unless total sales in the market can be increased sufficiently to absorb the costs of the campaigns. The extent to which the total market for dairy products can be expanded through advertising and sales promotion cannot be determined until research into consumer responses to such programs can be carried out.

Finally, it is possible that innovations will be developed that will reduce the costs of processing or distributing milk in such a way that the small distributor will have the same advantages as the large distributor.

Summary

1. Cost data obtained from the six plants processing and distributing dairy products in an isolated area showed the larger plants obtained cost advantages chiefly due to the more efficient utilization of capital and labor.

2. By using the costs observed for these six plants, costs for five synthetic model plants ranging from 9,080 pounds to 145,280 pounds of milk received per week were developed. Analyses of the resultant synthetic cost data showed that definite and important cost advantages would be gained by each of the five smaller synthetic plants (using the same combination of products).

3. Total production costs for model plants handling all products processed in the area varied from $71.45 per 1,000 pounds of milk received for the plant processing 9,080 pounds of milk a week to $29.16 per 1,000 pounds for the plant processing 145,280 pounds per week.

4. For the model and observed plants, capital and labor constitute the largest elements of costs. They also show the most pronounced tendency to decrease as size of plant increases. Capital costs varied from $26.61 per 1,000 pounds of milk received per week for a model plant processing 9,080 pounds of milk to $0.73 per 1,000 pounds for a model

plant receiving 145,280 pounds of milk. Labor costs varied for the same two sizes of plants from $22.75 to $12.45 per 1,000 pounds of milk received. Sales labor costs and management labor costs showed the least tendency to decrease per unit as size of operation increased.

5. Capital costs comprise the largest percentage of costs for small model plants, whereas labor costs are the most significant for large firms. The high percentage of capital costs in the case of small firms is an important reason for their competitive disadvantage. Any change in product combination which does not increase the total volume of sales adds significantly to the capital costs of the small firm.

6. Each size of model plant has a preferred production combination. For plants of less than 37,000 pounds capacity per week, the best returns over costs combination is the processing of milk in glass containers, together with ice cream and butter. Plants processing about 73,000 pounds of milk per week can maximize their returns by processing milk in paper containers together with ice cream and butter. The largest plant studied, one producing about 145,000 pounds per week, can maximize returns over costs by processing all products (glass, paper, butter, and ice cream).

7. Unless a plant processes more than 41,000 pounds of milk per week it cannot, under present conditions, cover all of its costs, even if it produces the most profitable product combinations under high processing and marketing efficiency. Small plants seem to have the greatest survival power if they keep their operations simple. The nature of modern milk processing is such, however, that a high premium is placed upon size. Large firms not only make more profits per unit than small firms, but they can also afford to pay more to producers, process a wider variety of products, and cater more to consumer preferences.

8. Several alternative procedures are open to the small plant to meet the competition of the larger plants. It can try to cut costs by paying less to producers; it can combine with other small plants into more economical units; it can carry on an aggressive and vigorous advertising and sales campaign to increase consumption of its dairy products. It can simplify operations or change its operations to a more favorable combination of products. Finally, innovations may be developed which will significantly decrease the costs of marketing milk and at the same time will give to the small distributor the same advantages as to the large distributor.

Appendix—Methodology

The project from which these data have been obtained dealt with an area analysis of fluid milk distribution. The University of Idaho undertook a pilot study as a part of the western regional dairy marketing research program. Briefly, the objective of the pilot study was to determine the method whereby one could ascertain the economic limits of expanding fluid milk marketing areas. At the completion of the pilot study a report was made to the Western Regional Dairy

Technical Committee on the results of the study. A full report on that pilot study will not be made because of the inadequacy of data on long distance hauling of milk.

The information obtained on the processing of fluid milk dairy products has significant appropriateness to the problems surrounding the small fluid milk plants. This information has been checked on specific counts, such as advertising expense, fuel expense, and average hauling cost per mile in 44 Idaho plants during February 1955. Significant variations from the data as presented in this report were adequately explained by the plant managers. Therefore, the authors feel that this information, even though supplied by a relatively small number of plants, has considerable general application to the current problems in the industry.

From observed plants the capital inventory was obtained, together with the original purchase date, description of equipment, its costs, and its estimated life. Total insurance costs, total taxes, total repair bills and the prevailing rate of interest in this area were also secured from the plant survey.

A complete labor utilization analysis was made for a short period of time. This information included statistics on the length of time required to clean bottle fillers, receiving equipment, and pipes to the churn. Data were also gathered on the time requirements to churn an average batch of butter, the rate of freezing of ice cream, the number of bottles of milk bottled per minute either in glass or paper, the length of time required to wash bottles, the time needed to set up the bottle washer and to clean the floors, etc. All of these operations were described in detail, so that the total labor requirements were ascertained within each plant.

From the detailed equipment inventory and the labor time records, the requirements for each job within the plant were obtained in relation to both the fixed labor, such as cleaning up and setting up the equipment, and the variable labor requirements, which include such items as the number of minutes required to wash or fill bottles, or to freeze ice cream with various types of equipment. From this, the respective output rates of the various labor-capital combinations were determined.

Each processing function, labor and capital combination included, was defined in such a manner that no allocations of overhead or joint costs to a particular function was necessary in ascertaining the end-cost of the products. Each job stood alone. For example, receiving milk is an overhead function. By treating the act of receiving as one of the total manufacturing processes necessary in the whole operation, one can determine the cost of receiving milk in terms of a volume of milk and no allocation is necessary when comparing the cost of one volume with another. The same is true of all functions from which joint products are produced. Separating, for example, is the act of separating a thousand pounds of milk. This has capital and labor requirements. The important consideration is the cost of separating a thousand pounds of milk as contrasted with two thousand pounds of milk, etc. All plants separate milk; therefore it was not necessary to analyze independently an operation without the cost of separation.

From the observed plants, the quantity of the various factory supplies and the prices paid for them were obtained. Cleaning supplies were classified as fixed within each plant size, while manufacturing supplies, such as sugar for ice cream mix, flavors, cartons made, were proportional to output.

The total number of various products produced by the observed plants were determined. The total number of each product sold by each plant in the different cities served was obtained. The quantity of each product in each container type in each town and its supplier was known.

The transportation data obtained included the distance between towns, the number of stops, both wholesale and retail, the amount of time required for stops, for going through towns, for volumes, and for the types of truck used. In addition cost data, fixed and variable, were secured. The fixed cost data included interest, licenses, and insurance. The variable costs included gas and oil consumption, tires, and repairs. There were some costs, such as batteries, and chains, which were intermediate to fixed and variable costs. These costs were grouped on the bases of association. If the truck were used so that chains, for example, would wear out in a relatively short period, the cost was considered variable. In cases where the truck was little used, such costs were considered fixed. The same type of condition applied to grease and oil costs. Trucks that were driven over 1,000 miles per month included these costs as variable. In cases where the distance was less than 1,000 miles per month, these were assumed to be fixed because most truck operators will grease their trucks once a month under such conditions.

Procedure for Determining Costs

Two different analyses were made of the cost data obtained in this study. The first analysis retained the identities of individual plants. These identities were retained by allowing variations resulting from operation of the plant to remain. Cost variations independent of the plant operation, such as variations in original cost of building and equipment, were also retained. In the second analysis, which is more fully described, all variations other than those due to volume of production were eliminated.

Observed costs were analyzed in four groups. These were labor, capital, factory supplies, and product supplies. Each function was analyzed in relation to these four types of cost. The functions were classified on the basis of processes, such as receiving, homogenizing, and bottling. Each function was set up with the problem of cost allocation in mind.

Costs were divided into two main divisions, unallocated costs and allocated costs. Unallocated costs include such capital costs as those on land, building, office equipment, refrigeration equipment, and separation equipment. It also takes in unallocated labor cost, which covers costs such as office labor, labor assigned to separation, and idle labor not assigned to specific functions. Also grouped in unallocated cost are general costs, including cost of fuel, water, sewage, electric power, telephone and telegraph, office supplies, laboratory, and advertising. Management is also considered as an unallocated cost.

Allocated costs include the costs in four categories: Allocated capital costs are charges for specific items of equipment used on a process or product. Allocated labor also relates to the labor requirements of specific processes or products. Allocated supplies include supply items necessary for a product or function. (In the case of products, the amount of salt used is an example; for a process, a filter bag relates to processing milk.) The general operating costs are composed primarily of truck operating expenses in the sales function.

Costs for each plant were allocated to the following functions: fluid milk function, homogenization, bottling, butter, ice cream, cottage cheese, chocolate drink, cream, and sales functions. No attempt has been made to establish a classification of intermediate functions. Such classifications involve allocations that are necessarily arbitrary and the value of any results so obtained is open to question.

When costs could not be allocated to a function, it was classified as overhead; for example, costs of advertising could not be divided as to separate products and was classified under overhead.

To accomplish the objectives, it was necessary to eliminate individual variations within groups of model plants. These plants have been constructed so that all factors other than the scale that affect costs have been standardized. This standardization eliminates all variation between plants that were not due to volume.

Capital Determinations

Variations in capital expenses were eliminated by setting up standard building sizes for each assumed volume. Equipment and buildings were depreciated at the same rate for all size plants. The rates of insurance, taxes, and interest were standardized. Labor rates were standardized. Repair rates were also standardized for all plant sizes.

Factors used in constructing model plants were as follows: (1) Building sizes were determined so the plant could get most effective use of equipment necessary for output. (2) Equipment was chosen in such a manner as to get an internal balance among the departments of the plant. The bottle filler was considered the basic item of equipment. Other equipment of the kinds and sizes currently manufactured was selected in relation to the performance of the bottle filler. The selection of the specific equipment was governed by the assumed volume.

Capital costs for the model plants were computed at 1954 prices, which were obtained from the equipment dealers or were estimated projections from secondary data, Appendix Table 1. Estimated projections were used for the most part in connection with building costs.[1]

[1]Clayton M. Page and Scott A. Walker, *Building Designs for Dairy Processing Plants*, University of Idaho Experiment Station, Bulletin No. 297, June, 1953.

Appendix Table 1.—Equipment list by basic model plants

Equipment	X No.	X Size	X Cost	X Life	2X No.	2X Size	2X Cost	2X Life	4X No.	4X Size	4X Cost	4X Life	8X No.	8X Size	8X Cost	8X Life	16X No.	16X Size	16X Cost	16X Life
			Dollars	Yrs.			Dollars	Yrs.			Dollars	Yrs.			Dollars	Yrs.			Dollars	Yrs.
Office:																				
cash register	1		250	20	1		250	20	1		300	20	1		300	20	1		325	20
filing cabinets	1		60	25	1		60	25	2		120	25	2		120	25	3		180	25
desk	1		125	20	1		125	20	1		125	20	2		250	20	3		375	20
chair	3		78	10	3		78	10	4		104	10	5		130	10	6		156	10
tables	1		30	20	1		30	20	2		60	20	2		60	20	2		60	20
typewriter and stand	1		140	20	1		140	20	1		140	20	1		140	20	1		140	20
posting and adding machine	1		200	20	1		200	20	2		500	20	2		550	20	3		700	20
calculator	.		......	....	.		......	....	.		......	....	1		450	20	1		450	20
safe	1		300	30	1		300	30	1		300	30	1		300	30	1		400	30
posting trays	1		50	30	1		50	30	2		100	30	2		100	30	3		150	30
misc. binder, etc.	.		80	5	.		90	5	.		100	5	.		100	5	.		150	5
Boilers:																				
oil boiler installed with accessories	1	15-hp.	3,000	25	1	15-hp.	3,000	25	1	35-hp.	4,000	25	1	35-hp.	4,000	20	1	45-hp.	4,200	20
Shop Tools:																				
plant tools only	.		250	10	.		250	8	.		300	8	.		350	8	.		400	6
Refrigeration:																				
soft water system	1		1,500	12	1		1,500	12	1		2,000	12	1		2,200	12	1		2,300	12
compressor	1	3T	2,500	15	1	6T	3,200	15	2	6T	6,400	15	2	10T	8,400	15	2	16T	9,200	15
													1	3T	2,750	15	1	10T	4,200	15
																	1	6T	3,200	15
for milk cooler	1		300	12	1		300	12	1		350	12	1		350	12	1		425	12
for sharp room	1		350	12	1		350	12	1		400	12	1		425	12	1		450	12
ice machine	1		850	15	1		850	15	1	.5T	920	15	1	1T	1,200	15	1	2T	1,500	15
Receiving milk:																				
weight tank and pump unit	1		550	15	1		600	15	1		750	15	1		750	12	1		1,200	10
cold milk filter	1		425	15	1		425	15	1		425	15	1		425	12	1		425	10
can washer			......	....	1	3	1,250	20	1	3	1,250	20	1	3	1,250	15	1	3	1,250	10
wash tank and steam jet	1		200	12	1		200	12	1		200	12	1		200	12	1		200	10
conveyors	.		120	20	.		150	20	.		200	15	.		300	15	.		300	15
sample racks, storage	.		100	15	.		200	15	.		300	15	.		300	15	.		450	12
Cream Receiving:																				
receiving vat	1		50	15	.		50	15	1		50	15	1		50	15	1		50	15
platform scales	1		125	25	1		125	20	1		125	20	1		125	20	1		125	20
can rack	1		50	20	1		75	20	1		100	20	1		125	20	1		125	20
Cream and Milk Lab:																				
centrifuge	1		150	25	1		150	25	1		150	25	1		150	25	1		150	25

Appendix Table 1.—Equipment list by basic model plants—Continued

Equipment	Plant Size																			
	X				2X				4X				8X				16X			
	No.	Size	Cost	Life	No.	Size	Cost	Life	No.	Size	Cost	Life	No.	Size	Cost	Life	No.	Size	Cost	Life
			Dollars	Yrs.			Dollars	Yrs.			Dollars	Yrs.			Dollars	Yrs.			Dollars	Yrs.
electric water heater	1		100	20	1		100	20	1		100	20	1		100	20	1		100	20
Torison balance scale	1		190	25	1		190	25	1		190	25	1		190	25	1		190	25
glassware	.		100	2	.		125	2	.		150	2	.		200	2	.		300	2
miscellaneous	.		100	4	.		150	4	.		200	4	.		300	4	.		400	4
Fluid Milk Processing:																				
pasteurizing equipment	2	100-gal.	3,800	15	2	200-gal.	4,200	15	2	300-gal.	4,800	15	1	2500# st.	7,100	20	1	4200# st.	7,800	20
									1	200-gal.	2,100	15								
surface cooler	.		1,000	15	.		1,150	15	1		1,500	15	.		......	....	.		......	....
storage tanks	.		......	....	.		......	....	.		......	....	2	800-gal.	5,300	25	2	1,600-gal.	6,400	25
milk pump	1		300	10	1		300	10	1		300	8	1	variable	650	12	1	variable	650	12
dual-control high-low level switch	1		125	10	1		125	10	1		125	10	.		......	....	.		......	....
separator	1	1,200 lbs.	297	8	1	1,200 lbs.	297	8	1	2,000 lbs.	475	8	1	4,000 lbs.	675	8	1	8,000 lbs.	1,125	8
homogenizer	1	1,075 #/hr.	1,850	15	1	1,075 #/hr.	1,850	15	1	2,500 #/hr.	2,250	15	1	2,500 #/hr.	2,250	15	1	4,200 #/hr.	3,250	15
Cream Processing and Butter:																				
cream coil vat	1	100-gal.	1,400	15	1	200-gal.	1,650	15	1	300-gal.	1,800	15	1	300-gal.	1,800	15	1	300-gal.	1,800	15
churn	1	500 lbs.	1,100	20	1	750 lbs.	1,400	20	1	1,200 lbs.	1,750	20	1	1,200 lbs.	1,750	20	1	1,200 lbs.	1,750	15
molds	5		50	4	9		90	4	17		170	4	17		170	4	17		170	4
cream pump	1		300	15	1		300	15	1		300	15	1		300	12	1		300	10
cream filter	1		50	12	1		50	12	1		50	12	1		50	12	1		50	12
miscellaneous	.		50	5	.		60	5	.		70	5	.		80	5	.		90	5
scales	.		125	15	.		125	12	.		125	12	.		125	10	.		475	25
Special Prod. Items:																				
batch vat	1	50-gal.	950	15	1	100-gal.	1,250	15	1	200-gal.	1,750	15	1	200-gal.	1,750	15	1	200-gal.	1,750	15
cottage cheese vat	1	15-gal.	200	12	1	30-gal.	250	12	1	60-gal.	300	12	1	120-gal.	350	12	1	120-gal.	350	12
curd utensils	.		50	12	.		50	12	.		50	12	.		50	12	.		50	12
Ice Cream Freezing:																				
freezer	1	5-gal.	3,200	12	1	10-gal.	3,500	12	1	20-gal.	3,600	12	1	40-gal.	3,900	12	1	80-gal. Con.	8,000	12
storage vat	.		......	....	.		......	....	.		......	....	.		......	....	1	400-gal.	1,250	15
cleaning table	1		95	15	1		95	15	1		95	15	1		95	15	1		95	15
mix pump	.		......	....	.		......	....	.		......	....	.		......	....	1		215	7
container maker	1		35	15	1		35	15	1		35	15	1		35	15	1		35	15
Glass Bottling:																				
bottle filler	1	20/min.	1,750	15	1	20/min.	1,750	15	1	20/min.	1,750	15	1	20/min.	1,750	15	1	20/min.	1,750	15
bottle washer	1	3-case/ min.	625	15	1	3-case/ min.	625	15	1	3-case/ min.	625	15	1	3-case/ min.	625	15	1	3-case/ min.	625	15
Paper Bottling:																				
can filler	1		10	15	1		10	15	1		10	15	1		10	15	1		10	15
bottle filler	1	MD	1,025	12	1	MD	1,025	12	1	Purpak Midget	12,440	10	1	Purpak Midget	12,440	10	1	Purpak Junior	16,500	10

The interest, insurance, and tax rates were based on the observed weighted-average rates. These rates were applied to the investment by functions. The investment level was obtained by estimating the expected life of the equipment. The 1954 purchase cost was depreciated for all functions 5.6 years in order to obtain the remaining life level of the observed plant. Repair costs were based in total on the observed weighted-average repair rate relative to observed investment. However, the repair cost was distributed to functions on the basis of the depreciation expense rather than investment level. The logic of this method is based upon the assumption that the more expensive equipment has the greater repair cost when the estimated life of two items is the same. On the other hand, if two items cost the same, but one has the longer life, one would expect the annual repair bill to be less for the one with the longer life. The method used for distributing repairs reflects the above assumptions.

Appendix Tables 2-6 show the capital costs of the various sized basic model plants by functions.

Assumed Volumes

Volumes of the various model plants were selected on the basis of total milk and milk products supplied in the area served by the observed plants. The largest model plant represented a plant that could supply the total volume of milk, cream, ice cream, and butter for the Camas Prairie area with a small amount of capacity leeway for expansion,

Appendix Table 2.—Annual capital expense of the basic model plant processing 9,080 pounds of milk per week by functions.

Function	Total purchase cost new	Depreciated investment	Annual capital expenses					
			Depreciation	Interest	Insurance	Repair cost	Taxes	Total
	dollars	dollars	dollars	dollars	dollars	dollars	dollars	dollars
Office	1,303	887.04	74.28	70.96	20.75	77.99	13.66	257.64
Boilers	3,500	3,360.00	140.00	268.80	78.62	146.99	51.74	686.15
Shop tools	250	110.00	25.00	8.80	2.57	26.25	1.69	64.31
Refrigerators	6,700	4,381.55	414.01	350.52	102.53	434.68	67.48	1,369.22
Receiving milk	900	545.41	63.32	43.63	12.76	66.48	8.40	194.59
Cream receiving	225	164.35	10.83	13.15	3.85	11.37	2.53	41.73
Fluid milk processing	4,630	2,858.55	316.33	228.68	66.89	332.13	44.02	988.05
Homogenization	3,200	2,005.35	213.33	160.43	46.93	223.98	30.88	675.55
Separation	1,750	525.00	218.75	42.00	12.29	229.67	8.09	510.80
Cream processing and butter	4,438	2,882.88	277.70	230.63	67.45	291.57	44.40	911.75
Special products process	1,100	661.35	78.33	52.91	15.48	82.24	10.18	239.14
Ice cream freezing	3,080	1,657.15	254.08	132.57	38.78	266.77	25.52	717.72
Bottling:								
glass	3,000	1,712.00	230.00	136.97	40.07	241.49	26.37	674.90
paper	1,025	546.65	85.42	43.73	12.79	89.69	8.42	240.05
can	50	31.35	3.33	2.50	.73	3.50	.48	10.54
Cream and milk lab	390	168.24	39.60	13.46	3.94	41.58	2.54	101.12
Bottle cases	1,040	755.12	187.30	60.41	17.67	196.65	11.63	473.66
Building	30,000	25,060.80	882.00	2,004.87	586.43	300.00	385.94	4,159.24
Sub-total	66,581	48,312.79	3,513.61	3,865.01	1,130.54	3,063.03	743.97	12,316.16
Bottle inventory	....	67.50	....	5.40	1.58	....	1.04	8.02
Inventory	....	2,000.00	....	160.00	46.80	....	30.80	237.60
TOTAL	66,581	50,380.29	3,513.61	4,030.41	1,178.92	3,063.03	775.81	12,561.78

Appendix Table 3.—Annual capital expense of the basic model plant processing 18,160 pounds of milk per week by functions.

Function	Total purchase cost new	Depre-ciated investment	Annual capital expenses: Depre-ciation	Interest	Insurance	Repair cost	Taxes	Total
	dollars	dollars	dollars	dollars	dollars	dollars	dollars	dollars
Office	1,313	885.83	76.28	70.87	20.73	78.26	13.64	259.78
Boilers	4,100	3,204.00	160.00	256.32	74.97	164.14	49.34	704.77
Shop tools	2,500	110.00	25.00	8.80	2.57	25.65	1.69	63.71
Refrigerators	7,300	4,779.94	450.01	382.40	111.85	461.67	73.61	1,479.54
Receiving milk	2,550	1,640.05	162.49	131.20	38.38	166.70	25.26	524.03
Cream receiving	250	182.35	12.08	14.59	4.27	12.39	2.81	46.14
Fluid milk processing	5,030	3,109.20	343.00	248.74	72.76	351.88	47.88	1,064.26
Homogenization	3,200	2,005.35	213.33	160.43	46.93	218.86	30.88	670.43
Separation	1,750	525.00	218.75	42.00	12.29	224.42	8.08	505.54
Cream processing and butter	5,113	3,264.83	330.03	261.19	76.40	338.58	50.28	1,056.48
Special products process	1,850	1,630.65	39.17	130.45	38.16	40.18	25.11	273.07
Ice cream freezing	3,484	1,872.60	287.75	149.81	43.82	295.20	28.84	805.42
Bottling:								
glass	3,000	1,712.00	230.00	136.97	40.07	235.96	26.37	669.37
paper	1,025	546.65	85.42	43.73	12.79	87.63	8.42	237.99
can	50	31.35	3.33	2.50	.73	3.42	.48	10.46
Cream and milk lab	390	168.24	39.60	13.46	3.94	40.62	2.59	100.21
Bottle cases	1,237	884.40	221.00	70.76	20.69	226.72	13.62	552.79
Building	30,000	25,060.80	882.00	2,004.87	586.43	300.00	385.94	4,159.24
Sub-total	71,892	51,613.24	3,779.24	4,129.09	1,207.78	3,272.28	794.84	13,183.23
Bottle inventory	....	135.00	....	10.80	3.16	....	2.08	16.04
Inventory	....	3,500.00	....	280.00	81.90	....	53.90	415.80
TOTAL	71,892	55,248.24	3,779.24	4,419.89	1,292.84	3,272.28	850.82	13,615.07

Appendix Table 4.—Annual capital expense of the basic model plant processing 36,320 pounds of milk per week by functions.

Function	Total purchase cost new	Depre-ciated investment	Annual capital expenses: Depre-ciation	Interest	Insurance	Repair cost	Taxes	Total
	dollars	dollars	dollars	dollars	dollars	dollars	dollars	dollars
Office	1,849	1,267.83	103.78	101.43	29.67	100.47	19.52	354.87
Boilers	4,500	3,492.00	180.00	279.36	81.71	174.25	53.78	769.10
Shop tools	300	132.00	30.00	10.56	3.09	29.04	2.03	74.72
Refrigerators	7,850	5,127.45	486.17	410.20	119.98	470.64	78.96	1,565.95
Receiving milk	2,850	1,828.00	182.50	146.24	42.78	176.67	28.15	576.34
Cream receiving	275	200.35	13.33	16.03	4.69	12.90	3.08	50.03
Fluid milk processing	7,690	4,764.95	522.33	381.20	111.50	505.65	73.38	1,594.06
Homogenization	3,200	2,005.35	213.33	160.43	46.93	206.52	30.88	658.09
Separation	1,750	525.00	218.75	42.00	12.29	211.76	8.08	492.88
Cream processing and butter	6,613	4,189.88	432.70	335.19	98.04	418.88	64.52	1,349.33
Special products process	2,450	1,493.35	170.83	119.47	34.94	165.37	23.00	513.61
Ice cream freezing	3,484	1,872.60	287.75	149.81	43.82	278.56	28.84	788.78
Bottling:								
glass	3,000	1,712.00	230.00	136.96	40.06	222.65	26.36	656.03
paper	12,440	6,634.65	1,036.67	530.77	155.26	1,003.57	102.18	2,828.45
can	50	31.35	3.33	2.51	.73	3.22	.48	10.27
Cream and milk lab	390	168.24	39.60	13.46	3.94	38.34	2.59	97.93
Bottle cases	1,482	989.60	267.00	79.17	23.16	85.12	15.24	469.69
Building	41,750	34,876.28	1,227.45	2,790.10	816.10	417.50	537.09	5,788.24
Sub-total	101,923	71,310.88	5,645.52	5,704.89	1,668.69	4,521.11	1,098.16	18,638.37
Bottle inventory	....	270.00	....	21.60	6.32	....	4.16	32.08
Inventory	....	6,500.00	....	520.00	152.10	....	100.10	772.20
TOTAL	101,923	78,080.88	5,645.52	6,246.49	1,827.11	4,521.11	1,202.42	19,442.65

Appendix Table 5.—Annual capital expense of the basic model plant processing 72,640 pounds of milk per week by functions.

Function	Total purchase cost new	Depre-ciated investment	Annual capital expenses: Depre-ciation	Interest	Insurance	Repair cost	Taxes	Total
	dollars	dollars	dollars	dollars	dollars	dollars	dollars	dollars
Office	2,500	1,729.27	137.63	138.34	40.46	132.51	26.63	475.57
Boilers	4,500	3,492.00	180.00	279.36	81.71	173.30	53.78	768.15
Shop tools	350	154.00	35.00	12.32	3.60	33.70	2.37	86.99
Refrigerators	10,445	7,023.85	610.92	561.91	164.36	588.19	108.17	2,033.55
Receiving milk	2,850	1,828.00	182.50	150.24	42.78	175.71	28.15	579.38
Cream receiving	300	218.35	14.58	17.47	5.11	14.04	3.36	54.56
Fluid milk processing	14,900	10,074.65	861.67	805.97	235.75	829.61	155.15	2,888.15
Homogenization	3,500	2,193.35	233.33	175.47	51.32	224.65	33.78	718.55
Separation	2,700	775.00	343.75	62.00	18.14	330.96	11.93	766.78
Cream processing and butter	6,613	4,189.88	432.70	335.19	98.04	416.60	64.52	1,347.05
Special products process	2,700	1,626.65	191.67	130.13	38.06	184.54	25.05	569.45
Ice cream freezing	3,484	1,872.60	287.75	149.81	43.82	277.04	28.84	787.26
Bottling:								
glass	3,000	1,712.00	230.00	136.96	40.06	221.44	26.36	654.82
paper	12,440	6,634.65	1,036.67	530.77	155.26	998.10	102.18	2,822.98
can	50	31.35	3.33	2.51	.73	3.21	.48	10.26
Cream and milk lab	390	168.24	39.60	13.46	3.94	38.13	2.59	97.72
Bottle cases	1,770	1,296.60	320.25	103.80	30.34	81.39	19.97	555.75
Building	43,500	36,338.16	1,278.90	2,907.06	850.32	435.00	559.61	6,030.89
Sub-total	115,992	81,358.60	6,420.25	6,512.77	1,903.80	5,158.12	1,252.92	21,247.86
Bottle inventory	....	540.00	....	43.20	12.64	....	8.32	64.16
Inventory	....	12,500.00	....	1,000.00	292.50	....	192.50	1,485.00
TOTAL	115,992	94,398.60	6,420.25	7,555.97	2,208.94	5,158.12	1,453.74	22,797.02

Appendix Table 6.—Annual capital expense of the basic model plant processing 145,280 pounds of milk per week by functions.

Function	Total purchase cost new	Depre-ciated investment	Annual capital expenses: Depre-ciation	Interest	Insurance	Repair cost	Taxes	Total
	dollars	dollars	dollars	dollars	dollars	dollars	dollars	dollars
Office	3,086	2,119.27	172.63	169.54	49.59	174.02	32.64	598.42
Boilers	5,000	3,880.00	200.00	310.40	90.79	201.61	59.75	862.55
Shop tools	400	176.00	40.00	14.08	4.12	40.32	2.71	101.23
Refrigerators	13,525	9,252.65	762.92	740.21	216.51	769.05	142.49	2,631.18
Receiving milk	3,450	2,204.00	222.50	176.32	51.57	224.29	33.94	708.62
Cream receiving	300	218.35	14.58	17.47	5.11	14.70	3.36	55.22
Fluid milk processing	18,750	13,166.80	997.00	1,053.34	308.10	1,005.02	202.77	3,566.23
Homogenization	4,750	2,976.65	316.67	238.13	69.65	319.22	45.84	989.5
Separation	3,200	960.00	400.00	76.80	22.46	403.22	14.78	917.20
Cream processing and butter	6,613	4,191.00	432.50	335.28	98.07	435.98	64.54	1,366.37
Special products process	2,700	1,626.65	191.67	130.13	38.06	193.21	25.05	578.1
Ice cream freezing	8,405	7,507.10	160.34	600.60	175.67	161.63	115.61	1,213.8
Bottling:								
glass	3,000	1,712.00	230.00	136.96	40.06	231.85	26.36	665.2
paper	16,500	8,800.00	1,375.00	704.00	205.92	1,386.05	135.53	3,806.5
can	50	31.35	3.33	2.51	.73	3.36	.48	10.4
Cream and milk lab	390	168.24	39.60	13.46	3.94	39.92	2.59	99.5
Bottle cases	2,865	2,096.64	518.10	167.73	49.06	138.31	32.29	905.4
Building	43,500	36,338.16	1,278.90	2,907.05	850.31	435.00	559.60	6,130.8
Sub-total	136,484	97,424.86	7,355.74	7,794.01	2,279.72	6,176.76	1,500.33	25,106.5
Bottle inventory	....	1,080.00	....	86.40	25.27	....	16.63	128.3
Inventory	....	24,500.00	....	1,960.00	573.30	....	377.30	2,910.6
TOTAL	136,484	123,004.86	7,355.74	9,840.41	2,878.29	6,176.76	1,894.26	28,145.4

namely about 3 percent.[2] The next plant volume is one-half the size of the largest. The third largest plant was one-half the size of the second, and so on down until the volume for six different model plants was assumed.

As the product combinations changed the volume for each sized plant was held constant except for plants processing only fluid milk. In this case the volume was dropped or the butterfat lowered with the excess skim disposed of for animal feed. In all other cases, the excess milk or butterfat was processed into either ice cream or butter. When

Appendix Table 7.—Sample production allocation by basic model plant (8X) processing 72,640 pounds of milk per week.

	MONDAY			TUESDAY			WEDNESDAY		
	Milk	Skim	Cream	Milk	Skim	Cream	Milk	Skim	Cream
		Pounds			Pounds			Pounds	
Received	2416.00	......	......	1208.00	......	......	1208.00	......	......
Carryover	......	......	10.00	539.99	156.74	24.14	800.00	629.75	60.34
On hand	2416.00	......	10.00	1747.99	156.74	24.14	2008.00	629.75	60.34
Separate	− 450.00	401.58	48.42	−947.99	845.99	102.00	......	......	......
Bottle:									
past	− 389.15	− 40.85	......	......	......	......	− 389.15	− 40.85	......
homo	−1036.86	−141.39	......	......	......	......	−1036.86	−141.39	......
whip	......	......	−16.06	......	......	......	......	......	......
c.c.	......	− 4.03	− 6.91	......	......	......	......	......	......
half & half	......	− 23.07	−11.31	......	......	......	......	......	......
skim	......	− 35.50	......	......	......	......	......	− 35.50	......
Ice cream mix	......	......	......	......	− 92.98	−65.80	......	......	......
Cottage cheese	......	......	......	......	−120.00	......	......	......	− 2.40
Butter	......	......	......	......	......	......	......	......	......
On hand	539.99	156.74	24.14	800.00	789.75	60.34	581.99	412.01	57.94
Dispose of	......	......	......	......	160.00	......	......	......	......
Carryover	......	......	......	......	629.75	......	......	......	......

	THURSDAY			FRIDAY			SATURDAY		
	Milk	Skim	Cream	Milk	Skim	Cream	Milk	Skim	Cream
		Pounds			Pounds			Pounds	
Received	1208.00	......	......	1208.00	......	......	1208.00	......	......
Carryover	581.99	412.01	57.94	220.00	292.74	37.57	1.99	48.84	3.35
On hand	1789.99	412.01	57.94	1428.00	292.74	37.57	1209.99	48.84	3.35
Separate	− 129.30	115.39	13.91	......	......	......	−1209.99	1079.80	130.19
Bottle:									
past	− 389.15	− 40.85	......	− 389.15	− 40.85	......	......	......	......
homo	−1036.86	−141.39	......	−1036.86	−141.39	......	......	......	......
whip	......	......	−16.06	......	......	−15.88	......	......	......
c.c.	......	− 4.03	− 6.91	......	− 4.10	− 7.03	......	......	......
half & half	......	− 23.07	−11.31	......	− 23.06	−11.31	......	......	......
skim	......	......	......	......	− 34.50	......	......	......	......
Ice cream mix	......	......	......	......	......	......	......	− 92.98	−65.80
Cottage cheese	......	......	......	......	......	......	......	......	......
Butter	......	......	......	......	......	......	......	......	−57.74
Choc. drink	− 14.68	− 25.32	......	......	......	......	......	......	......
On hand	220.00	292.74	37.57	1.99	48.84	3.35	......	1035.66	10.00
Dispose of	......	......	......	......	......	......	......	1035.66	......
Carryover	......	......	......	......	......	......	......	......	10.00

[2]This plant was included in the area analysis presented to the Western Dairy Technical Committee but has been omitted in this report.

only one type of fluid milk container was used, the route structure was changed to allow the observed proportion between wholesale and retail milk to exist. Therefore, a plant bottling milk in glass was assumed to have a larger share of its business on a retail route, while a plant bottling in paper had a greater share of its business on a wholesale route.

Appendix Table 7 shows the total receipts and disposition of milk in the basic model plant processing 72,640 pounds of milk per week.

Assumed Labor Required

The capital and labor combinations that were selected resulted in the least total cost per week for the various assumed volumes processed. In addition to the least cost combination, certain time periods were also selected. In the bottling operation it was assumed that the operation should be completed in a 5-hour period per day. If, however, the size of the operation dictated a relatively short period during the day, such as 30 or 40 minutes, it was assumed that this operation would be done every other day. Quality deterioration of products was also considered. For example, cottage cheese can be held for as along as 4 days with only slight deterioration in flavor, but cream will deterio-

Appendix Table 8.—Sample labor time schedule calculation for the basic model plant processing 72,640 pounds of milk per week.

MONDAY:

Time	No. 1 man	Time	No. 2 man	Time	No. 3 man
7:30- 8:00	Open plant	7:30- 8:00	Set up equipment	8:00- 8:32	Receive milk tank I
8:43- 8:58	Std. tank I past.	8:32- 9:13	Sepr. Skim-dump cans	8:32- 9:17	Receive milk tank II
9:07- 9:24	Std. tank II homo.	9:13- 9:27	Transfer to surge tank	9:17-10:33	Wash cans
9:24- 9:59	Bottle glass past. qt.	9:27-10:08	Bottle paper past. qt.	10:33-11:08	Transfer
9:59-10:05	Transfer	10:08-10:18	Bottle paper qt. homo	11:08-11:37	Rec. milk tank I 2nd time
10:40-10:56	Bottle glass homo. qt.		tank II	11:37-11:43	Transfer
10:56-11:56	Lunch	10:18-11:11	Bottle paper qt. homo	11:43-12:43	Bottle paper homo qt.
11:56-12:11	Bottle glass homo. qt.		tank I	12:43- 1:43	Lunch
12:11-12:15	Transfer	11:11-11:43	Bottle paper qt. homo	1:43- 2:12	Wash cans
12:15-12:39	Bottle glass ½ pt. homo.		tank II	2:12- 4:00	Wrap butter
12:39-12:45	Transfer	11:43-12:43	Lunch	4:00- 5:00	Cleanup
12:45- 1:51	Bulk homo. reg. disp.	12:43- 1:20	Bottle paper qt. homo		
1:51- 1:55	Bottle skim glass qt.		tank II		
1:55- 2:00	Bulk skim gal.	1:20- 1:25	Transfer		
12:45- 1:45	Past. cream for bottling	1:25- 1:51	Bottle paper ½ pts. homo		
	MP vat	1:51- 2:08	Sepr. Dump skim		
2:00- 2:05	Transfer		bottle skim		
2:05- 2:10	Bottle qt. glass whip	1:51- 2:08	Bottle skim paper qt.		
2:10- 2:22		2:08- 2:10	Transfer		
2:22- 2:30	Std. whip to c.c.	2:10- 2:22	Bottle whip ½ pt. paper		
2:30- 2:32	Bottle qt. glass c.c.	2:22- 2:30			
2:32- 2:35	Std. c.c. to half & half	2:30- 2:32	Bottle c.c. ½ pt. paper		
2:35- 2:40	Bottle qt. glass half & half	2:32-			
2:40- 3:00	Transfer	2:35- 2:47	Bottle ½ & ½ pt. paper		
3:00- 4:30	Cleanup	2:47- 3:00	Transfer		
		3:00- 4:30	Cleanup		

rate much sooner. Therefore, the labor requirement included the more frequent processing of some products.

The other assumptions used are as follows: (1) Plants do not bottle longer than 5 hours per day, which allows 3 hours a day for doing the rest of the work in the plant. (2) Laborers are capable of performing all jobs within the plant, if necessary. (3) Labor quality and productivity are essentially the same in all plants. (4) All plants produce the same quality of products. (5) All prices paid for raw materials and supplies are the same except production rentals.[3] (6) All prices paid for productive resources of a given kind of quality were equal for all plants. (7) All labor is hired for full shifts of 48 hours per week with the exception of office employees, who were hired on a 40-hour basis. (8) All milk received in all plants averaged 4.085 percent butterfat except as previously mentioned. (9) Yields of all products are equal in all plants. (10) Qualities of resources used are assumed to be the same for all plants.

Plant labor costs, which include wages, premium payments, social security, old age benefit insurance, and industrial insurance were prorated to each function or product. Appendix Table 8 shows a sample of the labor determinations for a plant processing 72,640 pounds of milk per week Plant labor costs were based on the weighted wage rate in observed plants. This rate was $1.47 per hour.

In determination of the quantity of plant labor required, it was necessary to compare labor requirements with different machine types that could process the various outputs. In the total plant labor-capital selection, an 8-hour day was used for labor. If the savings of time by using one machine relative to another did not result in less total labor costs, the second selection would be different from the original least-cost combination. The least-cost combination for a function may not result in least-cost for the total operation. If total plant utilization indicated that this additional saving of labor time could not be realized in dollars and cents, the cheaper machine which required more quantities of labor would be used.

Office labor requirements and costs were determined from observed data and were dependent primarily on types and kinds of records kept by observed plants. In the smaller plants office labor requirements of the observed area are compensated for types and amounts of records thought necessary for proper accounting. The office wage rate that was used in the model plants was $1.16 per hour, except in the smallest plant, where an accountant was hired on a part-time basis.

Sales requirements were determined by the number of units delivered, both wholesale and retail. The number of points used per route were based on a collective study of routes.[4] On a wholesale route it was assumed that 1,372 points per day and on a retail route 511 points per day were the maximum quantities per route. The wage rate used was the weighted commission rate of observed salesmen. This rate was 11.68 percent of sales for retail routes and 4.38 percent of sales for

[3]The quoted schedule of the manufacturer was followed. This schedule gave higher discounts with higher output levels.

[4]STEWART JOHNSON, *Load Size and Delivery Labor Cost in Milk Distribution*, Storrs Agricultural Experiment Station Bulletin No. 264, March, 1950.

wholesale routes. These units and commission rates resulted in a weekly salary for salesmen of about $75.

Management

The management expense was determined by use of a scatter diagram of observed data. In the observed plants time spent by management on other labor functions was divided between management and those functions. This was especially true in smaller plants where management performed many other labor functions. Management cost was ascertained on a volume basis and used as a guide for estimation in the model plants.

General Expenses

General expense requirements in the model plants were based promarily on observed data. Cleaning supply costs, office supply costs, fuel quantity, light and power quantity, telephone and telegraph expense, advertising expense, and miscellaneous expenses were assumed to be fixed within the size of each plant. With this assumption, a scatter diagram was made of quantities and costs in relation to the size of each observed plant. This information was used to develop the estimates for the model plants. The formulae derived are as follows:

1. Factory cleaning supplies.......... $Y = \$6.65 + \$0.70\ X$
2. Fuel.......................... $Y = 84\text{ gal.} + 21\text{ gal. } X$
3. Light and power................ $Y = 100\text{ kwh} + 250\text{ kwh } X$
4. Water.......................... $Y = \$8.25 + \$1.50\ X$
5. Laboratory..................... $Y = \$0.30\ X$
6. Office supplies................ $Y = \$2.35 + \$0.20\ X$
7. Telephone and telegraph.......... $Y = \$5.70 + \$0.05\ X$
8. Advertising.................... $Y = \$9.00\ X$
9. Miscellaneous.................. $Y = \$10.15 + \$0.60\ X$

X = the milk received per week in 10,000 pound units.

Packaging supplies and non-dairy products supplies were all computed by a formula and the total costs per week were linear to volume. Adjustments were made in packaging supplies depending upon the filler used. In the smallest plants the least-cost was obtained by use of a pre-formed carton. The larger plants used a carton processed during the filling operation.

Appendix Table 9.—Basic plants processing costs per week of different sized plants, by cost item.

Item	Unit	Price per unit	Costs per week: Plant size (pounds output per week) 9,080	18,160	36,320	72,640	145,280
		dollars	dollars	dollars	dollars	dollars	dollars
I. Capital Cost			241.57	261.83	373.90	438.40	541.26
II. Labor Cost:							
Plant	Hours	1.47	105.84	141.12	211.68	282.24	423.36
Office	Hours	1.16	20.00	46.51	93.02	139.53	139.53
Sales:							
Wholesale	% of sale	4.38	34.88	69.76	139.52	279.04	558.08
Retail	% of sale	11.68	29.20	58.40	116.80	233.60	467.20
Management	*	*	16.62	30.24	57.48	111.96	220.92
III. Container cost:							
Fluid milk:							
Glass quarts	Each	.0060	.41	.82	1.64	3.27	6.55
Glass ½ pts.	Each	.0054	.13	.26	.51	1.03	2.06
Paper quarts	Each	.0250	61.15	122.30			
	Each	.0154			150.56	301.12	602.24
Paper pts.	Each	.0210	1.91	3.82			
	Each	.0099			3.60	7.20	14.40
Paper ½ pts.	Each	.0180	6.52	13.04			
	Each	.0091			13.16	26.32	52.64
Butter:							
Parchments	Each	.0030	.33	.65	1.31	2.62	5.23
Cartons	Each	.0160	.21	.42	.83	1.66	3.33
Boxes	Each	.1095	.44	.88	1.75	3.50	7.01
Liners	Each	.0300	.15	.30	.45	.60	.75
Shipping boxes	Each	.2340	.70	1.40	2.80	5.62	11.23
Ice cream:							
Gallon container	Each	.1580	12.01	24.02	48.03	96.06	192.13
Cottage cheese:							
Container, 16-oz.	Each	.0244	.51	1.02	2.04	4.08	8.16
IV. Non-dairy product supply:							
Chocolate drink flavor	Quart	.0295	.62	1.24	2.48	4.96	9.92
Culture	Quart	.0076	.50	1.00	2.00	4.00	8.00
Butter salt and color	Pound	.0010	.29	.58	1.16	2.32	4.64
Cottage cheese salt	Pound	.0007	.02	.04	.08	.16	.32
Ice cream:							
Sugar	Pound	.1075	6.00	12.00	24.00	48.00	96.00
Skim powder	Pound	.1900	3.50	7.00	14.00	28.00	56.00
Stabilizer and emulsifier	Pound	.7500	.26	.52	1.05	2.10	4.19
Flavors	Per gal. ice cream	.0735	5.59	11.18	22.36	44.72	89.44
V. General supply expenses:							
Factory supplies:							
Cleaning	*		7.29	7.92	9.19	11.73	16.82
Operating	*		2.60	3.00	3.75	4.50	5.00
Fuel	*		18.23	21.59	28.32	41.95	68.85
Light and power	*		13.89	17.71	25.33	40.59	71.10
Water	*		9.61	10.97	13.69	19.13	30.01
Laboratory	*		.27	.54	1.08	2.16	4.32
Office supplies	*		2.53	2.71	3.07	3.79	5.23
Telephone and telegraph	*		6.15	6.61	7.52	9.33	12.96
Advertising	*		8.17	16.34	32.68	65.36	130.72
Miscellaneous	*		10.69	11.23	12.31	14.47	18.79

*See page 40.

Appendix Table 9.—Basic plants processing costs per week of different sized plants, by cost item—Continued.

Item	Unit	Price per unit	Costs per week — Plant size (pounds output per week) 9,080	18,160	36,320	72,640	145,280
		dollars	dollars	dollars	dollars	dollars	dollars
VI. Truck expenses:							
¾-ton route van:							
Depreciation	Per truck per year	320.00	6.15	6.15	12.30	18.45	43.05
Insurance	" "	125.00	2.40	2.40	4.80	7.20	16.80
Interest	" "	113.00	2.17	2.17	4.34	6.51	15.19
License	" "	18.00	.35	.35	.70	1.05	2.45
Oil	" "	29.00	.56	.56	1.12	1.68	3.93
Grease	" "	18.00	.35	.35	.70	1.05	2.45
Gasoline	Mile	.0594	3.56	5.94	7.12	17.82	33.26
Tires	Mile	.0103	.62	.93	1.24	3.09	5.77
Repairs	Mile	.0150	.90	1.35	1.80	4.50	8.40
Miscellaneous	Mile	.0070	.42	.63	.84	2.10	3.92
2-ton wholesale ice cream van:							
Depreciation	Per truck per year	510.00	......	......	......	9.81	9.81
Insurance	" "	130.00	......	......	......	2.50	2.50
Interest	" "	179.52	......	......	......	3.85	3.85
License	" "	30.00	......	......	......	.58	.58
Oil	" "	28.00	......	......	......	.54	.54
Grease	" "	20.00	......	......	......	.38	.38
Gasoline	Mile	.0594	......	......	......	2.85	3.56
Tires	Mile	.0103	......	......	......	.49	.62
Repairs	Mile	.0150	......	......	......	.72	.90
Miscellaneous	Mile	.0070	......	......	......	.34	.42
2-ton wholesale milk van:							
Depreciation	Per truck per year	525.00	......	10.10	10.10	20.20	60.60
Insurance	" "	130.00	......	2.50	2.50	5.00	15.00
Interest	" "	101.00	......	1.94	1.94	3.88	11.64
License	" "	30.00	......	.58	.58	1.16	3.48
Oil	" "	28.00	......	.54	.54	1.08	3.24
Grease	" "	20.00	......	.38	.38	.76	2.28
Gasoline	Mile	.0594	......	1.78	2.97	7.12	17.82
Tires	Mile	.0103	......	.31	.52	1.24	3.12
Repairs	Mile	.0150	......	.45	.75	1.80	4.50
Miscellaneous	Mile	.0070	......	.21	.35	.82	2.10
2-ton dual-temp van:							
Depreciation:							
Truck	Per truck per year	533.00	......	......	10.25	10.25	10.25
Van body	" "	320.00	......	......	6.15	6.15	6.15
Insurance	" "	130.00	......	......	2.50	2.50	2.50
Interest	" "	130.00	......	......	2.50	2.50	2.50
License	" "	40.00	......	......	.77	.77	.77
Oil	" "	28.00	......	......	.54	.54	54
Grease	" "	20.00	......	......	.38	.38	.38
Gasoline	Mile	.0594	......	......	5.94	1.78	1.78
Tires	Mile	.0103	......	......	1.03	.31	.31
Repairs	Mile	.0150	......	......	1.50	.45	.45
Miscellaneous	Mile	.0070	......	......	.70	.21	.21
Total operating cost per week			646.27	948.59	1,510.99	2,440.01	4,196.36

Appendix Table 10.—Volume of products processed and/or sold, selling price, and revenues for model plants processing 9,080 pounds of milk per week by product. (All other sized plants are multiples of these volumes.)

Product	Number of units		Selling price per unit		Revenue		Total
	Whsle.	Retail	Whsle.	Retail	Whsle.	Retail	Revenue
			dollars	dollars	dollars	dollars	dollars
Milk:							
Bulk:							
Homo. gal.	14	2	0.7265	0.7394	10.17	1.48	11.65
Homo. (disp.) gal.	11	...	0.7900	......	8.69	......	8.69
Glass qt. past.	100	249	0.1896	0.2051	18.96	51.07	70.03
qt. homo.	15	294	0.1861	0.2003	2.79	58.89	61.68
½ pt. homo.	236	2	0.0672	0.0700	15.86	.14	16.00
Paper qt. past.	479	32	0.1950	0.2200	93.40	7.04	100.44
qt. homo.	1,328	487	0.1950	0.2200	258.96	107.14	366.10
½ pt. homo.	260	...	0.0600	......	15.60	......	15.60
Skim milk:							
Bulk gal.	1	...	0.3400	......	.34	......	.34
Glass qt.	1	2	0.1300	0.1600	.13	.32	.45
Paper qt.	25	17	0.1593	0.1859	3.98	3.16	7.14
Chocolate drink:							
Paper qt.	13	4	0.1936	0.2200	2.52	.88	3.40
Cultured milk:							
Bulk gal.	1	...	0.4400	......	.44	......	.44
Paper qt.	46	15	0.1372	0.1625	6.31	2.44	8.75
Cream:							
Whip:							
Glass qt.	1	...	1.2360	......	1.24	......	1.24
Paper ½ pt.	73	19	0.3200	0.3228	23.36	6.13	29.49
Coffee cream:							
Glass qt.	13	1	0.7500	0.9000	9.75	.90	10.65
Paper ½ pt.	73	19	0.3200	0.3228	23.36	6.13	29.49
Cereal cream:							
Glass qt.	5	1	0.4785	0.5600	2.39	.56	2.95
Paper pt.	74	17	0.2472	0.2410	18.29	4.10	22.39
Butter:							
Bulk lb.	169	...	0.6302	......	106.50	......	106.50
Pound print	108	1	0.6875	0.7419	74.25	.74	74.99
Pound 1/4	12	1	0.6970	0.7600	8.36	.76	9.12
Pound patties	7	...	0.7450	......	5.22	......	5.22
Cottage cheese:							
16-oz package	19	2	0.2582	0.3398	4.91	.68	5.59
Ice cream:							
Gallon	76	1	1.2655	2.0000	96.18	2.00	98.18
Ice cream mix:							
12% butterfat	1	...	1.6500	......	1.65	......	1.65
6% butterfat	4	...	1.1000	......	4.40	......	4.40
Sherbet:							
Gallon	1	...	1.2000	......	1.20	......	1.20
TOTAL	.....	.....	......	......	819.21	254.56	1,073.77

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