Cost and efficiency of selected Mississippi fluid milk plants

Verner G. Hurt

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Cost and Efficiency of Selected Mississippi Fluid Milk Plants
By
VERNER G. HURT

INTRODUCTION

Combined sales of butter, cream, and milk by Mississippi farmers in 1954 totaled 981 million pounds of 4 percent milk equivalent and returned 44.7 million dollars.¹ These sales represented an increase over the average of the period 1935 through 1939 of 71 percent in volume marketed and 327 percent in cash income.² The fluid milk division of the industry has also expanded greatly. Information obtained concerning 36 fluid pasteurizing plants by interview in the summer of 1949 showed that 58 percent of these firms had been established within the ten-year period, 1939-1948.³

The Problem

The varied and complex problems which frequently accompany rapid growth in any industry are asserting themselves in the case of Mississippi fluid milk. These problems have led to some unrest and agitation in recent years among the various economic groups directly connected with the dairy industry. While steps have been taken to resolve some of the differences, and certainly to solve some of their problems, the task has been by no means completed.

Considerable concern has been expressed by many persons about the possibilities of improving the efficiency of the marketing system as a means of solving some of the problems which face the industry. Any attempt to improve the efficiency of the marketing system for fluid milk by an attack upon the entire system would be a gigantic and possibly an insurmountable task. However, if research were attempted on specific segments separately, accomplishment of the objectives can be foreseen.

Prior research in Mississippi has been concerned with the supply of utilization of fluid grade milk.⁴ Also, research has been conducted on the types of pricing plans and their effects on the seasonality of milk production.⁵ An examination of available materials indicated that the next major area of study should be on operating costs of distributing plants. While a limited amount of research relating to this has been accomplished in the North Central and the New England states, the field has not been opened in Mississippi and only to a very limited extent in the Southern Region. However, commercial accounting firms have done some very useful work.⁶ While results from research performed in the Northern states are quite adequate for that area, it appears necessary to develop information specifically applicable to the Mississippi industry. This necessity is due to variations which exist in certain cost items, for example, labor.

¹ United States Department of Agriculture, Agricultural Marketing Service, Crop Reporting Board; Farm Production, Disposition, and Income from Milk, 1953-1954. (Washington, D. C., April, 1955.) Table 11, p. 16. (Preliminary).
² United States Department of Agriculture, Bureau of Agricultural Economics, Farm Production, Disposition, and Income from Milk, 1935, 1939. (Washington, D. C., April, 1942), pp. 31-47.
⁵ Jenkins, L. P. and Moffett, W. W., Jr., A Study of Fluid Milk Pricing Plans in Mississippi and Their Effect on Seasonality of Production. Mississippi Agricultural Experiment Station Technical Bulletin No. 38, August, 1953.
⁶ For example, the work by the Edward B. McClain Company, Memphis Tennessee.
Objectives

This project was initiated in order to determine the costs and efficiencies of handling and processing fluid milk from the time it leaves the farmers' hands until it is deposited on the consumer's doorstep or is placed in the retail store. Specifically, the objectives were:

1. To determine whether or not there are economies to scale of operation.
2. To study input-output relations among costs of performing the various functions, such as (a) costs of administration, (b) costs of processing by departments, and (c) costs of distribution.
3. To evaluate labor efficiency and other major cost items as they relate to costs of operation.
4. To develop some basis and to suggest alternatives whereby fluid milk processors can make decisions aimed at reducing costs in all phases of operation.

Scope of Study

Twelve fluid milk plants handling from 2,716 to 43,008 quarts of producer milk daily were selected for this study. The type of operation of these plants was predominantly that of receiving, processing and distributing fluid milk. However, often-times facilities were available for the handling of milk received which constituted a surplus over that amount required to fulfill the fluid demand. Of the plants studied, Figure 1, one utilized the milk received from producers in a paper-filling operation only, three had paper- and glass-filling operations, three had paper-filling and ice cream operations, two had paper- and glass-filling and condensery operations, two had paper- and glass-filling and ice cream operations, and one had paper- and glass-filling, ice cream, and condensery operations. The bottling costs were isolated from the ice cream and condensery costs in order to keep the analysis restricted to the bottling phase. Eight of the plants studied processed their products in both paper and glass, and four had only a paper operation, Figure 1. The analyses have been designed to determine the unit costs of handling for those products in paper and those in glass.

Procedure

The fluid milk plants which are included in this study were selected on the basis of (1) size and type of operation, (2) geographical location, (3) type of records available, and (4) influence on other plants within the state. Data were obtained by interviews with plant managers, accountants, and clerical workers, from accounting records, and from observation of the specific operations within each plant. The information included methods of allocating costs within each plant. Also, certain cost categories, which were not readily available, were derived with the help of plant personnel. This information was gathered in 1953 and 1954 for the previous year's operation.

Plant records yielded information pertaining to actual costs of operating the business, volume of milk handled and utilized in different types of operations, plant inventories, and the amount and types of equipment in operation.

A basis for allocating certain costs was acquired from personal observation of the functional operation of each plant. Detailed information relative to the procedure for collecting data and allocating costs to the various functions and departments can be found in Appendix A.

Limitations of Data

This study was designed to include plants of different sizes. Originally the basis for the assignment of each plant to a specific size group was its average daily receipts of fluid milk from producers for the year. Four size groups were planned at first, however, difficulties encountered in processing the data necessitated the assignment of plants to size groups on the basis of volume of milk utilized by each function and department.

The data collected reflected the act-
COST AND EFFICIENCY OF SELECTED MISS. FLUID MILK PLANTS

Type of operation for all products

- Paper-bottling only
- Paper- and glass-bottling only
- Paper-bottling and ice cream
- Paper- and glass-bottling and ice cream
- Paper- and glass-bottling and condensery
- Paper- and glass-bottling, ice cream, and condensery

Figure 1. Classification according to method of utilizing all milk received, selected Mississippi fluid milk plants, 1952-54.

The sample was not designed to be representative of all Mississippi plants. Therefore, the generalizations and deductions made in the analyses would be applicable only to the selected plants, or to plants having like characteristics in most respects to those studied.

\*For example, original costs of equipment and depreciation rates were not adjusted to a common or uniform base.
ANALYSIS OF OPERATING COSTS

Basic Concepts

It seems desirable to set forth some of the basic concepts of the individual firm and the industry within which this firm is operating, before attempting to analyze the relationship existing between cost per unit and daily volume for the various departments of the fluid milk plants studied. Only the theory relative to the characteristics of average total costs for the firm and for the industry will be mentioned, since this is the segment of the theory upon which the forthcoming analysis is based.

In each individual firm, unit costs would be expected to be high for a small volume of output. These costs would be expected to decrease as output increased until the most efficient size of operation was reached, and then to increase again as the organization of the firm became more complex and unmanageable. These characteristics are presented graphically in Figure 2. Firm A, designed to handle a specified volume of products will have a certain point at which the average total cost is lowest. (Using per unit cost of production as the criterion, this point will represent the optimum size and cost. However, the optimum size and cost may vary under certain short-run situations and when profit maximization is the criterion.) At any volume more or less than that at which the optimum cost is attained, the average total cost would be expected to be higher. Assuming that there exist within the dairy industry other firms which were designed to handle larger and smaller volumes than Firm A, their average costs would be illustrated by the same characteristic U-shaped curve as is shown in Figure 2. However, for those firms designed for a higher volume than Firm A, their optimum point of operation would be at a higher average cost and volume than Firm A's, providing that Firm A's design was such that it represented the most efficient size for the industry. In such a case, for those firms designed for a lower volume range than was Firm A, their optimum point would be at a lesser volume and higher cost than Firm A.

The average total costs for the industry would be illustrated by the characteristic U-shaped curve as was the case for the firm, Figure 3. However, the volume for the industry would be many times that for the individual firm.

All of the variability of unit costs that has been found in the Mississippi fluid milk plants cannot be attributed to pure-scale relationships or to the indivisibility of resources. Some of this variability must be explained by differences in the proportions with which various resources are combined.

In the analysis which follows an attempt will be made to point out the relationship that exists, in the firms studied, between unit costs and volume of operations. Also, observations relative to the causes of variations in certain of the costs will be given. No attempt has been made to develop average total cost curves for the firm or for the industry.

In attempting to determine the relationship existing between unit costs and volume, mathematical curves using

---

logarithms in the independent variable were fitted to the data for various functions and departments\(^\text{10}\) of the plants studied. This logarithmic regression was chosen on the assumption that as volume of output increased, unit costs decreased, but at a decreasing rate. It is also assumed that the volume of operations of the largest plant included in the study was not sufficient to have encountered unfavorable economic results.

In addition to presenting the relationship between unit costs and daily volume, averages of the costs per unit of the various functions, departments, and cost categories, for the plants studied are shown. These average costs have been developed as a model to provide a basis for cost-reducing decisions by plant operators. In using the model, it must be remembered that the average costs are not representative of the optimum costs for the plants studied. A plant would not be considered efficient necessarily, if it were operating with the same costs as those of the model. The above is not meant to imply that the model costs may not be representative of the optimum for some volume of operations. It does mean that there are possibilities for costs lower than those of the model.

**Administrative Costs**

Costs of administration were separated into two categories, (1) salary costs, and (2) other costs. Salary costs included the wages paid administrative personnel, such as, general managers, office workers, and plant superintendents. Other costs consisted of office supplies, floor space utilized, office equipment, communications, and certain general expenses.

**Salary costs**

Salary costs per unit would be expected to vary among plants according to the size of the operation, type of records maintained, and the wage rate paid. Plants with larger volumes would be expected to have lower salary costs per unit due to the indivisible nature of the management resource. Decreases (with certain discontinuities) in the unit costs of clerical salaries would be expected from increases in volume. However, the use of more complex control records to supplement the management factor as the operation became larger and more complicated would slow the rate of decrease in unit costs in the larger operations. As a general rule, a plant with a large volume could justify complex records, while a smaller plant could not.

\(^{10}\) See Appendix A for what constitutes a function and/or a department.
The practice, in some cases, was for owner-operators to draw a monthly salary just sufficient to meet their living expenses. Thus, the remainder of the returns to management accrued as business earnings. This practice would lead to an expectation of lower salary costs per unit for owner-operated plants than for those which were manager-operated.

The cost of salaries per 1,000 quart units, as developed for the model, was a simple average of the unit costs of eleven of the plants studied. One plant was not included because it was not possible to separate office salaries from other costs. The model cost, as shown in Table 1, was $6.20. Costs among plants ranged from $2.50 to $10.41. Plants which were efficient in the utilization of administrative labor would have had lower than the average costs per unit. Costs of inefficient plants would have been higher. Still, a plant might justify temporary inefficiency, if its administrative organization was too complex for the present volume of operations. This would be true if the operations were expected to expand in the near future to a volume requiring such a complex organization.

Variations in salary costs per unit among plants indicate opportunities for reducing this item. Whether these opportunities were as large as indicated by the data would depend on, among other things, whether or not the lower costs would maintain sufficient records. Also, the monthly salaries which some of the owner-operators were drawing for their services would not be sufficient to obtain managers with comparable qualifications.

The effect of lower salaries on the ability to obtain or retain capable administrative personnel, particularly for management, should not be ignored when attempting to lower costs. Possibly, lower salaries would be reflected in inefficiencies in other phases of the operation. However, in the plants studied it was not evident that lower salary costs resulted in inefficiencies in other phases of the operation. This finding may have been due to the lower costs for plants having owner-operators. Thus, it appears that actual salaries did not reflect the incentive for efficient organization or the volume of the managers' capabilities.

### Other administrative costs

Certain factors lead to an expectation of variation in other costs per unit among plants. Difference in the type of records maintained, as they affected the cost of office supplies, would be expected to account for some of the variation. Also, the more complex records would be expected to result in a higher cost for supplies. In addition, differences in office machinery required for the various records would be expected to influence costs. The indivisible nature of the office equipment resources, indicates that certain economics would be expected from the larger operations. Thus, variations due to differences in the size of the operations would cause variations in other costs. Differences in the cost of office space would be expected to cause some variations. These variations would be due to differences in the amount of floor space utilized. Also, differences in the original cost of the building, and the depreciation rates, as they affected building expenses, would be expected to cause variations in costs. If the building were rented, differences in rental charges would affect variations in costs.

Only eleven plants were used to determine the average of other costs. The omission of one plant was necessary because office salaries were included in other costs. The average of other costs per 1,000 quart units, Table 1, was $3.46. Costs among plants ranged

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### Table 1. Average cost of administration per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Pct. of total</th>
<th>Avg. cost</th>
<th>Cost range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>64.2</td>
<td>$6.203</td>
<td>$2.505 - $10.408</td>
</tr>
<tr>
<td>Other</td>
<td>35.8</td>
<td>$3.461</td>
<td>$1.085 - $7.290</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>9.664</td>
<td><strong>$4.221 - $15.671</strong></td>
</tr>
</tbody>
</table>

*Average of eleven plants.

**Does not agree with sum of column since the cost for some plant's may be high or low for one category, while different plants have the highest or lowest total cost.
from $1.08 to $7.29. The range of costs indicates opportunities for operating at lower costs.

A decrease in the cost of office space per unit might be effected by either reorganization of the office requirements, or an increase in the volume of output. Elimination of unnecessary records and forms should lead to a reduction in the cost of office supplies. Also, alterations in the type of records maintained could lead to lower equipment costs by eliminating the necessity for certain items of equipment. However, adequate records should not be sacrificed for lower unit costs. Adjustment of the utilization of office space would be of a long-run nature, while changes in records could be accomplished in the short-run.

**Total administrative costs**

In summary, salary cost and other cost determined the average total administrative cost. Thus, causes of expected variations in total administrative costs among plants would be the same as those mentioned above. Also, the previous discussion of opportunities for reducing costs of the categories would be applicable to the total administrative cost.

Total administration cost per 1,000 quart units, as shown in Table 1, was $9.66. Salary and other administrative costs accounted for 64 and 36 percent, respectively, of the total. Costs among plants ranged from $4.22 to $15.67.

When unit costs were related to daily volumes, the relationships shown in Figures 4 and 5 were found. However, only 7 percent of the variations in cost per unit among plants was attributable to differences in volume of output per day in quart units.

**Processing Costs**

Certain characteristics of the cost categories of the processing function lead to an expectation of variations in unit costs of processing among the plants. Some of these variations in unit costs were due to the cost of the resources and were not susceptible to any appreciable change by plant managers. Other variations were due to differences in the proportion in which the resources were combined and were susceptible to change by plant managers. First to be discussed will be those variations attributable to differences in the cost of the resources. This will be followed by an analysis of the variations due to differences in the proportions in which the resources were combined. The following discussion will be applicable to each of the departments of the processing function in which the particular cost categories were utilized.

Variations in unit costs of the departments due to the cost of the resources were evident in certain of the cost categories. Differences in the original costs and the depreciation rates for buildings and equipment gave rise to variations in their cost per unit among plants. Differences in the cost...
of the floor space assigned to each department resulted in variations in building costs. Variations in labor costs per unit were caused by differences in wage rates. Differences in the amount and type of general supplies used caused some variations. The volume of product handled by each plant in which they were utilized may have caused variations in the unit cost of manufacturing supplies. If electricity rates differed among plants, variations in unit costs would be expected from this source. Since some plants had their own water supply while others purchased theirs from outside sources, variations from differences in water costs were also expected.

Ordinarily, variations among plants in unit costs of the processing department would be expected which may have been the results also of differences in the proportion in which the resources or cost categories were combined. The variations expected from each of the cost categories will be the content of the following analyses.

Variations among plants might arise from differences in the amount of floor space required per unit of output. Usually, plants with a large volume of output should have lower costs for floor space per unit than those with smaller operations. The requirements for floor space would not be expected to vary appreciably even though volume changed. If an increase in floor space requirements were necessary for an increased volume, the allocation of the total to each unit of output should be less than was required originally.

Labor costs per unit, due primarily to the indivisible nature of this resource, should vary among plants. Also, differences among plants in the relative efficiency and the degree of utilization of this resource might have resulted in variations in labor costs per unit. In addition to the above, differences in the assembly and clean-up time required per unit could have caused variations. As volume increased, assembly and clean-up time per unit would probably decrease. Another source of variations among plants in labor costs per unit might have been the relative portion of different products and the containers of various sizes utilized in each of the plants. The time required to change from one product to another or to change container sizes may have caused variations in the labor cost per unit.

Variations in departmental costs among plants attributable to the equipment resource might have been the result of volume of operation varying among plants. Other variations may have been due to the size, type, and amount of equipment utilized. The indivisible nature of the equipment resource could have been responsible for other variations. Generally, equipment costs per unit for the larger plants would tend to be less than those for the smaller operations.

Variations in departmental costs for general supplies, mostly cleaning agents, would depend upon the volume of output and the relative efficiency with which such supplies were utilized. Since assembly and clean-up time per unit should decrease when volume is increased, costs per unit for general supplies should decrease with an increase in output.

The utilization of containers of different sizes and the proportion in which the different sizes were utilized may have caused variations among plants in costs per unit. Differences in bottle breakage and closure costs, as influenced by the type and size of container used, could have caused variations. Variations attributable to paper container costs would be largely the result of differences in the size lot in which they were purchased.

The variations in unit costs among plants, attributable to the service departments, may have been due to differences in the utilization of certain resources. Fluctuations in building costs might have influenced dry storage costs per unit of output. Differences in the amount and type of fuel and the size and type of equipment used as they affected power plant costs per unit, may have caused a portion of the variations. Size and type of equipment also contributed to the differences in refrigeration cost per unit. Some of the
plants maintained a separate repair and maintenance department, while others did not. This practice probably caused another part of the variations in the cost per unit of output.

Variations and their causes, mentioned above, were evident in each department where the particular cost category to which they were applicable was utilized. Therefore, in the following analysis of the processing function, these variations were responsible, to some extent, for the differences in the departmental costs among plants. If most of the variations in the departmental costs among plants were due to the factors mentioned above, then the opportunities for reducing unit costs would not have been as great as the cost range indicates. However, if most of the variations were due to differences in the combination of resources, then the cost range would more nearly reflect the opportunities which existed for lowering costs.

**Receiving and bulk storage costs**

The first department which the milk reached when it arrived at the plant and was unloaded from the truck or the tank truck, was the receiving and bulk storage department. The costs included in this department were those of receiving, sampling, dumping, weighing, cooling, and storing of the bulk milk. Also included was the cost of washing the cans in which the milk was shipped to the plant and the laboratory costs.

The type of container in which the product was packaged usually would not affect the unit costs of this department. Therefore, all plants studied were included when the model costs were determined. The cost of receiving and bulk storage, as shown in Table 2, was $3.51 per 1,000 quart units. Costs among plants ranged from $1.27 to $6.62. Labor was the highest single cost item averaging $1.25 and accounting for 36 percent of the total. Cost of labor, equipment, and general supplies made up 73 percent of the total.

Twenty-four percent of the variations among plants indicated by the cost range was attributable to differences in the daily volume of the plants. The relationship between unit costs and daily volume is shown in Figures 6 and 7.

![Figure 6](image)

**Figure 6. Relationship existing between daily volume and receiving and bulk storage costs per quart unit, selected Mississippi fluid milk plants, 1952-54.**

![Figure 7](image)

**Figure 7. Average cost of receiving and bulk storage per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.**

**Clarification, Standardization, and Pasteurization Costs**

The second department through which the milk passes during processing has been designated as clarifica-
tion, standardization, and pasteurization. This department included the operations signified by its title, plus those of product preparation, such as the making of buttermilk and chocolate milk. All of the operations required to move the milk from the storage tanks to the filling machines, other than homogenization, were included in this department. In most plants the milk was clarified prior to entering the bulk storage tanks. In order to simplify the handling of costs, this operation has been included in this department for purposes of analysis.

The type of container in which the product was packaged did not influence the costs of this department. Hence, all plants studied were included in determining an average of unit costs for the model. The average of total costs for this department per 1,000 quart units, Table 3, was $6.82. Costs among plants ranged from $3.49 to $13.75. Equipment was the highest single cost item, averaging $1.81, and accounting for 26.5 percent of the total. Costs per 1,000 quart units for labor, equipment, manufacturing supplies, and general supplies were $5.68. These costs accounted for 83 percent of the total.

Unit costs tended to decrease as daily volume increased, Figures 8 and 9. Fifty-two percent of the variations in unit costs among plants was attributed to differences in the daily volume.

Homogenization costs

If the milk product being processed was to be homogenized, the third department through which it passed was that of homogenization. The costs of this department were largely those of equipment, floor space, labor, and general supplies.

Figure 8. Relationship existing between daily volume and clarification, standardization, and pasteurization costs per quart unit, selected Mississippi fluid milk plants, 1952-54.

![Figure 8](image)

Figure 9. Average cost of clarification, standardization, and pasteurization per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.

![Figure 9](image)

All plants studied were included when determining the average of the costs per unit for this department. The cost per 1,000 quart units was $1.22, Table 4. Costs among plants ranged among plants ranged from $3.49 to $13.75. Equipment was the highest single cost item, averaging $1.81, and accounting for 26.5 percent of the total. Costs per 1,000 quart units for labor, equipment, manufacturing supplies, and general supplies were $5.68. These costs accounted for 83 percent of the total.

Unit costs tended to decrease as daily volume increased, Figures 8 and 9. Fifty-two percent of the variations in unit costs among plants was attributed to differences in the daily volume.

Homogenization costs

If the milk product being processed was to be homogenized, the third department through which it passed was that of homogenization. The costs of this department were largely those of equipment, floor space, labor, and general supplies.

Table 3. Average clarification, standardization, and pasteurization costs per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Average cost, dollars</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>.285</td>
<td>4.2</td>
</tr>
<tr>
<td>Labor</td>
<td>1.543</td>
<td>22.6</td>
</tr>
<tr>
<td>Equipment</td>
<td>1.806</td>
<td>26.5</td>
</tr>
<tr>
<td>Manufacturing supplies</td>
<td>1.545</td>
<td>22.6</td>
</tr>
<tr>
<td>General supplies</td>
<td>.788</td>
<td>11.5</td>
</tr>
<tr>
<td>Electricity and water</td>
<td>.257</td>
<td>3.8</td>
</tr>
<tr>
<td>Service department:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power plant</td>
<td>.400</td>
<td>5.9</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>.102</td>
<td>1.5</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>.097</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td>6.323</td>
<td>100.0</td>
</tr>
<tr>
<td>Cost range</td>
<td>$3.486 to $13.749</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Average homogenization costs per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Average cost, dollars</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>.036</td>
<td>3.0</td>
</tr>
<tr>
<td>Labor</td>
<td>.348</td>
<td>28.6</td>
</tr>
<tr>
<td>Equipment</td>
<td>.382</td>
<td>31.4</td>
</tr>
<tr>
<td>General supplies</td>
<td>.192</td>
<td>15.7</td>
</tr>
<tr>
<td>Electricity and water</td>
<td>.101</td>
<td>8.3</td>
</tr>
<tr>
<td>Service department:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power plant</td>
<td>.141</td>
<td>11.5</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>.019</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>1.219</td>
<td>100.0</td>
</tr>
<tr>
<td>Cost range</td>
<td>$2.84 to $3.933</td>
<td></td>
</tr>
</tbody>
</table>
from $28 to $3.95. The highest single cost item was equipment, being $.38. The costs of labor, equipment, and general supplies averaged $.92 per 1,000 quart units, or 76 percent of the total.

Units costs tended to decrease as daily volume increased, Figures 10 and 11. Forty-five percent of the variations in costs among plants was attributable to differences in the daily volume handled.

average of the glass-washing costs per 1,000 quart units, as shown in Table 5, was $7.41. Labor was the highest single cost item averaging $3.15, and accounting for 42.5 percent of the total. Building, labor, equipment, and general supplies accounted for 88 percent of the total. Their cost was $6.52 per 1,000 quart units. Glass-washing costs among plants ranged from $2.85 to $14.02.

In an attempt to explain some of the variations in unit costs by relating them to daily volume, it was found that unit costs tended to decrease as daily volume increased. However, only 4 percent of the variations in costs was attributable to differences in the daily volume.

Glass-filling costs

As the milk flow was followed through the plant, the fourth department which the homogenized product encountered, if it was to be packaged in glass, was the glass-filling department. The costs included in this department were those necessary to fill and close the containers, plus the cost of the containers and closures. The dry storage costs were also included and prorated to the glass operation on the basis of utilization.

The model costs for this department were derived by calculating the average of the costs of all plants studied which had a glass operation. The average of the glass-filling costs, as shown in Table 6, was $15.23 per 1,000 quart units. The highest single cost item was containers, amounting to $6.23 and accounting for 41 percent of the total. Labor, containers, and dry storage ac-
counted for 79 percent of the total.
Costs among plants ranged from $6.03 to $24.18.

Table 6. Average glass-filling costs per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.*

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Average cost, dollars</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>.370</td>
<td>2.4</td>
</tr>
<tr>
<td>Labor</td>
<td>3.831</td>
<td>25.2</td>
</tr>
<tr>
<td>Equipment</td>
<td>.933</td>
<td>6.1</td>
</tr>
<tr>
<td>Container</td>
<td>6.232</td>
<td>40.9</td>
</tr>
<tr>
<td>General supplies</td>
<td>1.375</td>
<td>9.0</td>
</tr>
<tr>
<td>Electricity and water</td>
<td>.090</td>
<td>.6</td>
</tr>
<tr>
<td>Service department:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry storage</td>
<td>1.926</td>
<td>12.7</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>.474</td>
<td>3.1</td>
</tr>
<tr>
<td>Total</td>
<td>15.231</td>
<td>100.0</td>
</tr>
<tr>
<td>Cost range</td>
<td>$6.030 to $24.178</td>
<td></td>
</tr>
</tbody>
</table>

*Includes only those plants having a glass operation.

The relationship between unit costs and daily volume for this department was determined with the cost of containers excluded. Then the relationship between container costs and volume was calculated. Glass-filling costs per unit, exclusive of the cost of containers, tended to decrease as daily volume increased, Figures 12 and 13. Fifteen percent of the variations in unit costs among plants was attributed to volume differences in this relationship. Glass-container costs per unit decreased slightly as daily volume increased, Figures 14 and 15. Differences in the daily volume accounted for only 2 percent of the variations in glass-container costs among plants.
the costs of the floor space, labor, equipment rental, utilities, and the container and related supplies such as wire, wax, and glue.

Eleven of the plants studied used similar paper-filling machines. The machine in the other plant was substantially different. Therefore, in deriving the model costs, only the eleven similar plants were considered.

The average costs of the paper-filling department, as shown in Table 7, was $24.51 per 1,000 quart units. Costs among plants ranged from $19.99 to $29.18. The highest single cost item was for containers, amounting to $16.57 and accounting for 68 percent of the total. The cost of labor, equipment, and general supplies accounted for another 26 percent of the total. Their cost was $6.42 per 1,000 quart units.

Container costs were separated from the remainder of the paper-filling costs when the relationship was determined between units costs and daily volume. Paper-filling costs, exclusive of the cost of the containers, tended to decrease as daily volume increased, Figures 16 and 17. Forty-eight percent of the variations in these unit costs was attributed to differences in the daily volume in this relationship. Container cost usually decreased as daily volume increased, Figures 18 and 19. However, only 20 percent of the variations among plants in unit costs was attributable to differences in the daily volumes.

### Table 7. Average paper-filling costs per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.*

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Average cost, dollars</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>.333</td>
<td>1.4</td>
</tr>
<tr>
<td>Labor</td>
<td>2.169</td>
<td>8.8</td>
</tr>
<tr>
<td>Equipment</td>
<td>3.397</td>
<td>13.9</td>
</tr>
<tr>
<td>Container</td>
<td>16.568</td>
<td>67.6</td>
</tr>
<tr>
<td>General supplies</td>
<td>.855</td>
<td>3.5</td>
</tr>
<tr>
<td>Electricity and water</td>
<td>.085</td>
<td>.3</td>
</tr>
<tr>
<td>Service department:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry storage</td>
<td>.881</td>
<td>2.8</td>
</tr>
<tr>
<td>Power plant</td>
<td>.077</td>
<td>.3</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>.196</td>
<td>.8</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>.150</td>
<td>.6</td>
</tr>
<tr>
<td>Total</td>
<td>24.511</td>
<td>100.0</td>
</tr>
<tr>
<td>Cost range</td>
<td>$19.990 to $29.177</td>
<td></td>
</tr>
</tbody>
</table>

*Eleven of the plants studied which had similar paper operations.

### Figure 16. Relationship existing between daily volume and paper-filling costs per quart unit, selected Mississippi fluid milk plants, 1952-54.

### Figure 17. Average cost of paper-filling per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.

### Figure 18. Relationship existing between daily volume and paper-container costs per quart unit, selected Mississippi fluid milk plants, 1952-54.

**Cold storage costs**

The final department in the processing function was the cold storage department. The costs of this department were considered to be mostly those of
floor space, labor, general supplies, and refrigeration.

The cold storage department was operated essentially the same, regardless of the product or package. Therefore, all plants studied were used to determine the model costs. The average cost of the cold storage department was $1.79 per 1,000 quart units, Table 8. Costs among plants ranged from $1.16 to $2.71. Refrigeration was the highest single cost item, amounting to $.84 and accounting for 47 percent of the total. The costs of building and of labor accounted for another 39 percent of the total.

Table 8. Average cold storage costs per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Average cost, dollars</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>.256</td>
<td>14.9</td>
</tr>
<tr>
<td>Labor</td>
<td>.428</td>
<td>24.0</td>
</tr>
<tr>
<td>Equipment</td>
<td>.129</td>
<td>7.2</td>
</tr>
<tr>
<td>General supplies</td>
<td>.045</td>
<td>2.5</td>
</tr>
<tr>
<td>Electricity and water</td>
<td>.045</td>
<td>2.5</td>
</tr>
<tr>
<td>Service department:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigeration</td>
<td>.837</td>
<td>46.9</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>.036</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>1.786</td>
<td>100.0</td>
</tr>
<tr>
<td>Cost range</td>
<td>$1.165 to $2.714</td>
<td></td>
</tr>
</tbody>
</table>

Cold storage costs per unit tended to decrease as daily volume increased. Only 26 percent of the variations in unit costs among plants was attributable to differences in the daily volumes.

Total processing cost

Average total processing cost was determined separately for the products bottled in glass and those packaged in paper. The average cost of processing in glass, as shown in Table 9, was $35.98 per 1,000 quart units. Costs among plants ranged from $24.71 to $48.15. The filling department accounted for 42 percent of the total. Another 21 percent was accounted for by the washing department. These two departments together with that of clarification, standardization, and pasteurization accounted for 82 percent of the total.

The average cost of 1,000 quart units of processing in paper, as shown in Table 10 was $37.85. Costs among plants ranged from $31.18 to $50.17. The filling department accounted for 65 percent of the total. The clarification, standardization, and pasteurization department accounted for another 18 percent of the total cost. The two together for 83 percent of the total. Total processing cost for packaging in paper averaged $1.97 per 1,000 quart units higher than for bottling in glass. However, in three plants these operations were cheaper for paper than for glass.

The cost per unit of processing in glass tended to decrease as daily volume increased, Figures 20 and 21. Thirty-five percent of the variations among plants in unit cost was attributable to differences in the daily volume of output. This relationship represents a summation of the variations of all

Table 9. Average cost of processing in glass per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Department</th>
<th>Average cost</th>
<th>Percent of total</th>
<th>Cost range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Receiving and bulk storage</td>
<td>$ 3.513</td>
<td>9.8</td>
<td>$1,273</td>
</tr>
<tr>
<td>Clarification, standardization, pasteurization</td>
<td>6.823</td>
<td>19.0</td>
<td>3.486</td>
</tr>
<tr>
<td>Homogenization</td>
<td>1.219</td>
<td>3.4</td>
<td>284</td>
</tr>
<tr>
<td>Glass washing</td>
<td>7.410</td>
<td>20.6</td>
<td>2,850</td>
</tr>
<tr>
<td>Glass filling</td>
<td>15.231</td>
<td>42.3</td>
<td>6,030</td>
</tr>
<tr>
<td>Cold storage</td>
<td>1.786</td>
<td>4.9</td>
<td>1,165</td>
</tr>
<tr>
<td>Total</td>
<td>$35.982</td>
<td>100.0</td>
<td>$24,708*</td>
</tr>
</tbody>
</table>

*Does not agree with sum of column due to certain plants having high or low costs in one department while only one plant has the highest or lowest total costs.
COST AND EFFICIENCY OF SELECTED MISS. FLUID MILK PLANTS

Table 10. Average costs of processing in paper per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Department</th>
<th>Average cost</th>
<th>Percent of total</th>
<th>Cost range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Receiving and bulk storage</td>
<td>$3.513</td>
<td>9.3</td>
<td>$1.273</td>
</tr>
<tr>
<td>Clarification, standardization, pasteurization</td>
<td>6.823</td>
<td>18.0</td>
<td>3.486</td>
</tr>
<tr>
<td>Homogenization</td>
<td>1.219</td>
<td>3.2</td>
<td>0.284</td>
</tr>
<tr>
<td>Paper filling</td>
<td>24.511</td>
<td>64.8</td>
<td>18.060</td>
</tr>
<tr>
<td>Cold storage</td>
<td>1.786</td>
<td>4.7</td>
<td>1.165</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$37.852</strong></td>
<td><strong>100.0</strong></td>
<td><strong>$31.180</strong></td>
</tr>
</tbody>
</table>

*Does not agree with sum of column due to certain plants having high or low costs in highest or lowest total cost.

The costs per unit of processing in paper tended to decrease as daily volume increased in the plants studied, Figures 22 and 23. Differences in the daily volume among plants accounted for 48 percent of the variations in unit costs.

General

Considerable variation in costs per unit in the departments of the processing function and in the total for the function itself, was shown by the cost ranges in the above findings. These variations indicated opportunities for reducing costs in the plants studied. The extent of these opportunities would depend upon, among other things, the sources of the variations. Some of these variations were attributed to differences in the volume of product handled, others to differences in the costs of the departments contributing to the total cost of processing in glass per unit.

Costs per unit of processing in paper tended to decrease as daily volume increased in the plants studied, Figures 22 and 23. Differences in the daily volume among plants accounted for 48 percent of the variations in unit costs.

**Figure 20.** Relationship existing between daily volume and total cost of processing in glass per quart unit, selected Mississippi fluid milk plants 1952-54.

**Figure 21.** Average total cost of processing in glass per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.

**Figure 22.** Relationship existing between daily volume and total cost of processing in paper per quart unit, selected Mississippi fluid milk plants, 1952-54.

**Figure 23.** Average total cost of processing in paper per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.
and in the proportion in which the resources were combined. Generally, the variations due to differences in the costs of the resources would not be subject to cost-reducing activities. The variations due to differences in the volume of output would be susceptible to activities directed toward reducing costs in the long-run. Most of the opportunities for reducing costs in the short-run were to be found in the variations attributable to differences in the proportion in which the resources were combined.

Before discussing the possibilities for reducing costs in the plants, it seems fitting to mention some of the factors which contributed to higher than average costs in some of the plants. Generally, inefficient utilization of labor was one of the most important factors which contributed to high unit costs. In some of the plants, apparently the labor force was larger than justified by the volume of product being handled. This resulted in a failure to provide sufficient work to utilize the time of the personnel while they were supposedly available.

Most of the other factors contributing to higher than average costs apparently were the result of plant operations at less than the capacity for which it was designed. This resulted in higher than average cost for equipment, labor, building, and, to some extent, supplies. In some instances, bottle-necks in the flow of milk through the plant resulted in high unit costs for certain of the departments.

Apparently most of the opportunities for reducing costs in the plants studied would come about from increases in the volume of product handled. The somewhat indivisible nature of the equipment and labor resources would prevent variations of any extent in the proportion in which these resources would be combined. Therefore, most of the suggestions and generalizations which follow will be directed to practices which will be accomplishable mostly in the long-run.

Reductions in the cost per unit of floor space utilized would be expect-
water, and repair and maintenance costs could result also from an increase in the volume of output handled.

**Distributive Costs**

Certain characteristics of the distributive costs per unit could have caused some variation in costs among plants. The costs of the distributive function have been divided into the salary, vehicle, advertising, and other cost categories. These categories will be analyzed separately. Then a summation of their characteristics will be shown by an analysis of total distributive costs per unit of output. Only ten of the plants studied were considered when the model costs were determined. Two of the plants were not included in arriving at the cost for the model, due to their extreme variations from the others. These variations were probably the results of the proportion sold at retail and at the platform.

**Salary costs**

Differences among plants in the wage scale, type of commission payments, and volume of product handled by each route-man would ordinarily have caused some variations in salary costs per unit of product handled. Also, the proportion of the total product sold as retail, wholesale, or platform sales may have caused some variation in salary costs per unit. There should not have been any salary cost for platform sales.

The cost of distributive salaries per 1,000 quart units was $15.36, Table 11. Costs among plants ranged from $11.01 to $22.92. Salary costs per unit tended to increase as daily volume increased, Figures 24 and 25. However, only 8 percent of the variations in costs among plants was attributable to differences in the volume of operation. The cost range indicates that opportunities existed for reducing salary costs per unit in some of the plants. However, these opportunities may not have been as large as indicated. If lower salaries would tend to attract less capable personnel to the industry, the volume of output might be curtailed or the control over other costs relaxed. This practice could result in diseconomies in other phases of the operation which would more than offset the economies gained from lower salaries. The plants

Table 11. Average cost of distribution per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Average cost</th>
<th>Percent of total</th>
<th>Cost range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Salaries</td>
<td>$15.357</td>
<td>50.0</td>
<td>$11.012</td>
</tr>
<tr>
<td>Vehicle costs</td>
<td>$10.684</td>
<td>34.8</td>
<td>$4.145</td>
</tr>
<tr>
<td>Advertising</td>
<td>$1.941</td>
<td>6.3</td>
<td>$1.533</td>
</tr>
<tr>
<td>Other</td>
<td>$2.750</td>
<td>8.9</td>
<td>$0.000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$30.732</strong></td>
<td><strong>100.0</strong></td>
<td><strong>$26.102</strong></td>
</tr>
</tbody>
</table>

*Average of ten plants.

**Does not agree with sum of column due to certain plants having high or low costs in one category while only one plant had the highest total cost and another had the lowest.
might be justified in paying salaries to attract personnel whose capabilities exceed the firm's present requirements. This hypothesis would be true, if expectations were for future operations to require personnel with such capabilities. Capable and efficient personnel should not be sacrificed for lower salaries.

**Vehicle costs**

Ordinarily, vehicle costs per unit among plants would have varied. Differences in the original costs and depreciation rates of the delivery equipment could have caused some variation. Also, differences in the costs of fuel, lubricants, and tires may have given rise to some variation. Utilization of the distribution vehicles at different percentages of their maximum capacity could have caused other variations. Generally, the larger the number of units of product handled by each vehicle, the less the cost per unit should be. Differences in the size of the sales territory, the number of stops, and the volume sold at each stop might have contributed to the variations. If the stops per mile of route were increased and the volume delivered at each stop increased also, the length of the route would have to either be shortened or the volume handled increased. Either case should result in a decrease in vehicle costs per unit of product handled.

The proportion of the total product sold at retail, wholesale, or platform would have caused some variation in vehicle costs per unit. Costs would have been less for the wholesale than for the retail sales. The platform sales should have had no vehicle expenses.

Average vehicle cost among the plants studied, as shown in Table 11, was $10.68 per 1,000 quart units. Costs among plants ranged from $4.14 to $15.74.

Vehicle costs tended to decrease as daily volume increased. Only 2 percent of the variations in unit costs among plants was attributable to differences in the daily volume of product handled.

If the variations indicated by the range were due primarily to differences in the combination of resources, then opportunities for reducing costs would be present. However, if these variations were primarily the result of differences in the costs of the resources due to accounting methodology, the opportunities for decreasing costs would not be as great as indicated by the range. Also, certain physical characteristics of the sales territory may have been responsible for some of the variations and would not be suited to activities directed at reducing costs.

This hypothesis would be true if the sales territory were over-expanded for competitive purposes. This over-expansion is indicated by the use of overlapping routes where the primary purpose would be to afford an opportunity to counteract price manipulation by the competitor. Very little change in the practice of using overlapping routes would be expected. Therefore, most decreases in vehicle costs ordinarily would come from increasing the total volume handled by each vehicle and the amount sold at each stop.

**Advertising costs**

Differences in the kind and the scope of advertising programs in effect in each of the plants would have caused costs per unit to vary. The average cost of advertising, as shown in Table 11, was $1.94 per 1,000 quart unit. Costs among plants ranged from $.53 to $3.55. The cost of the advertising program should be determined by the managerial factor. An increase in the cost of advertising would be justifiable if it resulted in an increased volume, provided, however, the increased volume brought about economies in the total operation which would more than offset the cost of advertising. Advertising would also be justified if returns to the business were increased sufficiently by the program.

**Other costs**

Normally, other distributive costs per unit should have varied among plants. These variations would have been due to differences in the costs of supplies, building, and certain equipment items used by the distributive function. Whether or not the trucks were re-
frig erated by ice or by ammonia would have caused some variations.

The cost of advertising was included with other distributive costs when the unit costs were related to 1,000 quart units. The relationship which existed is shown in Figures 26 and 27. Eight percent of the variations in costs per unit among plants was accounted for by differences in the volume of output daily.

![Figure 26. Relationship existing between daily volume and other distributive costs per quart unit, selected Mississippi fluid milk plants, 1952-54.](image)

Figure 26. Relationship existing between daily volume and other distributive costs per quart unit, selected Mississippi fluid milk plants, 1952-54.

![Figure 27. Average other distributive costs per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.](image)

Figure 27. Average other distributive costs per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.

Generally, other costs per unit would be expected to decrease as volume handled increased. The average of other costs per 1,000 quart units was $2.75. Table 11. Costs among plants ranged from $.00 to $12.57. Apparently, opportunities existed for decreasing other distributive costs. However, these opportunities would not have been as large as indicated by the range. Since most of the other costs consisted of building and supplies, an increase in the volume handled should result in a decrease in costs per unit. Utilization of the supplies in a more efficient manner should also give rise to decreases in unit costs.

**Total distributive costs**

The sources and causes of variations and the generalizations of the preceding analysis of the cost categories would be applicable to total distribution costs. Ordinarily, these costs per unit would vary among plants.

Average total distributive cost, as shown in Table 11, was $30.73 per 1,000 quart units. Costs among plants ranged from $26.10 to $38.40. Salary costs accounted for 50 percent of the total. Another 35 percent was accounted for by vehicle costs. Only .02 percent of the variations among plants in total distributive cost per unit was attributable to differences in the daily volume. Total distributive cost per unit tended to remain relatively stable regardless of the volume of output daily, Figures 28 and 29.

Apparently, most of the opportunities for reducing unit distributive cost would be those directed toward decreasing the unit costs of the salaries and of the vehicles. Reduction would most likely come from adjustments in the vehicle costs, since the salaries would probably be retained on the same basis as was formerly used.

![Figure 28. Relationship existing between daily volume and total distributive costs per quart unit, selected Mississippi fluid milk plants, 1952-54.](image)

Figure 28. Relationship existing between daily volume and total distributive costs per quart unit, selected Mississippi fluid milk plants, 1952-54.
Total Handling Costs

The previous analysis of the functions, departments, and cost categories would be applicable to the total costs of handling. These costs were determined separately for the glass and the paper operations.

The average total cost of handling the products bottled in glass, as shown in Table 12, was $76.38 per 1,000 quart units. This cost did not include the costs of the raw product or of procurement. Administration, processing, and distribution costs accounted for 12.7, 47.1, and 40.2 percent, respectively, of the total. Total handling costs per unit ranged from $66.07 to $89.28 per 1,000 quart units.

![Figure 29. Average total cost of distribution per quart unit by size groups, selected Mississippi fluid milk plants, 1952-54.](image)

Table 12. Average total cost of handling per 1,000 quart units, selected Mississippi fluid milk plants, 1952-54.

<table>
<thead>
<tr>
<th>Function, department and cost category</th>
<th>Glass operation</th>
<th>Paper operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average cost</td>
<td>Percent of total</td>
</tr>
<tr>
<td>Administration:</td>
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<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$ 6,203</td>
<td>8.1</td>
</tr>
<tr>
<td>Other</td>
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</tr>
<tr>
<td>Sub-total</td>
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<td>12.7</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td>10,544</td>
<td>13.8</td>
</tr>
<tr>
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<td>Cost range</td>
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of processing per unit decreased as daily volume increased. However, only 13 percent of the variations among plants in unit costs was accounted for by differences in the daily output.

It was pointed out in the previous analysis of the functions, departments, and cost categories that some of the causes of variations in unit costs among plants were not susceptible to cost-reducing activities. The same would hold true for total handling costs. However, alteration of the proportion in which the resources were combined should effect a decrease in total handling costs in the same manner it would for the functions, departments, and cost categories.

**Comparison of Costs**

A comparison of the model costs with those of 16 plants in four size groups is shown in Table 13. Four of the Mississippi plants were included in the 16 Southern plants, one in each of the size groups. Therefore, the costs of certain of the Mississippi plants would have influenced both the model and the costs for the 16 plants. However, the influence of the four Mississippi plants would not have been as great on the results for the Southern plants as it was for the model. This would be true because the ratio of other plants to the four Mississippi plants was 3 to 1 for the Southern region and 2 to 1 for the model.

![Figure 31. Average total cost of handling per quart unit by size groups, selected Mississippi fluid milk plants 1952-54.](image)

**Table 13. Comparison of average costs per quart unit of selected Mississippi plants with 16 Southern plants in four size groups.**

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<thead>
<tr>
<th>Item</th>
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<td>past.</td>
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<td>.682</td>
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<td>.460</td>
<td>.404</td>
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<td>.122</td>
<td>.243</td>
<td>.243</td>
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<td>1.523</td>
<td>1.523</td>
<td>1.523</td>
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<td>.179</td>
<td>.179</td>
<td>.319</td>
<td>.319</td>
<td>.225</td>
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</table>

*Penny, N. M., and Purcell, J. C., an unpublished manuscript prepared and distributed to members of the Technical Committee of the Southern Regional Dairy Marketing Project, SM-10, January, 1955.

**Differ because only three of the four plants in this group had a paper operation, and only the three plants were used in the average.

Cost of administration per unit was lower for the Mississippi plants than for three of the four groups of the Southern region, but was higher for the largest, or Group IV. This indicates that the Mississippi plants were relatively efficient by comparison in the utilization of resources for administration.

Average receiving and bulk storage costs per unit were higher, generally, in the Mississippi than in the Southern plants. Clarification, standardization, and pasteurization, and glass-washing costs per unit were considerably lower in the Southern than in the Mississippi plants. Also, glass-filling costs per unit were lower in three of the four groups of the Southern plants. Paper-filling and cold storage costs per unit were lower for the Mississippi plants than for three of the four groups. Generally, total costs of processing in paper...
were lower, while costs for processing in glass were higher for the Mississippi than for the Southern plants. Average distributive costs for the Mississippi plants were considerably lower than for the Southern plants. This comparison indicates that either the Mississippi plants were more efficient in the utilization of resources for distribution, or had a higher proportion of the product sold at wholesale or at the platform.

Average total costs of handling per unit were generally lower in the Mississippi than in the Southern plants. Generally, administrative and distributive costs were lower and processing costs, except for the paper operation, were higher in the Mississippi than in the Southern plants. However, the inefficiencies in the processing function were more than overcome by efficiencies in administration and distribution, by comparison, resulting in generally lower total costs of handling per quart unit for the Mississippi plants.

**SUMMARY AND CONCLUSIONS**

The rapid growth of the fluid milk industry in Mississippi has brought about a need for some basis from which economic adjustments can be made in the utilization of the resources of production within the processing plants. This study has been directed toward the development of such a basis. It was felt that the basis could best be developed through the accomplishments of certain intermediate objectives. Specifically, these were to determine whether or not there were economies to scale of operation; to determine the cost of performing the various functions by studying input-output relations; to evaluate major cost items as they affected the cost of operation; and to suggest alternatives for reducing costs in all phases of the operation.

Data were collected from 12 fluid milk-processing plants selected on the basis of size and type of operation, geographical location, type of records maintained, and their influence on other plants within the state. Some of the plants processed products other than those sold as Class I or fluid. In such cases, costs of the fluid operation were isolated from the others and analyzed separately. The cost data were taken from the accounting records of the firms and assigned to the functions, departments and cost categories on the basis of actual or estimated utilization. The results of the analysis of these data will be applicable to the plants studied and to plants having like characteristics in most respects.

Considerable variability among plants was found in costs per unit of output. Attempts were made to relate some of this variability to differences in the volume of output which existed among plants. Mathematical curves, logarithmic in the independent variable (volume), were fitted to the data as one means of relating unit costs to volume. Also, the plants were divided into size groups for cross-tabulation analysis.

The average cost of administration per 1,000 quart units for the plants studied was $9.66. Costs among plants ranged from $4.22 to $15.67. Administration accounted for 12.3 and 12.7 percent, respectively, of the total cost of handling in paper and in glass.

The average total cost of processing in paper per 1,000 quart units was $37.85. Costs among plants ranged from $31.18 to $50.17. The costs of the paper-filling department were 65.8 percent of the total.

For processing in glass, the average total cost per 1,000 quart units was $35.98. Costs among plants ranged from $24.71 to $48.15. The washing and the filling departments accounted for 62.9 percent of the total processing costs. The average total cost of processing in glass and in paper accounted for 47.1 and 48.4 percent, respectively, of the total cost of handling. Average processing costs per 1,000 quart units were $1.87 lower for the products packaged in glass than for those packaged in paper.

Distributive costs accounted for 39.3 and 40.2 percent, respectively, of the total cost of handling in paper and in glass. The average total cost of distribution per 1,000 quart units was $30.73. Costs among plants ranged from $26.10 to $38.40. Salaries accounted
for 50 percent of the total distributive costs.

Average total cost of handling per 1,000 quart units was $78.25 when the products were packaged in paper and $76.38 when bottled in glass. Costs among plants ranged from $71.80 to $104.25 when the products were packaged in paper. When glass bottles were used, costs among plants ranged from $66.07 to $89.28 per 1,000 quart units. Labor accounted for 34.8 percent of the total costs in paper and 42 percent in glass.

Generally, average costs per unit of the Mississippi plants were lower for the products packaged in paper and higher for those bottled in glass than those of distributors in the Southern area during the same time period. Average distributive costs were considerably lower, also, in the Mississippi plants than for Southern plants.

The trend for total costs of handling per unit to decrease as the volume of output increased suggests that there were economies resulting from larger operations. Whether these economies were the result of pure-scale relationships or variable proportions in the combination of resources could not be determined. This study indicates that most of the decreases in unit costs resulting from increases in the volume of the operation would appear in the administrative and processing functions. Unit cost of distribution did not appear to be affected to any extent by the volume handled. Costs within the individual plant, proving it was operating at less than the optimum volume, should be subject to more economies from increases in the size of operations than was indicated for the industry.

Some of the variations among plants in unit costs, as shown by the range of costs, were due to differences in the accounting methodology, and to original costs and depreciation rates of the assets. Other variations were due to differences in the proportion in which resources were combined.

The range in unit costs among plants indicates that opportunities existed for decreasing handling costs. However, the opportunities were not as great as indicated. The differences in the costs of the buildings and equipment resources and certain other fixed assets would not be subject to alterations of any magnitude in their affect upon unit costs. The major attack for decreasing costs should be directed toward the proportion in which the resources were combined within the plants. Opportunities existed for improving the efficiency with which labor, equipment, and supplies were utilized in some of the plants. Improvements in the efficiency with which these resources were utilized should result in a decrease in unit costs. However, the magnitude of the cost decreases which would result could not be definitely established.

APPENDIX A

Procedure

The problems encountered in the collection of data from the plants and in making allocations to departments depended largely upon the type of accounting records maintained by the plants. In some cases the costs required in Section I of the field schedule could be taken directly from the plant's profit and loss statement. However, in some instances, it was necessary to gather this information from unassembled records, such as invoices and plant inventories.

The assignment of costs to the functions of administration, procurement, processing, and distribution was made on the basis of actual or estimated requirements for each of these functions. These allocations will be explained in more detail as the procedures are developed further in this section.

A floor plan was prepared for each plant and sample observations necessary for the allocation of plant labor costs were made, concurrent with the collection of the data from plant records.

14 The plant was divided into the productive departments: receiving and bulk storage; clarification, standardization, pasteurization; homogenization; glass washing; glass filling; paper filling; cold storage; and, the service departments: dry storage, power plant, refrigeration, and repair and maintenance; also, the departments related to processing other products, such as, ice cream, condensery, and cottage cheese, when applicable.
Allocation of Labor Costs Among Departments

The distribution of labor costs in the individual departments was one of the more time-consuming tasks of the study. Prior to making the sample observations, a route was worked out for the observer to follow through the plant, whereby he might observe all of the personnel and of the operations. Also, each employee was given a number which was to be recorded for the department in which he was working on each observation trip through the plant. It was necessary to record each employee, due to differences in individual wage rates, in order to arrive at a more representative allocation of labor costs to each department.

Observation trips through each plant were made at 20 or 30 minute intervals. A comparison of the co-efficients of variations of the data collected in the Pilot Study on the different intervals indicated that there was no significant difference in reliability between the intervals. In all cases, the information was extremely variable.

The information obtained by the observation trips was summarized and converted to percentages of each individual's time utilized in the respective departments. These percentages were then applied to the individual's annual salary in order to derive the allocation of costs for each individual to the various departments for the year. The sum of the individual labor costs for each department determined the total labor cost allocated to each respective department.

Allocation of Total Costs to Functions and Departments

Total costs were allocated to the functions by cost items. After total processing costs were determined, they were allocated to the productive and service department by cost items, then the costs of the service departments were prorated to the productive departments which they served. The basis of allocating these cost items was as follows:

1. Building costs, including depreciation, repairs, taxes, and rent, were computed for the entire building or buildings and distributed to the various functions and departments on the basis of floor space utilized.

2. Labor costs, including wages, social security tax, state unemployment tax, and hospitalization benefits, were allocated to the functions, then to the departments of the processing function by the procedure explained above.

3. Equipment costs included depreciation, repair, and machine rental. Depreciation costs were allocated to the functions and the processing departments on the basis of the utilization of each machine to which the depreciation cost was applicable as determined from plant depreciation schedules, where available. In cases where the depreciation costs for each machine were not available, the costs were allocated on the basis of an index derived for a similar size and type of plant in this study. Repair costs were distributed in proportion to depreciation costs. Machine rental was allocated to the machine, function, and department to which it was applicable.

4. Container costs were determined as glass, paper, ice cream, cottage cheese, and other, and allocated to the appropriate department.

5. Manufacturing supplies included those supplies, such as sugar and chocolate, used in making the products. The costs were allocated to the clarification, standardization, and pasteurization departments.

6. General supply costs were those of cleaning compounds, etc. These costs were allocated to the various processing departments in relation to the index of direct labor time.

7. Fuel costs were allocated to the power plant departments.

8. Electricity and water costs were allocated to the various departments on the basis of an electricity and water utilization index computed in a pilot study of a North Carolina Plant.

9. The cost of dry storage was prorated among the productive departments on the basis of the estimated
utilization by the respective departments.

10. The power plant cost was allocated to the productive departments on the basis of the steam utilization index worked out in the North Carolina study.

11. The cost of refrigeration was also distributed on the basis of information obtained through the North Carolina study.

12. The cost of repair and maintenance was allocated to the productive departments in relation to the index of direct labor time.

Administration and Distribution Costs

In some cases, products other than those construed as fluid milk products were handled by the firms. Often it was impossible to determine the actual allocation of administration and distribution costs to the fluid products. Whenever such circumstances existed, total administration and distribution costs were prorated to the fluid and other products on the basis of volume of milk utilized for each respective type. For example, if 20 percent of the volume were utilized in manufacturing ice cream and 80 percent were utilized in fluid products, then, 20 percent of the total administration and/or distribution costs would be assigned to ice cream and 80 percent to fluid products.

Volume of Milk Processed

The volume of milk handled by the functions and departments was obtained from plant sales records, daily load-out sheets, records of producer receipts, and in some cases from Pure-Pak reports. Information relative to type of product and size and type of container, was collected whenever available. All of the products were converted to a quart unit basis. For example, two pints, regardless of the product, equaled one quart unit.

The quantity for the receiving and bulk storage department represented only the milk purchased from producers. The quantity for the clarification, standardization, and pasteurization department represented all milk processed through this department regardless of source. The quantity homogenized was determined from plant records where available or from estimates by the plant managers. The quantities for the filling and cold storage departments represented all milk handled by these departments as determined by plant records. The quantities for administration and distribution were the total amounts processed by the plant and sold as fluid products.

Costs Per Unit of Output

Costs per unit of output were derived by dividing the cost assignable to each department or function by the quantity of milk in quart units handled by it.

Model Costs

Costs for the model were determined by taking a simple average of the unit costs of the plants studied. All of the plants were utilized except in certain instances. Only eleven plants could be used for determining the model costs for the administration function due to an inability to separate office salaries from other expenses. One plant was not utilized in determining paper-filling costs per unit for the model due to its having a paper-filling operation which was different from the others. Only the eight plants having glass operations were included when model costs were determined for glass washing and for glass filling. Two plants were not included when determining model costs for the distributive function due to the extreme variations of their costs as compared to those of the other plants.

APPENDIX B

Statistical Supplement

Certain statistical procedures were used in determining the relationship existing between unit cost and daily volume in the Mississippi plants. Mathematical curves using logarithms in the independent variable were fitted to the data for unit costs and daily volume. These curves were determined by the
standard statistical least-squares method. The b-value which was derived indicated the magnitude of the increase or decrease in unit costs which corresponded to an increase of one unit in the logarithm of the volume. If the b-value were negative, a decrease in unit costs was signified; if positive, an increase in unit costs was indicated. A summary of the regression analyses which were calculated is shown in Appendix Table 1.

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**Appendix Table 1. Summary of logarithmic regression analyses.**

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