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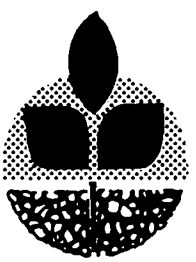
An Economic Analysis of Alternative Milk Packaging Containers in Washington, Oregon, and California



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SUMMARY AND CONCLUSIONS

The fluid milk processing industry faces a problem arising from demands of consumers and environmentalists. Consumers want an inexpensive, high quality milk product in a convenient package, based on varying family needs. Environmental groups are concerned about the best container for packaging milk when the capacity of solid waste disposal systems, environmental quality, and natural resource utilization are considered. For industry and government policymakers, the problem is to evaluate the current technological efficiencies of each system, the relative economic costs of each system, and the consumers' preference for convenience, without reducing the overall welfare of consumers.

The purpose of this study is to provide information to industry and government policymakers facing the problem outlined above by delineating, estimating, and comparing the relative cost of processing, packaging, and delivering Class I fluid milk in five packaging systems. The five systems are: (1) paper, (2) returnable rigid plastic, (3) disposable blow-mold plastic, (4) plastic pouch, and (5) glass.

The study is based on a non-random stratified sample of 28 firms in Washington, Oregon, and California. The industry structure characteristics of the number and size of firms, based on volume of Class I milk processed, and the relative importance of each type of container were used in stratifying the sample.

In this study, the specific cost categories analyzed are: (1) raw product, (2) processing, (3) direct packaging expense, which includes direct packaging labor and the cost of the container, (4) general plant expenses, and (5) total unit dock costs, which are simply the summation of the costs listed above. In addition, the cost of delivery was estimated for each firm. However, delivery costs varied to such a degree because of the size of the marketing area, density of the population in the marketing area, and the system of distribution, that an average would become more misleading than

helpful in a comparative analysis. Therefore, the delivery data for plants in this sample could not be analyzed to identify differences from type and size of containers delivered. Relative delivery costs by type and size of container are presented for plants in California, based on supplemental data from the California Department of Agriculture.

A cost accounting technique was employed to weight the costs of processing and packaging the fluid milk products. Costs were identified by departments or functions to reflect the various production or handling stages. Then the appropriate categories were combined for each type of fluid milk container to ascertain average unit costs.

The analytical results of the study show that the average total dock cost for whole milk in all sizes of paper containers and gallon in-plant blow-mold plastic containers declines as the volume of fluid milk processed by a firm increases. These economies of size arise from the consistent decline in total processing and packaging costs and general plant expenses as the firms become larger.

In addition, the effects of container type and container size are analyzed relative to each cost component. Even with large variation in some cost categories by container type, there appears to be little difference in the average total dock cost among the returnable rigid plastic, paper, in-plant blow-mold plastic, and plastic pouch containers. Half gallon glass containers have a higher total dock cost than paper, for a comparable plant size.

Paper is the only type of container with multiple container size in this study. The half gallon container has the lowest total dock costs, and gallons, quarts, and half pints have a higher cost.

INTRODUCTION

The fluid milk processing industry has undergone rapid technological change during the last 20 years with respect to fluid milk packaging. The once dominant glass bottle has been replaced by several alternative packages: paper containers, returnable rigid plastic containers, disposable blow-mold plastic containers, and the plastic pouch. These container systems were initially developed to fulfill several needs of the milk processing industry: consumer preference for convenience, product differentiation (a marketing tool often times used in a highly competitive market), and potentially lower unit costs of packaging and distribution.

Today, the milk processing industry is being confronted with new demands. The consumer is still demanding a relatively inexpensive, convenient product of high quality which meets state and federal health and safety regulations. At the same time, individuals and private and public institutions are voicing growing concern about solid waste management and environmental and natural resource utilization with respect to alternative raw materials used for packaging milk. However, before public policymakers, health officials, and industry representatives can adequately address these problems, basic data are required concerning the safety, toxicology, and/or contamination potential for all milk containers. In addition, the relative processing, packaging, and delivery cost structure of representative firms using various containers must be recognized. Given adequate and necessary data, a socio-economic study evaluating the comparative economic and environmental impacts of alternative packaging containers can be made.

The purpose of this study is to delineate, estimate, and compare typical costs of milk processors to process, package, and deliver milk to the point of the final sale through five containers: (1) refillable glass bottle, (2) returnable rigid plastic bottle, (3) paper carton, (4) disposable blow-mold plastic bottle, and (5) plastic pouch. The research procedure involved identifying and surveying fluid milk processing plants utilizing these various packaging systems, and then analyzing the data obtained to

provide comparable budget summaries for each system, given its size, measured in volume of Class I fluid milk processed.

Scope of the Study

This study pertains to milk processing plants in Washington, Oregon, and California. In particular, the costs of processing, packaging, and delivering Class I milk are identified. Class I milk is comprised basically of fluid whole milk, fluid low fat, half and half, and fluid skim. The study concentrates on the relative costs of processing, packaging, and distributing Class I milk for the five identified milk packaging containers. Since the costs associated with each Class I product are constant relative to each other, only the costs of whole milk are presented in the study.

Market Structure and the Relative Importance of Alternative Milk Packaging Containers

The market structure of processor-distribution fluid bottling plants in the three western states and the United States can best be characterized as changing to fewer but larger bottling plants. The total number of fluid milk plants in the United States and in Oregon and California has decreased steadily since 1950 (Table 1). This long-time trend has accelerated since 1965 with the number of fluid milk bottling plants in the United States decreasing more than 58 percent.

A USDA report shows that from 1964 to 1971, the number of plants operated by local proprietary firms, cooperatives, and national and regional firms decreased [7]. The only category showing an increase was integrated supermarket plants, which increased 36 percent during this time. In 1970, integrated supermarkets accounted for 8.2 percent of sales of fluid milk products in the United States.

However, the importance of integrated supermarket plants varies substantially among regions. In 1970, the greatest concentration was in California, where 22 percent of the State's total milk sales was from integrated supermarket plants [7]. That percentage grew to 29 percent by

Table 1. Number of Processor-Distributor Fluid Milk Bottling Plants in the United States, Oregon, and California, December 1950 to 1975

December	United States[a/] Number	United States[a/] % decrease from the previous period	Oregon[b/] Number	Oregon[b/] % decrease from the previous period	California[c/] Number	California[c/] % decrease from the previous period
1950.....	8,195	-	131	-	693	-
1955.....	6,726	17.9	95	27.5	616	11.1
1960.....	5,328	20.8	65	31.6	581	5.7
1965.....	3,743	29.8	63	3.1	561	3.4
1970.....	2,216	40.8	53	15.9	394	29.8
1975.....	1,552	30.0	36	32.1	177	55.1

SOURCE: [a/] Alden C. Manchester. Market Structure, Institutions, and Performance in the Fluid Milk Industry, Agricultural Economics Report No. 248, Economic Research Service, USDA, January 1974, 40 pp.; and telephone interview, October 20, 1976.

[b/] Oregon Department of Agriculture.

[c/] California Crop and Livestock Reporting Service.

1973 [1]. In Oregon and Washington, integrated supermarket plants accounted for 18 percent of the states' total fluid milk sales in 1975.

In general, the decline in the total number of processor-distributor fluid milk plants resulted from the closures of smaller plants. For a group of comparable federal order and state markets, the total number of plants decreased 36 percent between 1965 and 1970 (Table 2). The number of plants selling less than 4 million pounds of fluid milk per month decreased, while plants handling more than 4 million pounds per month increased in number.

The size distribution of fluid milk plants for the three states in this study is also presented in Table 2. A comparison of the size distribution in 1975 with previous years is not possible. However, industry sources believe that changes similar to those described for the U.S. -- an increase in the number of large size plants and a decrease in the smaller plants -- apply in general to the West Coast.

Table 2. Size Distribution of Fluid Milk Plants, Comparable Federal Order and State Markets, United States, 1965 and 1970, and West Coast,[a] 1975

Monthly plant volume of Class I fluid milk		U.S. plants[b]		Percent change	West Coast[c] plants
Group	Million pounds	1965	1970	1965 to 1970	1975
I	less than 2	1,916	1,052	-45.09	160
II	2 to 4	230	190	-17.39	33
III	4 to 9	168	203	+20.83	12
IV	more than 9	52	68	+30.77	17
TOTAL.....		2,366	1,513	-36.05	222

[a] West Coast states are Washington, Oregon, and California.
SOURCE:
[b] Alden C. Manchester. Market Structure, Institutions, and Performance in the Fluid Milk Industry, Agricultural Economic Report No. 248, Economic Research Service, USDA, January 1974, 40 pp.
[c] Milk Market Administrators, Oregon, Washington, and California.

Other changes in the structure of the fluid milk processing industry can be identified. The most important of these are in the product, service, or container. The introduction and high acceptance of low-fat milk have changed the plants' product mix. Some integrated plants process and package only four or five fluid products in a limited number and size of containers. Processing plants, in general, have decreased the reliance on retail home delivery, moving increasingly to limited wholesale delivery to institutions and stores, and even to dock sales to independent sub-distributors. The result has been an expansion of a plant's market boundaries. Prior to 1950, few plants distributed milk more than 50 miles. Now, distribution of 100 to 200 miles is common, and in some areas of the West, milk moves up to 500 miles. The number of milk plants located in any given market area has declined sharply; the number of competitors in a market area has declined much less.

A consideration associated with changes in the structure of the fluid milk processing industry is the cost effect. Prior studies have shown that

processing raw milk into a packaged fluid milk product is subject to economies of size [4,7]. There were large economies to be gained by processing at least 2 million pounds per month. Economies continued to occur beyond this volume, but at a rapidly diminishing rate.

The percentage of total fluid milk processed during one month of 1975 by size and type of container in Oregon and Washington is shown in Table 3. Paper is shown to be the predominant container, with 86.5 percent of the fluid milk being packaged in various sizes of that container. Two different plastic packages are summarized under the plastic category: milk packaged in returnable rigid plastic gallon and half-gallon containers which account for the majority of the 7.6 percent of sales, and milk packaged in gallon disposable plastic pouches. Institutional sales in plastic dispensing containers (bag-in-box) account for 3.4 percent of fluid milk sales. Glass, the least important container category, accounted for only 1.7 percent of fluid milk sold in November 1975.

The distribution of fluid milk by container type and size for California plants is presented in Table 4. Several differences are apparent when the California data are compared with data for Oregon and Washington (Tables 3 and 4). Less fluid milk is packaged in paper containers in California than in Oregon and Washington. Secondly, a relatively larger proportion of fluid milk is sold in disposable blow-mold plastic gallon containers in California, amounting to 20 percent of the fluid milk sales. Milk plants in California package a larger percent of their fluid milk in half-gallon paper containers than plants in Oregon and Washington, 54.2 and 31.8 percent, respectively.

Sample Size and Stratification

Given the structural characteristics of the fluid milk processing industry in the three western states, and the relative importance of each size and type of packaging container, a stratified sample based on the size of the processing plant and type of packaging container was used in this study. A non-random stratified sample of 28 firms was established, with some firms using two types of containers. For example, a processing

Table 3. Percent of Fluid Milk by Container Type and Size in Washington and Oregon, November 1975

Container size	Type of container				
	Paper	Plastic[a/]	Plastic lined box	Glass	Total
	percent of fluid milk sales				
Larger than gallons	-	-	3.4	-	3.4
Gallons	38.9	5.0	-	.2	44.1
Half-gallons	31.8	1.8	-	1.3	34.9
Quarts	6.4	.3	-	.1	6.8
Less than quarts	9.4	.5	-	.1	10.0
TOTAL[b/]	86.5	7.6	3.4	1.7	99.2

[a/] This group is primarily composed of rigid returnable plastic containers, however, some disposable plastic pouch containers are included.

[b/] 0.8 percent of total fluid milk sales was in other containers, (i.e., 10-gallon cans).

SOURCE: Detail Summary of Size and Type of Containers and Method of Distribution, Oregon-Washington, Inland Empire, and Puget Sound, Market Area, Federal Milk Market Administrator, Portland, Oregon, November 1975.

Table 4. Percent of Fluid Milk by Container Type and Size in California, October 1975

Container size	Type of container				
	Paper	Blow mold plastic	Plastic lined box	Glass	Total
	percent of fluid milk sales				
Larger than gallon	-	-	3.8	-	3.8
Gallons	0.4	20.0	-	a/	20.4
Half-gallons	54.2	3.1	-	2.3	59.6
Quarts	5.8	0.1	-	0.4	6.3
Less than quarts	9.9	-	-	-	9.9
TOTAL	70.3	23.2	3.8	2.7	100.0

a/ Less than 0.05 percent.

SOURCE: Dairy Information, California Crop and Livestock Reporting Service, Sacramento, California, February 11, 1976, 11 pp.

plant may use the disposable blow-mold plastic container for gallon fluid milk, and paper containers for all other packaged milk.

The number of plants used in computing average unit costs for each relevant category in the sample, by size and type of container, is presented in Table 5. Firms were grouped into each category so relative cost comparisons could be made. Some plants included in Group II were not assigned to other size classes to avoid disclosure of confidentiality.

Table 5. Number of Class I Milk Processing Plants in the Non-Random Stratified Sample, by Size and Type of Container

Monthly plant volume of Class I fluid milk		Type of container				
Group	Million pounds	Paper	Returnable rigid plastic	Disposable blow mold plastic	Plastic gallon pouch	Glass
		number of plants				
I	less than 2	2	-	-	-	-
II	2-4	3	4[a/]	-	2[a/]	2[a/]
III	4-9	7	-	3	-	-
IV	more than 9	12	-	11	-	-
	TOTAL.....	24	4	14	2	2

[a/] Plants range from 1 to 5 million pounds per month.

A DESCRIPTION OF COSTS

The data associated with the costs of processing, packaging, and delivering Class I milk were obtained by collecting accounting records from the sample firms for one quarter of the year. The time ranged from the first quarter of 1973 to the first quarter of 1976. Therefore, the data used for comparative analysis were summarized, weighted, standardized, and averaged to permit comparisons among different accounting periods and different accounting procedures. The California State Department of Food and Agriculture's manual of auditing and costing procedures was used as a guide to standardize each plant's costs [2]. In addition, this allowed the use of relevant segments of a number of plant audits compiled by the California State Department of Food and Agriculture, which had been reviewed by each plant and published in the "Total Reasonable Necessary Unit Costs for Fluid Milk, Low Fat, and Non Fat" reports for various marketing areas in California.[1/]

Raw Product, Processing, General Plant, and Delivery Expense

Raw product, processing, and packaging expenses are defined as all expenses incurred from the time the raw milk enters the processor's holding tank until the processed product is ready for sale at the processor's loading dock. These cost components, which will be presented and discussed separately for each type of container, are: (1) raw product cost, (2) processing expense, (3) packaging labor expense, (4) container cost, and (5) general plant expense. The importance and the problems associated with estimating and using delivery expense for comparative analysis are discussed.

[1/] Three reports presented at public hearings were used: (1) Southern Metropolitan Marketing Area - Zone 1, November 1974; (2) Central Coast Counties Marketing Area, August 1974; and (3) North Central Valley Marketing Area - Zone 1, November 1973.

Raw Product Cost

Raw product cost for processing plants in the three states is computed on current raw product component costs, which take into consideration the amount of butterfat, solids-not-fat, and fluid required for each processed unit. The component costs vary according to the location of the plant and the minimum price established by the stabilization and marketing plan in effect for that particular market. In addition, the established price is for milk delivered to the plant with a one percent allowance for plant loss for all components.

The cost of raw product used in this study is a representative price of Class I milk in the various marketing areas in the three western states, which was in effect during December 1975. This price is simply used for expository purposes. That is, the raw product cost of $10 per hundredweight (3.5 percent test milk) is used for all the sample plants, even though the raw product cost for Class I milk in the plants surveyed ranged from $9.35 to $10.55 per hundredweight during December 1975. This procedure allows the study to focus on the relative costs associated with the various packaging systems, by size of plants rather than the specific locality of a plant.

Processing Expense

The sample processor's records were analyzed and only those expenses that were applicable to the processing of fluid milk were included. The firm's payroll was analyzed, and with the assistance of supervisory personnel and some time studies, costs were allocated to various functions based on the amount of time required to perform or supervise each function. The functions, allocated on a time basis, are: receiving and tanker washing, pasteurizing and standardizing, separating, case and carton handling, and cold room labor.

Building and equipment expenses associated with processing were allocated to various types and sizes of containers on a quart equivalency basis. These costs include depreciation of the building and equipment used in pasteurizing, standardizing, and separating.

Two specific processing expense categories are isolated for analysis in this report: packaging labor expense and container cost. Packaging labor expense is the direct labor wages and fringe benefits associated with filling and casing fluid milk. For example, if an employee spends his entire time filling half-gallon paper containers, his entire salary is allocated directly to the filling schedule for half-gallon paper. Sanitation and cold room labor is not included in this category. The labor expense used in this study was $8.19 per hour, which was representative of the wage rate and fringe benefits of plants in the three western states in 1975.

The second specific processing expense -- container cost -- was determined on the basis of unit costs obtained from the latest available price quotation of the principal supplier. It included the handle or cap in the case of plastic or glass. A one percent loss allowance was used for all types of containers. In addition, the royalties paid for the use of automatic filling machines were included in the container cost. The container cost for returnable rigid plastic and glass containers includes the labor necessary for washing and visually inspecting each unit. It was estimated that, on the average, each rigid plastic container was reused 50 times, and each glass container was reused 30 times before being replaced.

For in-plant blow-molding, the container cost includes all costs associated with the blow-molding operation: resin, scrap loss, direct labor, utilities, label and cap, depreciation, property taxes, interest on investment, and maintenance. The average in-plant blow-mold gallon cost at plants where these costs were obtained was approximately eight cents per unit.

General Plant Expense

This expense category refers to all other expenses associated with processing Class I fluid milk in the plant. These costs include: occupancy expense, based on a square footage basis, maintenance; professional services; dues; real estate taxes; office expense, labor, and supplies; and general and administrative expenses incurred in the direction and administration of the company. All these expenses, with the exception of occupancy, are based on a quart equivalency.

Delivery Expense

All expenses associated with the actual delivery process, once the product left the dock of the processing plant, were allocated to the delivery function for each plant in the sample. There was a large variation in the delivery expense between plants and in the ratio of delivery expense to the total cost of processing. This variation was not highly correlated with different types of containers.

Two previous studies of delivery costs helped identify the problem of analyzing delivery costs relative to size and type of container. Delivery expenses are affected by characteristics of the container. However, total delivery costs also vary substantially by: the quantity of milk delivered per customer stop, the size and density of the market area, the degree of vertical integration, and the size of truck used for delivery [3,5].

The plants in this sample encompass the extremes of each of the variables listed above: a market size and density representative of Los Angeles and San Francisco to rather remote rural areas in Oregon and Washington, for example. In addition, the sample was too small to stratify to account for each combination of variables. Therefore, the delivery data for plants in this sample could not be analyzed to identify differences caused by the type and size of container delivered.

The California State Department of Food and Agriculture has developed two types of modifiers to allocate distribution costs in the audits of milk processing plants in California [2]. The labor modifier is used to determine the unit cost of delivery labor, including supervision. A case modifier is used to determine the unit cost for all other delivery expenses, except labor, such as truck depreciation and gas and oil expense. These two modifiers show the relative costs of labor and other expenses in delivering different sizes and types of containers in California.[2/] The relative delivery costs of each size and type of container, as a percent of the

[2/] A partial listing of the wholesale and retail modifiers for various packages is contained in Appendix A.

delivery cost of a paper quart container, are shown in Table 6. Half gallon paper containers have the lowest delivery expense. Glass and returnable plastic containers have a higher relative delivery expense than paper and disposable blow-mold plastic because of the additional cost of handling the container in the process of returning it to the processing plant.

Table 6. Relative Wholesale Delivery Costs as a Percent of the Costs to Deliver a Paper Quart Container, California

	Type of container			
	Paper and blow-mold plastic		Glass and returnable plastic	
Container size	Labor	Case	Labor	Case
	percent			
Gallon	100.0	100.0	a/	a/
Half-gallon	87.5	89.0	150.0	155.0
Quart	100.0	100.0	150.0	135.0
Pints	170.0	114.0	170.0	140.0
1/2 pints	280.0	132.0	280.0	280.0

a/ Gallon glass and returnable plastic containers were not included in the California study.

SOURCE: Calculated from the modifiers in Manual of Auditing and Cost Procedures for Processing and Distribution of Dairy Products, California Department of Food and Agriculture, revised September 1974, and included as Appendix A of this report.

ANALYTICAL RESULTS

Estimates of Average Unit Costs

This analysis of costs utilizes a cost accounting technique which defines each cost category in the same manner as described in the previous chapter. The volume of each product handled during the corresponding time the costs of each plant were obtained also was recorded. Using a "quart equivalent" as a standard unit or common denominator, the costs were allocated by departments or functions to reflect the relative importance of each product by size and type of container to total volume of product handled and cost of operation. Then the appropriate categories were combined for each packaged product to represent an average weighted unit cost at the final production stage (total dock costs). These average unit costs, by type and size of container and plant size, are presented in Appendix B.

Processing and Packaging Expense

The unit costs, by container type and size, serve as the basis for analysis. However, the use of unit costs requires constant conversion between container sizes. This problem can be alleviated by converting the unit costs to a standard of 100 pounds of 3.5 percent milk. This procedure is utilized in the following analysis.

Average Total Processing and Packaging Expense

Three factors can be isolated to identify differences with respect to average total processing and packaging costs: plant size, type of container, and size of container. From Table 7, it is apparent that economies of plant size, with respect to average total processing and packaging expenses, are prevalent for both paper and in-plant blow-mold plastic containers. For example, for paper half-gallon containers, the average total processing and packaging costs for plants processing more than 9 million pounds of Class I fluid milk per month are 22.07 percent less than plants processing less than 2 million pounds per month. For firms with in-plant blow-mold

Table 7. Average Total Processing and Packaging Costs by Plant Size and Type and Size of Container, Per 100 Pounds[a] of 3.5 Percent Fluid Milk

Type and size of container	Plant size			
	Group I	Group II	Group III	Group IV
	Less than 2 million lbs./mo.	2-4 million lbs./mo.	4-9 million lbs./mo.	More than 9 million lbs./mo.
	dollars			
PAPER				
Gallon	2.193	2.174	1.851	--
Half-Gallon	2.084	2.028	1.770	1.709
Quart	2.981	2.614	2.116	1.991
Half Pint	4.893	4.298	3.777	3.758
IN-PLANT BLOW MOLD PLASTIC				
Gallon	--	--	1.919	1.772
RIGID PLASTIC				
Gallon	--	1.926[b]	--	--
PLASTIC POUCH				
Gallon	--	2.165[b]	--	--
GLASS				
Half Gallon	--	2.530[b]	--	--

[a] One gallon of milk weighs 8.6 pounds.

[b] Plant size ranges from 1 to 5 million pounds per month.

containers, the average total processing and packaging costs decreased by 7.66 percent for plants processing more than 9 million pounds per month, relative to plants processing 4 to 9 million pounds per month.

Because of the effect of plant and container size on costs, differences in the total processing and packaging expense (due to the type of container) can be analyzed only for identical containers within each given size of plant. For example, if the gallon paper container is used as a standard of comparison, the relative average costs of returnable rigid plastic and plastic pouch containers can be compared for plants processing 2 to 4 million pounds of Class I milk per month. The average total processing and packaging costs of rigid plastic containers are 11 percent less than paper, the same costs for the plastic pouch containers are practically identical to paper. The cost of packaging 100 pounds of milk in half-gallon glass containers is 25 percent more than packaging the same quantity of milk in half-gallon paper.

The packaging expense results for the returnable rigid plastic and glass containers are based on the average number of trips for returnable plastic and glass of 50 and 30 times, respectively. However, it was observed that the number of trips for the returnable rigid plastic container ranged from a low of 35 to a high of 100 trips. The extremes of this variation in number of trips raise or lower the cost of the plastic container by approximately one-half cent per container. On the other hand, the life of a glass container ranges from 20 to 50 trips before being replaced, and this variation raises or lowers the cost of the glass container by approximately one cent per container.

The average total processing and packaging costs for in-plant blow-mold plastic containers also can be compared to the gallon paper container costs. For plants processing 4 to 9 million pounds per month, the average costs for in-plant blow-mold plastic containers are 3.70 percent more than paper.

The size of the container also affects the average total processing and packaging expenses. Paper is the only type of container with multiple sizes. The half-gallon container has the lowest average cost for all plant

sizes. Using plants processing 2 to 4 million pounds per month as an example, the effects of container size can be shown. Total processing and packaging expenses for gallon containers are 6.72 percent more than half gallons, and quarts and half pints are 22.42 and 52.81 percent more than half gallons, respectively.

Total packaging costs -- packaging labor plus the cost of the container -- also vary by plant size, type of container, and size of container. These costs are shown in Appendix B, Table 1, and on a per hundred pound basis, the average total packaging costs for half gallon paper containers decrease by 3.7 percent for the largest plant size relative to the smallest.

There is a larger variation in the average total packaging costs by type of container. Again, for plants processing 2 to 4 million pounds of Class I milk per month, and using the gallon paper container as a standard, the average total packaging costs for rigid plastic containers are 11.7 percent less than paper. The plastic pouch containers are practically the same as paper; the packaging cost of half-gallon glass containers are 24.7 percent more than half-gallon paper. For firms processing 4 to 9 million pounds per month, the total packaging costs for in-plant blow-mold gallon containers are 3.6 percent more than paper.

There is also a large variation in the relative total cost of packaging by size of container. For paper, the total cost of packaging the half gallon is less than the gallon for all plant sizes except firms processing 4 to 9 million pounds per month, in which case, the gallon is 2 percent less than the half gallon. For both gallons and quarts, the total cost of packaging is approximately 10 to 12 percent more than the half gallon container. The total cost of packaging half pint containers is substantially higher, 135 percent more than half gallons.

Average Total Dock Cost

An analysis of average total dock costs yields results similar to those found for average total processing and packaging. This could be expected, given the fact that the raw product cost is constant, and general plant expenses are a relatively small percent of total dock costs.

The total dock costs, on a 100-pound basis, are presented in Table 8, and vary by plant size, type of container, and size of container. There are economies of plant size throughout, for paper and in-plant blow-mold containers. Again, using the half gallon paper as an example, the average total dock cost for the largest size plants is 9 percent less than the costs for the smallest size plants. Total dock costs for plants using the blow-mold container declined 2 percent when the largest plant was compared to the smallest.

The total dock costs also vary by type of container. For plants processing 2 to 4 million pounds per month, and once again using the paper gallon as a standard, the average dock costs for the rigid plastic container are 1.9 percent less than paper. Costs for the plastic pouch containers are practically the same as paper. But half-gallon glass containers are 6.4 percent more than half-gallon paper containers.

For plants processing 4 to 9 million pounds of Class I milk per month, the total dock costs of the in-plant blow-mold container are .97 percent higher than paper.

Container size also affects total dock costs. For example, for plants that process 2 to 4 million pounds of Class I milk per month, the total dock cost for gallon paper containers is 1.09 percent higher than half gallons, and quarts and half pints are 4.58 and 22.08 percent more than half gallons, respectively.

Summary of Survey Findings

Three factors are isolated to identify differences in the average costs of processing and packaging, and total dock costs: plant size, type of container, and size of container. For plants using the paper and in-plant blow-mold container, there are economies of plant size throughout for all cost categories. Because of a small sample size, it was not possible to isolate the effect of plant size for rigid plastic, plastic pouch, and glass containers.

Table 8. Average Total Dock Expense by Plant Size and Type and Size of Container, Per 100 Pounds[a] of 3.5 Percent Fluid Milk[b]

Type and size of container	Plant size			
	Group I	Group II	Group III	Group IV
	Less than 2 million lbs./mo.	2-4 million lbs./mo.	4-9 million lbs.mo.	More than 9 million lbs./mo.
	dollars			
PAPER				
Gallon	13.621	13.034	12.401	--
Half Gallon	13.512	12.893	12.316	12.230
Quart	14.414	13.484	12.656	12.502
Half Pint	16.428	15.740	15.088	15.051
IN-PLANT BLOW MOLD PLASTIC				
Gallon	--	--	12.521	12.242
RIGID PLASTIC				
Gallon	--	12.792[c]	--	--
PLASTIC POUCH				
Gallon	--	13.010[c]	--	--
GLASS				
Half Gallon	--	13.723[c]	--	--

[a] One gallon of milk weighs 8.6 pounds.

[b] A raw product cost of $10 per hundredweight (Class I milk) is used for all the sample plants.

[c] Plant size ranges from 1 to 5 million pounds per month.

Since the cost of the raw product is a constant in this study, and general plant expenses are a relatively small percent of total dock cost, the variation in total dock cost is primarily explained by the relative changes in average total processing and packaging expenses. Even though total processing expenses for rigid plastic and plastic pouch gallon containers are higher than for paper gallon containers, lower packaging expenses more than offset these cost disadvantages, and the gallon rigid plastic and plastic pouch containers have a slightly lower average total dock cost than paper. On the other hand, in-plant blow-mold plastic and glass containers are higher than paper in all cost categories for a comparable container and plant size.

Container size is the third effect on costs. Paper is the only type of container with multiple container sizes in this study. The half gallon container has the lowest total dock cost, with gallons, quarts, and half pints having higher costs.

The results of this study are pertinent for fluid milk processors on the West Coast. The sampling and analytical procedures deem using averages, thus any given plant may have higher or lower costs than those presented here. In addition, cost comparisons are computed up to, and including, total dock costs. Implications of these cost comparisons should not be extrapolated to the store or consumer level. For example, what appears to be a cost advantage for rigid plastic or plastic pouch containers at the processor's dock may be reduced or even eliminated if total delivery and store handling expenses are considered. Likewise, the costs and their analysis are based on the product mix of plants surveyed at the time of the study. If that product mix were to change, the average costs and comparative results also could change.

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Appendix A

WHOLESALE AND RETAIL MODIFIERS FOR VARIOUS PACKAGES HANDLED BY DISTRIBUTORS WHEN 1 QUART OF MILK IN A FIBRE CONTAINER EQUALS 1 UNIT

	Units per case	Wholesale labor units	Retail labor units	Wholesale and retail: Case modifiers: 16 quart case	Wholesale and retail: Case modifiers: 20 quart case	Wholesale and retail: Case modifiers: 24 quart case	Wholesale and retail: General and administrative units
FIBRE OR PLASTIC CONTAINERS:							
1 gallon (16 qt. case).....	4	4.00	3.40	4.00	--	--	3.60
1 gallon (20 qt. case).....	4	5.00	3.40	--	5.00	--	3.60
1 gallon (24 qt. case).....	6	4.00	3.40	--	--	4.00	3.60
1/2 gallon (16 qt. case).....	9	1.75	1.70	1.78	--	--	1.90
1/2 gallon (20 qt. case).....	12	1.65	1.70	--	1.67	--	1.90
1/2 gallon (24 qt. case).....	12	1.95	1.70	--	--	2.00	1.90
Quarts.....	16	1.00	1.00	1.00	--	--	1.00
Quarts.....	20	1.00	1.00	--	1.00	--	1.00
Quarts.....	24	1.00	1.00	--	--	1.00	1.00
Pints.....	20	.85	1.50	.80	1.00	--	.75
Pints.....	25	.85	1.50	.64	--	.96	.75
Pints.....	35	.85	1.50	--	.57	.69	.75
1/2 pints.....	24	.70	1.40	--	.83	--	.50
1/2 pints.....	25	.70	1.40	--	--	.80	.50
1/2 pints.....	30	.70	1.40	--	--	.80	.50
1/2 pints.....	56	..70	1.40	--	.36	.43	.50
1/2 pints.....	70	.70	1.40	--	.29	.34	.50

	Units per case	Wholesale labor modifiers	Retail labor modifiers	Wholesale and retail: Case modifiers	Wholesale and retail: General and administrative modifiers
GLASS OR RETURNABLE PLASTIC:					
1/2 gallon.....	6	3.00	1.70	3.10	1.90
48 ounce decanter.....	6	3.00	1.70	3.10	1.50
Quart.....	12	1.50	1.00	1.35	1.00
Pint.....	20	.85	1.50	.70	.75
1/2 pint.....	20	.70	1.40	.70	.50

SOURCE: Manual of Auditing and Cost Procedures for Processing and Distribution of Dairy Products, California Department of Agriculture, revised September 1974.

APPENDIX B

Table 1. Paper Containers: Average Unit Expenses by Cost Category, and Plant and Container Size for Selected Washington, Oregon, and California Plants; Class I Whole Fluid Milk, 1975

Cost Category	Plant size: Group I, Less than 2 million lbs./mo. — Dollars	% of Dock Cost	Group II, 2-4 million lbs./mo. — Dollars	% of Dock Cost	Group III, 4-9 million lbs./mo. — Dollars	% of Dock Cost	Group IV, More than 9 million lbs./mo. — Dollars	% of Dock Cost
GALLON								
Raw product	.8630	73.67	.8630	76.92	.8630	80.92	N.A.	N.A.
Processing & Packaging Expense:								
Processing expense	.0896	7.65	.0889	7.92	.0736	6.90		
Packaging expense:								
Labor	.0171	1.46	.0171	1.53	.0045	0.42		
Container	.0819	6.99	.0815	7.26	.0811	7.60		
TOTAL PROCESSING & PACKAGING EXPENSE	.1886	16.10	.1875	16.71	.1592	14.93		
General plant expense	.1198	10.23	.0714	6.37	.0443	4.15		
TOTAL DOCK COST	1.1714	100.00	1.1219	100.00	1.0665	100.00		
HALF-GALLON								
Raw product	.4315	74.27	.4315	77.83	.4315	81.48	.4315	82.05
Processing & Packaging Expense:								
Processing expense	.0449	7.73	.0435	7.85	.0326	6.16	.0304	5.78
Packaging expense:								
Labor	.0024	0.41	.0018	0.32	.0018	0.34	.0018	0.34
Container	.0423	7.28	.0419	7.56	.0417	7.87	.0413	7.86
TOTAL PROCESSING & PACKAGING EXPENSE	.0896	15.42	.0872	15.73	.0761	14.37	.0735	13.98
General plant expense	.0599	10.31	.0357	6.44	.0220	4.15	.0209	3.97
TOTAL DOCK COST	.5810	100.00	.5544	100.00	.5296	100.00	.5259	100.00
QUARTS								
Raw product	.2158	69.64	.2158	74.44	.2158	79.31	.2158	80.28
Processing & Packaging Expense:								
Processing expense	.0389	12.55	.0316	10.90	.0210	7.72	.0185	6.88
Packaging expense:								
Labor	.0010	0.32	.0005	0.17	.0005	0.18	.0005	0.19
Container	.0242	7.81	.0241	8.31	.0240	8.82	.0238	8.85
TOTAL PROCESSING & PACKAGING EXPENSE	.0641	20.68	.0562	19.38	.0455	16.72	.0428	15.92
General plant expense	.0300	9.68	.0179	6.18	.0108	3.97	.0102	3.80
TOTAL DOCK COST	.3099	100.00	.2899	100.00	.2721	100.00	.2688	100.00
ONE-HALF PINTS								
Raw product	.0540	61.16	.0540	63.83	.0540	66.58	.0540	66.75
Processing & Packaging Expense:								
Processing expense	.0126	14.27	.0102	12.06	.0076	9.37	.0076	9.39
Packaging expense:								
Labor	.0010	1.13	.0005	0.59	.0005	0.62	.0005	0.62
Container	.0127	14.38	.0124	14.66	.0122	15.04	.0121	14.96
TOTAL PROCESSING & PACKAGING EXPENSE	.0263	29.78	.0231	27.31	.0203	25.03	.0202	24.97
General plant expense	.0080	9.06	.0075	8.86	.0068	8.39	.0067	8.28
TOTAL DOCK COST	.0883	100.00	.0846	100.00	.0811	100.00	.0809	100.00

Table 2. In-Plant Blow Molded Plastic Container: Average Unit Expenses by Cost Category and Plant Size for Selected California Plants; Class I Whole Fluid Milk, 1975

GALLON	Plant size			
	Group III 4-9 million lbs./mo.		Group IV More than 9 million lbs./mo.	
Cost Category	Dollars	% of Dock Cost	Dollars	% of Dock Cost
Raw product.....	.8630	80.15	.8630	81.97
Processing & Packaging Expense:				
Processing expense.....	.0749	6.95	.0638	6.06
Packaging expense:				
Labor.....	.0069	0.64	.0069	0.66
Container.....	.0832	7.73	.0817	7.76
TOTAL PROC. & PKG. EXPENSE.....	.1650	15.32	.1524	14.48
General Plant expense.....	.0488	4.53	.0374	3.55
TOTAL DOCK COST.....	1.0768	100.00	1.0528	100.00

Table 3. Rigid Plastic Container: Average Unit Expenses by Cost Category and Plant Size for Selected Washington and Oregon Plants; Class I Whole Fluid Milk, 1975

GALLON	Plant size	
	1-5 million lbs./mo.	
Cost Category	Dollars	% of Dock Cost
Raw product.....	.8630	78.45
Processing & Packaging Expense:		
Processing expense.....	.1119	10.17
Packaging expense:		
Labor.....	.0145	1.32
Container.....	.0392	3.56
TOTAL PROCESSING & PACKAGING EXPENSE.....	.1656	15.05
General plant expense.....	.0715	6.50
TOTAL DOCK COST.....	1.1001	100.00

Table 4. Plastic Pouch Container: Average Unit Expenses by Cost Category and Plant Size for Selected Washington and Oregon Plants; Class I Whole Fluid Milk, 1975

GALLON	Plant size: 1-5 million lbs./mo.	
Cost Category	Dollars	% of Dock Cost
Raw product	.8630	77.13
Processing & Packaging Expense:		
Processing expense	.0934	8.35
Packaging expense:		
Labor	.0092	0.82
Container	.0836	7.47
TOTAL PROCESSING & PACKAGING EXPENSE	.1862	16.64
General plant expense	.0697	6.23
TOTAL DOCK COST	1.1189	100.00

Table 5. Glass Container: Average Unit Expenses by Cost Category and Plant Size for Selected Oregon and California Plants; Class I Whole Fluid Milk, 1975

HALF-GALLON	Plant size: 1-5 million lbs./mo.	
Cost Category	Dollars	% of Dock Cost
Raw product	.4315	73.12
Processing & Packaging Expense:		
Processing expense	.0595	10.08
Packaging expense:		
Labor	.0082	1.39
Container	.0411	6.97
TOTAL PROCESSING & PACKAGING EXPENSE	.1088	18.44
General plant expense	.0498	8.44
TOTAL DOCK COST	.5901	100.00