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Milk Processing

Costs and Impacts of Alternative Milk Packaging Systems

by

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TABLE OF CONTENTS

LIST OF TABLES

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INTRODUCTION

Packaging accounts for a quarter of the total costs of fluid milk processing and distribution. Since the 1950's, the paperboard container has been the principle method of packaging. However, innovations in packaging material (the disposable pouch, disposable plastic and returnable polyethylene containers) have found increased acceptance among milk processors, retailers, and consumers. The gallon size plastic containers are less vulnerable to leakage and require smaller investments in packaging equipment than paperboard. 1/ The total market share of plastic containers grew from 3 percent in 1964 to 30 percent in 1975. 2/ In the Upper Midwest milk order area, plastic containers accounted for 11 percent of sales in 1973, but their share rose to 24 percent in 1977. 3/

Although they have several significant advantages, disposable plastic milk containers have generated considerable controversy in Minnesota. The disposable plastic container is a heavy user of nonrenewable hydrocarbon resources and presents greater solid waste disposal problems than reusable containers. In May 1977, the sale of milk in rigid disposable plastic containers was banned by the Minnesota legislature. The ban was to become effective July 1, 1978. The law was declared unconstitutional by the Ramsey County District Court, but the controversy continues as the Attorney General's Office prepares to appeal the District Court's decision to the Minnesota Supreme Court.

In this study of milk packaging, we have two general objectives: (1) to estimate packaging costs to the dairy for milk in alternative containers and (2) to examine considerations other than in-plant processing costs that relate to use of alternative containers. Other

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1/ For disposable plastic jugs, this is true if the dairy purchases the container rather than blow molds its own jugs.

2/ U.S. Department of Agriculture, "Packaged Fluid Milk Sales in Federal Order Milk Markets during November 1973," AMS-553, Washington, D.C., July 1977, p. 7.

3/ U.S. Department of Agriculture, "Market Administrator's Bulletin," Upper Midwest Marketing Area Federal Order 68, Minneapolis, Minnesota, May 1978, p. 5.

considerations include impacts on retail food store operations, environmental impacts of the containers, and problems of use by processors and consumers. The analysis focuses on five packaging alternatives: paperboard, disposable plastic, disposable pouch, returnable glass, and returnable polyethylene. The information should be useful to both policymakers and dairy plant managers in evaluating packaging alternatives.

COSTS OF MILK PACKAGING

Methodology

To estimate the costs of packaging milk, we used the economic engineering approach. This approach standardizes all capital and operating costs to the current price level. Packaging systems for each packaging alternative were designed to incorporate current milk packaging technology. The systems were based on specifications and layouts provided by milk packaging equipment specialists. Requirements for labor, packaging material, fuel, and electricity were developed from information provided by equipment manufacturers and dairy plant managers. All costs were evaluated for 1978 wage and price levels. Operating rates for the equipment incorporated into the alternative packaging systems were selected on the basis of requirements for efficient packaging in a medium-sized dairy processing 150,000 gallons per week.

Investment Requirements for Alternative Packaging Systems

In this and the following sections, we present estimates of costs for the milk packaging operation only. Investments for packaging systems refer to the cost of all items of equipment used in filling, capping, casing, and washing milk containers. These items are (1) fillers, (2) cappers, (3) handle applicators and staplers, (4) label applicators, (5) carton conveyors and combiners, (6) automatic casers, (7) bottle washers, and (8) sensing devices (used to detect contaminants in returnable polyethylene containers).

Investment requirements for alternative packaging systems, with output rates specified by equipment manufacturers, are summarized in Tables 1-5.

Investment requirements are substantially lower for the disposable plastic jug filling system than for other systems. Although the same filling equipment is used for bottling glass, polyethylene, and disposable plastic jugs, the returnable packaging systems also require a bottle washer and a container conveyor from the washer to the filler. This adds to the capital investment requirements for returnable packaging systems. The bottle washing unit for cleaning returnable polyethylene is somewhat more costly than that required for glass, and a sensing device must be used with the returnable polyethylene system. The sensing device is necessary to detect toxic materials that may be absorbed in the plastic container.

The disposable pouch system is the most costly in the gallon size, and the paperboard filling system is second in cost. For half gallons and half pints, capital investments are greatest for paperboard filling equipment.

Table 1. Capital cost for paperboard milk packaging systems.

Item	Container size: Gallon	Half gallon	Standard half pint	Small, cross-sectional half pint b/
Filler model	Excello K	Excello H	Excello QM2	Excello QMD2
Cartons per minute	60	125	170	170
	dollars			
Cost:				
Filler	$175,000	$215,000	$229,000	$230,000
Caser	17,000	15,600	14,700	14,700
Carton conveyor	6,000	6,000	6,000	6,000
Carton combiner	--	--	3,500	3,500
Handle applicator	11,150	--	--	--
Total a/	$209,150	$236,600	$253,200	$254,200

a/ Installation included.
b/ "Ecko-pak."

Table 2. Capital costs for plastic pouch filling systems.

Item	Container size: Gallon	Half gallon	Half pint
Filler model	Pitcher Pak IS-6 (2)	Pitcher Pak IS-6 (2)	Pitcher Pak IS-6 (2)
Containers per minute	66	132	180
	dollars		
Cost:			
Fillers	$136,000	$136,000	$136,000
Baggers to overwrap	36,000	--	--
"Kwik Lok" closures	16,000	--	--
Caser	23,000	16,550	16,550
Accessories	9,820	11,520	11,520
Installation	4,500	4,500	4,500
Total	$225,320	$168,570	$168,570

Table 3. Capital cost for disposable plastic jug milk packaging system.

Item	Cost
	(dollars)
Filler: Federal GWS-266, 67 gallons per minute a/	$40,000
Fogg screw on capper	6,900
Automatic caser	17,000
Label applicator	5,500
Carton conveyors	12,000
Installation	3,000
Total	$84,400

a/ Manufacturer's list price for Federal GWS-266 could not be obtained. This figure is the price paid for the GWS-266 by two local bottling plants, adjusted for inflation with the wholesale manufactured goods price index.

Table 4. Capital cost for returnable polyethylene filling system.

Item	Cost
	(dollars)
Federal GWS-266 filler, 67 gallons or half gallons per minute, with capper a/	$44,000
Automatic caser	17,000
Carton conveyors	18,000
Continental PLX-12 bottle washer	56,000
Installation	4,500
Total purchase	$139,500
Rental cost for hydrocarbon sensing device	$100/mo.

a/ Based on prices paid by local fluid milk firms.

Table 5. Capital cost for returnable glass filling equipment.

Item	Cost
	(dollars)
Federal GWS-266 filler, 67 gallons or half gallons per minute, with capper a/	$44,000
Automatic caser	17,000
Carton conveyors	18,000
Continental JA-10 bottle washer	47,600
Installation	4,500
Total	$131,100

a/ Based on prices paid by local fluid milk firms.

It should be noted that the filling system for gallon and half gallon in paperboard can be used to fill only one container size. An advantage of the other systems is that a single packaging system can be used to fill two or more sizes of containers. For this reason, smaller processing firms can reduce total packaging investment if a multi-container system is used instead of several single-size paperboard systems.

Operating Costs for Packaging Milk in Alternative Containers

Using 1978 wage and price data, the equipment costs presented above, and utility and supply requirements specified by equipment manufacturers and dairy managers, we estimated the total cost of bottling milk in each of the containers. The categories and definitions of cost items are presented below.

Containers. Container cost includes the cost of the container, handle, staple, cap, overwrap, and label, as required by the particular container. Costs for all packaging materials are summarized in Tables 6, 7, and 8. Detailed information on the style and coloring assumed for caps, labels, and containers, as well as the cost of individual packaging items, are also presented.

The cost figure for disposable plastic gallon jugs is for purchased containers. A savings of up to 2 cents per container can reportedly be realized if the dairy blow molds its own containers. We have not investigated the costs of blow molding disposable plastic containers.

Table 6. Cost of containers, closures, handles, and labels for alternative gallon containers.

Item	Paper-board a/	Plastic pouch b/	Glass c/ 25 trip	Glass c/ 50 trip	Nonreturnable plastic d/	Returnable plastic e/ 25 trip	Returnable plastic e/ 50 trip
	cost in dollars per thousand						
Container	$84.25	$41.62	$29.39	$14.70	$90.00	$25.60	$12.80
Handle, ~~style~~ staple ...	9.34	NA	4.62	2.31	NA	NA	NA
Cap ~~of~~ or overwrap	NA	30.00	8.34	8.34	7.60	8.70	8.70
Label	NA	NA	NA	NA	7.46	NA	NA
Total	$93.59	$71.62	$42.35	$25.35	$105.06	$34.30	$21.50

a/ Based on two-color containers and Gripit handles.

b/ Based on 10,000 square inches per pound polyolefin with two-color imprint and 3 cents for bag overwrap.

c/ Based on decorated bottle (3.5 pounds), attached colored plastic handle, 48 mm., two-color imprinted disc and seal skirt.

d/ Based on 65 gram bottle, imprinted screw-on cap, and ultra violet varnished, two-color irregular label.

e/ Based on 200 gram polytrip bottle with handle attached, one-color imprint on two sides, and snap-on cap with imprint.

Table 7. Cost of alternative half-gallon containers.

Item	Paperboard a/	Plastic pouch b/	Glass c/ 25 trip	Glass c/ 50 trip	Returnable plastic d/ 25 trip	Returnable plastic d/ 50 trip
	cost in dollars per thousand					
Container	$43.00	$20.81	$18.77	$ 9.39	$21.80	$10.90
Handle	NA	NA	4.19	2.10	NA	NA
Cap and overwrap	NA	NA	8.34	8.34	8.70	8.70
Total	$43.00	$20.81	$31.30	$19.83	$30.50	$19.60

a/ Based on two-color containers.
b/ Based on "Sclairfilm" polyolefin and two-color imprint.
c/ Based on 2.13-pound container, 48 mm., two-color imprinted disc and seal skirt.
d/ Based on polytrip container with handle attached, one-color imprint on two sides, and snap-on imprinted cap.

Table 8. Cost of alternative half-pint containers.

Item	Standard, cross-sectional paperboard [a]	Small, cross-sectional paperboard [a]	Plastic pouch [b]
	cost in dollars per thousand		
Container	$12.20	$10.95	$6.15
Straw	NA	NA	1.22
Cost per half pint	$.0120	$.0101	$.0074

a/ Based on two-color containers.
b/ Based on "Sclairfilm" polyolefin with one-color imprint.

Depreciation, Interest, and Repairs. All capital components of packaging were depreciated on a straight-line basis over 15 years, and interest was computed at 10 percent on the average value of equipment over 15 years. We were unable to obtain precise data on expenditures for repairs and maintenance of packaging equipment. However, on the basis of discussions with equipment manufacturers and dairy plant managers, we estimated repair costs at 3 percent of initial equipment cost per year. The conversion to per unit cost for items in this category was based on an assumed 40 hours per week equipment operation.

Labor and Benefits. Labor costs included wages and fringe benefits for filler operations, conveyor loaders, and washing equipment operators. The total labor cost was $9.60 per hour. This figure was based on a 42-hour workweek, a base wage of $7.50 per hour, an overtime wage of $11.25 per hour, and 25 percent additional for payroll taxes, uniforms, and benefits.

Utilities and Supplies. This category includes costs of electricity, natural gas, and cooling water consumed by packaging equipment and accessories, as well as costs of chemicals and solutions used in bottle washing. Utility and supply requirements were specified by equipment manufacturers and bottling plant personnel. Prices indicated by local utilities were 4 cents per kilowatt hour, $2.2472 per 1,000 cubic feet for natural gas, and 98.5 cents per 100 cubic feet for water, including sewer service charges. Prices for caustic powder and sanitizing agents used in washing returnable bottles were provided by a local chemical manufacturer.

Additional Distribution Costs. There are additional costs for distributing milk in the relatively heavy glass containers. Weight is the limiting factor in volume of milk carried on any particular distribution vehicle. Vehicle capacity is 30 to 38 percent greater when milk is packaged in paperboard or plastic rather than glass. This difference is entirely due to the added weight of the glass container. Using estimates of vehicle costs to be presented in a forthcoming publication, [4/] we determined that for most distribution routes vehicle cost will be 0.3 to 0.6 cents per gallon greater if milk is distributed in glass rather than paperboard or plastic.

Comparison of Unit Costs. The operating costs for the various types of packaging systems were used to compute costs per unit for each container type and several container sizes. For gallon packaging, costs range from 3.1 to 11.1 cents per gallon (Table 9). If returnable packaging can be used 50 times, lowest packaging costs are incurred with the returnable polyethylene container (3.1 cents per gallon). [5/]

4/ Martin Fischer, Jerome Hammond, and Wallace Hardie, Fluid Milk Processing and Distribution Costs, forthcoming, Agricultural Experiment Station, University of Minnesota.

5/ Because the number of trips for reusable containers is difficult to determine, we computed costs on the basis of 25 trips and 50 trips per container. Actual use is likely to fall in this range.

Table 9. Total costs of packaging milk in alternative gallon containers.

Item	Paper-board	Nonreturn-able plastic	Plastic pouch	Returnable glass 25 trip	Returnable glass 50 trip	Returnable polyethylene 25 trip	Returnable polyethylene 50 trip
	----------	cents per gallon	----------				
Packaging material	9.359	10.506	7.162	4.235	2.535	3.430	2.150
Depreciation, interest, and repairs:							
Filling and casing	0.419	0.151	0.410	0.129	0.129	0.129	0.129
Washing	--	--	--	0.107	0.107	0.136	0.136
Labor and benefits:							
Filling and casing	0.267	0.478	0.242	0.239	0.239	0.239	0.239
Washing	--	--	--	0.239	0.239	0.239	0.239
Utilities and materials:							
Filling	0.084	0.009	0.021	0.008	0.008	0.008	0.008
Washing	--	--	--	0.198	0.198	0.201	0.201
Added distribution cost	--	--	--	0.400	0.400	--	--
Total cost per gallon	10.129	11.144	7.835	5.555	3.855	4.382	3.102

Primarily because of greater weight of the returnable glass that increases distribution costs, glass containers are slightly more costly than returnable polyethylene. The cost of packaging in 50-trip polyethylene gallons is only 28 percent of the costs of packaging in disposable plastic and only 31 percent of the costs of packaging in paperboard. Cost for the plastic pouch is almost twice that of the returnables.

For plants that blow mold their own disposable plastic gallons, it is reported that 2 cents per gallon could be eliminated from the packaging cost per gallon. Elimination of 2 cents from the cost of the disposable jug would reduce the cost of this container below that of paperboard.

For all gallon containers, the cost of packaging materials is the largest component of total packaging costs, accounting for 66 to 94 percent of total packaging costs. Depreciation, interest, and repairs are the second most important component of packaging costs for disposable containers. Labor is the second largest cost component for returnable containers. Labor is more costly for returnables because of washing and handling of the returns.

In the half-gallon size, a somewhat different ranking of costs arises. As Table 10 shows, the disposable plastic pouch is the least costly half-gallon container. Costs of packaging half gallons in the plastic pouch are only 50 percent of the costs of packaging in paperboard. The 50-trip polyethylene container has the second lowest packaging cost in the half-gallon size. If the trip rate for half-gallon polyethylene containers could be extended to 75, packaging costs for returnable polyethylene could be reduced to \$22.59 per 1,000—slightly less than the cost of packaging in the disposable pouch.

Container costs for returnable glass and polyethylene containers are similar. However, added distribution costs because of greater weight causes glass to be 11 to 13 percent more costly in total than with the polyethylene container.

As was the case with gallon containers, packaging materials for half-gallon containers are the largest component of packaging costs, accounting for 59 to 91 percent of total packaging cost. Costs of packaging material are relatively low for plastic pouch and 50-trip polyethylene containers. The added costs of washing the polyethylene container result in its cost being greater than the disposable pouch in the half-gallon size.

Only three half-pint container styles were analyzed with respect to cost. The half-pint pouch is less costly than either the standard or small cross-sectional paperboard (Table 11). The small cross-sectional paperboard container is less costly than the standard cross-sectional half pint but is still 38 percent more costly than the pouch.

Table 10. Costs of packaging milk in alternative half-gallon containers.

Item	Paper-board	Plastic pouch	Returnable glass 25 trip	Returnable glass 50 trip	Returnable polyethylene 25 trip	Returnable polyethylene 50 trip
	cents per half gallon					
Packaging material ...	4.300	2.081	3.130	1.983	3.050	1.960
Depreciation, interest, and repairs:						
Filling and casing	0.228	0.153	0.129	0.129	0.129	0.129
Washing	--	--	0.107	0.107	0.136	0.136
Labor and benefits:						
Filling	0.128	0.121	0.239	0.239	0.239	0.239
Washing	--	--	0.239	0.239	0.239	0.239
Utilities and supplies:						
Filling	0.042	0.009	0.008	0.008	0.008	0.008
Washing	--	--	0.198	0.198	0.201	0.201
Added distribution cost	--	--	0.450	0.450	--	--
Total cost per gallon	4.698	2.364	4.500	3.353	4.002	2.912

Table 11. Costs of packaging milk in alternative half-pint containers.

Item	Paperboard		Plastic pouch
	Standard	Small cross-sectional	
	---------- cents per half pint ----------		
Container	1.220	1.095	0.737
Depreciation, interest, and repairs	0.179	0.180	0.169
Labor and benefits	0.094	0.094	0.089
Utilities	0.019	0.018	0.007
Total	1.512	1.387	1.002

To summarize, this analysis shows substantial cost advantages of returnable containers—especially polyethylene—over disposable paperboard or disposable plastic jugs in the gallon and half-gallon sizes. For half-gallon or half-pint packaging, the plastic pouch has a cost advantage over other containers. It is perhaps surprising that the pouch has not been widely introduced in Minnesota, given its apparent advantage in terms of cost.

The disposable plastic jug was analyzed only in the gallon size and on the assumption that the jug is purchased rather than blown by the bottling firm. Under these assumptions, the disposable plastic jug is the most costly gallon container.

An interesting finding from the packaging cost analysis is that total packaging cost per gallon of milk in half-gallon paperboard or plastic pouch containers is lower than for milk packaged in gallon containers. For paperboard, packaging costs are 9.4 cents per gallon in half gallon and 10.1 cents per gallon in gallon containers. For the pouch, the cost is 4.8 cents per gallon in half gallon and 7.8 cents per gallon in the gallon size. In other words, there are diseconomies of size in packaging beyond the half-gallon size. This occurs for paperboard because of the additional cost of a handle and the equipment cost for attaching the handle to gallon containers. For the pouch, it occurs because the gallon packaging requires an additional plastic overwrap.

OTHER FACTORS INFLUENCING SELECTION OF MILK PACKAGING

Costs of packaging and distribution are not the only considerations in selection of milk packaging systems. The following briefly considers some additional factors.

Health and Nutrition Considerations

Midwest Research Institute (MRI) analyzed alternative milk containers with respect to implications for health and nutrition. We do not presume to analyze these problems, rather to cite factors that have been analyzed by others. MRI identified several areas of concern regarding health and nutrition implications. 6/

(1) Absorption of chemical compounds by the returnable polyethylene container.

(2) The possibility of bacterial contamination of milk stored in paperboard containers.

(3) Potential injuries to dairy employees and consumers from breakage of glass containers.

(4) The loss of nutrients.

Absorption of Compounds by Polyethylene. A problem from a public health perspective is absorption of toxic chemicals by the returnable plastic container. Absorption of toxic chemicals occurs if consumers store chemicals in the containers prior to return. The firms which manufacture the polyethylene container have developed a sensing device which detects dangerous amounts of volatile organic compounds in the container and renders the container unusable. This device is required for use with returnable polyethylene containers and was included in the polyethylene packaging systems designed above. However, the MRI study notes: 7/

> ...evidence does point to a number of other organic contaminants whose level of ionization is much lower than the typical volatile hydrocarbons for which the polytrip system is calibrated. Included in this

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6/ Midwest Research Institute, Resource and Environmental Profile Analysis of Five Milk Container Systems, with Selected Health and Economic Considerations, Volume II, MRI Project No. 4003-D, June 18, 1976. Report prepared for the Environmental Protection Agency, Office of Solid Waste Management Programs, Washington, D.C. (Referenced with permission of MRI.)

7/ Ibid., p. 34.

> category are chemicals, such as formaldehyde, and various pesticides, such as malathion, lindane, and DDT. While the potential for contamination of milk through contact with containers used for storage of chemicals does exist, the actual threat to human health represented in each case is unknown at this time.

The "sniffer" does not detect nonhydrocarbon chemicals or certain pesticides. But, most contaminants likely to be stored in the polyethylene container are either hydrocarbons themselves or are emulsified in a hydrocarbon carrier and would, therefore, be detected. 8/

Wicking. The possibility of contamination of milk stored in paperboard containers through wicking has reportedly been eliminated by sanitation guidelines of the U.S. Public Health Service and FDA regulations applicable to paperboard cartons. Wicking, which can lead to bacterial contamination, occurs when contact at the raw or cut edge of paperboard with milk enables microorganisms to migrate into the milk. MRI concludes that the wicking phenomenon "...is not in fact a public health concern." 9/

Glass Breakage. Data on injuries to consumers and dairy employees resulting from glass breakage were not available. However, several local dairy managers cited injuries and other factors related to glass breakage as a factor in their decisions to switch to paperboard containers from glass.

Nutrition. The loss of riboflavin, supplemental vitamin A, and ascorbic acid as a result of exposure of milk to light can significantly reduce the nutritional value of milk. This problem may be significant for milk packaged in transparent glass or plastic containers. Retention of nutrients after exposure to light is greatest for milk packaged in printed paperboard containers. 10/ Application of dark inks or laminates to the plastic containers resulted in better retention of nutrients in milk.

Resource and Environmental Considerations

Milk containers differ substantially with respect to the quantity of resources and energy required for their manufacture and use and their impacts in terms of pollution and waste. The resources consumed

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8/ This is the position of the container manufacturers and is supported by the Food and Drug Administration. See MRI, op. cit., pp. 29-31.

9/ Ibid., p. 35.

10/ Ibid., p. 63.

and pollutants emitted by the dairy itself constitute only a fraction of the total resources used and pollutants emitted as a result of bottling milk. Significant quantities of resources are consumed and pollutants emitted in processes which occur before and after bottling, such as mining, container manufacturing, container transportation, and container disposal. In evaluating resource and environmental implications of alternative container systems, it is important to take account of both direct impacts incurred at the dairy and secondary impacts incurred in other processes related to container use. Using data compiled by MRI, the total resource and environmental impacts—direct and secondary—can be compared for the different containers. 11/ The impact categories for which containers are evaluated are energy, wastewater volume, atmospheric emissions, waterborne wastes, and postconsumer solid waste.

Impacts cited are direct and indirect impacts from delivering 1,000 gallons of milk in the indicated container.

Energy. Energy requirements for 1,000 gallons of milk delivered in alternative containers are summarized in Table 12. The data demonstrate the advantages of returnable systems with respect to total energy requirements. The energy required to deliver 1,000 gallons in returnable polyethylene containers is only 18 to 31 percent of the energy required to deliver 1,000 gallons in paperboard, and only 18 to 22 percent of the energy required to deliver 1,000 gallons in plastic, nonreturnable containers. Glass containers require only slightly more energy than returnable polyethylene containers. Of the disposable containers analyzed, the plastic pouch requires the least amount of energy—only 26 to 42 percent of the amount required by the other disposable containers. The half-gallon pouch requires less energy than either returnable container when trip rates are less than 30.

Wastewater Volume. The volume of wastewater released to the environment as a result of delivering 1,000 gallons of milk in alternative containers is shown in Table 13. The plastic pouch requires the least amount of wastewater, whereas the paperboard container requires the most. Disposable plastic containers compared favorably with returnable glass and returnable polyethylene containers in this impact category.

Atmospheric Emissions. Contaminants emitted to the atmosphere as a result of the production and utilization of milk containers consist mainly of particles, nitrogen oxide, sulfur oxides, hydrocarbons, and carbon monoxide. The disruption to the environment

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11/ MRI did not analyze impacts for 25-trip glass or polyethylene, nor for 50-trip, half-gallon glass containers. Impacts for these containers were interpolated with permission of MRI.

Table 12. Energy requirements for delivering 1,000 gallons of milk in alternative containers. a/

Container size and style	Energy requirements
	(million BTU's)
Gallon:	
Paperboard	8.59
Plastic pouch	3.59
Disposable plastic	8.62
25-trip glass	2.65
50-trip glass	2.00
25-trip polyethylene	1.90
50-trip polyethylene	1.55
Half gallon:	
Paperboard	9.00
Plastic pouch	2.37
25-trip glass	3.25
50-trip glass	2.40
25-trip polyethylene	2.80
50-trip polyethylene	2.20
Half pint:	
Paperboard	13.82
Plastic pouch	4.49

a/ Source of data: Midwest Research Institute, Environmental Profile Analysis of Five Milk Containers, Volume I, MRI Project 4003-D, June 18, 1976. Report prepared for the Environmental Protection Agency, Office of Solid Waste Management Programs, Washington, D.C. (Data for 25-trip glass and polyethylene and 50-trip half-gallon glass were interpolated with permission of MRI.)

Table 13. Volume of wastewater released to the environment as a result of delivering 1,000 gallons of milk in alternative containers. a/

Container size and style	Wastewater emitted
	(thousand gallons)
Gallon:	
Paperboard	2.87
Plastic pouch	0.32
Disposable plastic	0.65
25-trip glass	0.61
50-trip glass	0.51
25-trip polyethylene	0.47
50-trip polyethylene	0.44
Half-gallon:	
Paperboard	3.07
Plastic pouch	0.21
25-trip glass	0.73
50-trip glass	0.61
25-trip polyethylene	0.88
50-trip polyethylene	0.82
Half pint:	
Paperboard	4.51
Plastic pouch	0.52

a/ Source of data: Midwest Research Institute, Environmental Profile Analysis of Five Milk Containers, Volume I, MRI Project 4003-D, June 18, 1976. Report prepared for the Environmental Protection Agency, Office of Solid Waste Management Programs, Washington, D.C. (Data for 25-trip glass and polyethylene and 50-trip half-gallon glass containers were interpolated with permission of MRI.)

caused by these atmospheric emissions depends upon the sensitivity of the environment in which they are emitted, whether contaminants accumulate or are dispersed, whether there are synergistic impacts, and on the volume and rate of emissions. Estimates of the quantity of atmospheric pollutants emitted as a result of delivering 1,000 gallons of milk in alternative containers are shown in Table 14. The disposable paperboard and disposable plastic containers contribute considerably more atmospheric emissions than the other containers. The gallon container which requires the least atmospheric emissions is the returnable polyethylene container. The disposable pouch container generates substantially less atmospheric emissions than other disposable containers and in the half-gallon size actually contributes fewer atmospheric emissions than either refillable container.

Table 14. Volume of atmospheric emissions released as a result of delivering 1,000 gallons of milk in alternative containers. a/

Container size and style	Pounds of emissions
Gallon:	
Paperboard	25.70
Plastic pouch	14.02
Disposable plastic	29.25
25-trip glass	14.49
50-trip glass	11.56
25-trip polyethylene	10.25
50-trip polyethylene	8.77
Half gallon:	
Paperboard	26.32
Plastic pouch	10.64
25-trip glass	17.74
50-trip glass	14.15
25-trip polyethylene	13.20
50-trip polyethylene	10.77
Half pint:	
Paperboard	37.99
Plastic pouch	15.13

a/ Source of data: Midwest Research Institute, Environmental Profile Analysis of Five Milk Containers, Vol. I, MRI Project 4003-D, June 18, 1976. Report prepared for the Environmental Protection Agency, Office of Solid Waste Management Programs, Washington, D.C. (Data for 25-trip glass and polyethylene and 50-trip half-gallon glass containers were interpolated with permission of MRI.)

Waterborne Wastes. Waterborne wastes emitted as a result of delivering 1,000 gallons of milk are summarized in Table 15. Dissolved solids, BOD, and suspended solids constitute the major portion of waterborne waste. Returnable containers have no advantage over disposable plastic or plastic pouches in this impact category because of the wastewater emitted in bottle washing. Paperboard containers contribute the greatest quantity of waterborne wastes. The least offensive container in terms of waterborne wastes is the plastic pouch container, generating only 17-48 percent of the waterborne wastes of other containers.

Table 15. Waterborne wastes emitted as a result of delivering 1,000 gallons of milk in alternative containers. a/

Container size and style	Pounds of waterborne waste
Gallon:	
Paperboard	6.22
Plastic pouch	1.51
Disposable plastic	3.04
25-trip glass	3.53
50-trip glass	3.16
25-trip polyethylene	3.35
50-trip polyethylene	3.24
Half gallon:	
Paperboard	6.45
Plastic pouch	1.19
25-trip glass	3.90
50-trip glass	3.50
25-trip polyethylene	3.69
50-trip polyethylene	3.48
Half pint:	
Paperboard	9.59
Plastic pouch	1.70

a/ Source of data: Midwest Research Institute, Environmental Profile Analysis of Five Milk Containers, Vol. I, MRI Project 4003-D, June 18, 1976. Report prepared for the Environmental Protection Agency, Office of Solid Waste Management Programs, Washington, D.C. (Data for 25-trip glass and polyethylene and 50-trip half-gallon glass containers were interpolated with permission of MRI.)

Postconsumer Solid Waste. The volume of postconsumer solid waste generated as a result of delivering 1,000 gallons of milk is presented in Table 16. In this impact category, there is a clear advantage of returnable containers over paperboard or disposable plastic. The paperboard gallon requires 39 times the landfill area required by the 50-trip polyethylene gallon, and the disposable plastic jug requires 32 times the landfill space. The plastic pouch requires less landfill space in the half-gallon and half-pint sizes than either returnable container and is clearly superior to other disposable containers in this impact category.

Table 16. Volume of postconsumer solid waste generated as a result of delivering 1,000 gallons of milk in alternative containers. a/

Container size and style	Cubic feet of solid waste
Gallon:	
Paperboard	17.72
Plastic pouch	1.51
Disposable plastic	14.55
25-trip glass	4.53
50-trip glass	2.10
25-trip polyethylene	1.02
50-trip polyethylene	0.45
Half gallon:	
Paperboard	18.07
Plastic pouch	0.58
25-trip glass	4.91
50-trip glass	2.28
25-trip polyethylene	1.15
50-trip polyethylene	0.66
Half pint:	
Paperboard	20.97
Plastic pouch	1.37

a/ Source of data: Midwest Research Institute, Environmental Profile Analysis of Five Milk Containers, Vol. I, MRI Project 4003-D, June 18, 1976. Report prepared for the Environmental Protection Agency, Office of Solid Waste Management Programs, Washington, D.C. (Data for 25-trip glass and polyethylene and 50-trip half-gallon glass containers were interpolated with permission of MRI.)

Actual charges for milk carton disposal for households are difficult to measure because waste disposal charges are for all household wastes, and charges are not usually based on volume of waste. However, for schools and other institutions, disposal costs may be based on volume. According to a local refuse hauling firm, the current cost of waste removal for institutions is \$1.50 per cubic yard. Based on the data on postconsumer solid waste presented above, schools would be required to pay \$1.165 per thousand paperboard containers removed but only \$.076 per thousand pouches in the half-pint size. There is certainly a cost advantage to schools in purchasing the pouch rather than the paperboard half pints.

Marketability of Milk Packaged in Alternative Containers

From the dairy manager's perspective, it does no good whatsoever to package milk in an environmentally advantageous, inexpensive container unless consumers and retailers are prepared to accept the container. Through interviews with milk processors and retail food store managers, characteristics of milk containers which bear on marketability of the product were identified. These characteristics include convenience, effect on flavor, sanitation, appearance, and disposal cost.

Convenience. From a marketing perspective, perhaps the most important characteristic of disposable containers is that they are disposable--they need not be returned for a deposit. Returning milk bottles is viewed as an inconvenience by many consumers. And since a deposit is frequently charged for returnables, there is the added inconvenience of a \$.50 to \$1.00 outlay per container at the time the initial purchase is made. Several local dairy managers cited the deposit as a factor in consumer rejection of returnable polyethylene containers.

Although no data were available on costs to food retailers incurred in handling returnables and refunding deposits, many local food store managers voiced dissatisfaction with returnables because of additional storage requirements and inconvenience and cost of handling returnables, charging deposits, and making refunds.

A major disadvantage of the plastic pouch is that the package, other than the half-pint consumer package, cannot be used by itself for milk dispensing. The half-gallon pouch must be placed in a rigid container for dispensing. The half-pint pouch requires a straw. Lack of rigidity may make the pouch more difficult to handle than other containers.

Flavor. The impacts of container style on flavor are fairly well-known, but very little is known about the impact of flavor on consumer purchasing habits. Many factors other than container style influence milk flavor, including length and method of storing, method of processing, and others. Here, we mention only the effects of container style on flavor. There are two ways in which container style influence the flavor of milk: through light absorption and through absorption of chemicals and fats. Returnable polyethylene containers may absorb nontoxic chemicals and fats or may absorb compounds at levels below the tolerance limits set by the FDA. This may not pose a public health threat but may affect flavor and odor changes in milk. Absorption by polyethylene containers increases with the number of times the container is reused, so this problem increases with trip rate. 12/

Flavor and odor changes resulting from exposure of containers to light are most important for clear containers, such as glass, polyethylene, disposable plastic, and the plastic pouch. This problem is reduced for paperboard containers which have dark ink labels. Application of laminates or dyes or use of tinted glass or plastics could reduce flavor and odor changes caused by exposure to light in other containers. 13/

Sanitation. Sanitation was cited by several food store managers as a problem with returnable containers. If milk is not rinsed from the container after use by consumers, the containers may develop a sour odor and may attract insects.

Container leakage also posed a sanitation problem for food retailers. Processors report leakage more likely with paperboard containers than with other containers.

Appearance. Several milk plant managers thought milk visibility was a major advantage of glass, plastic, and polyethylene containers. Milk visibility would also be a factor for clear pouches.

After many uses, returnable glass and polyethylene containers may be scarred, scratched, or chipped. In addition, mold or dried milk may be retained in returnable containers after washing. Though no health threat is posed by retention of these nuisance items in returnable containers, they certainly detract from the product's appearance.

The impact of the plastic pouch on consumer acceptability is uncertain. Since most consumers in Minnesota have never had experience with disposable pouches, the unconventional appearance of the pouch would probably necessitate a period of "getting used to" if this container were introduced on a broad scale.

12/ Midwest Research Institute, op. cit., Vol. II, p. 32.
13/ Ibid., p. 49.

SUMMARY

In this report, we analyzed the costs and considerations for different types of milk packaging. The State of Minnesota recently passed legislation (which has subsequently been declared unconstitutional) banning the sale of milk in rigid, disposable plastic containers. The principal rationale for the restriction was the disposal problem of plastic containers. Comparison of packaging costs for the various container types (package cost, labor, and other costs of operating the packaging equipment and extra delivery costs, if necessary) shows the disposable plastic gallon jug to be the most costly container, 11.1 cents per gallon. The least costly disposable gallon container is the plastic pouch, 7.8 cents per gallon. The plastic pouch has not been widely marketed in Minnesota. Reusable containers, however, are the least costly form of packaging in the gallon size. Costs for returnables vary according to the average number of trips per container. The packaging cost of a 50-trip polyethylene package is estimated at 3.1 cents per gallon, about one third the cost of the disposable plastic jug.

In the half-gallon and half-pint sizes, the disposable pouch is the least costly package, 2.4 cents for the half gallon and 1.0 cents for the half pint. However, half-gallon returnable polyethylene containers were nearly as inexpensive, 2.9 cents per half gallon for the 50-trip container. The half-gallon pouch does require use of a rigid container for dispensing by the consumer. Paperboard half-gallon packaging is the most expensive of those analyzed, 4.7 cents per half gallon.

In addition to costs of milk packaging systems, there are several other important considerations in selection of a system. We reviewed some of the impacts on health and nutrition, resource use, environmental quality, and marketability. A potential health problem of the returnable polyethylene container is its potential for absorption of toxic compounds that may come in contact with the container. A hydrocarbon detector, required for use with packaging systems for returnable polyethylene containers, greatly reduces the risk. But, the possibility of milk contamination through nonhydrocarbon compounds remains a risk.

Comparison of milk containers with respect to resource and environmental impacts demonstrates substantial advantages of refillable containers over both paperboard and nonrefillable plastic. Of the disposable containers analyzed, the plastic pouch is the least environmentally disruptive in the impact categories studied. In nearly every impact category, the plastic pouch and refillable polyethylene containers showed smaller adverse impacts than the other milk containers. Resource and environmental impacts of returnable milk containers depend critically on the number of times the container is used. If trip rates for glass or polyethylene containers could be increased beyond 50 trips per container, even greater environmental advantages could be realized by a shift to returnable containers.

Each container has advantages and disadvantages in terms of marketability. The convenience of disposable paperboard and rigid plastic jugs to consumers and retailers may reduce the ability of processing firms to successfully market milk in returnable containers. Although less costly to package, the disposable pouch is handicapped by the need to use another rigid container for dispensing.

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