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Costs and Impacts of Alternative Milk Packaging Systems

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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.

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 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]		Nonreturnable plastic [d]	Returnable plastic [e]	
			25 trip	50 trip		25 trip	50 trip
	cost in dollars per thousand						
Container	$84.25	$41.62	$29.39	$14.70	$90.00	$25.60	$12.80
Handle, style ...	9.34	NA	4.62	2.31	NA	NA	NA
Cap of 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]		Returnable plastic [d]	
			25 trip	50 trip	25 trip	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

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

Item	Paper-board	Plastic pouch	Returnable glass		Returnable polyethylene	
			25 trip	50 trip	25 trip	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

> 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.

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.)

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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Clover Leaf Creamery, 420 W. Broadway, Minneapolis, Minnesota.

Continental Equipment Corporation, 6103 No. 76th St., Milwaukee, Wisconsin.

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Ex-Cell-O Corporation, Packaging Systems Group, 10212 Xerxes Ave. So., Bloomington, Minnesota.

Fogg Filler Corporation, 37 Van Dyke Ave., Holland, Missouri.

Graham Polytrip Company, 1420 6th Ave., York, Pennsylvania.

International Paper Company, 6100 Olsen Memorial Highway, Minneapolis, Minnesota.

Land O'Lakes, Inc., 415 Grove St., St. Paul, Minnesota.

Pitcher Pak Corporation, 67 Cummings Park, Woburn, Massachusetts.

Smith-Lee Company, 537 Fitch St., Oneida, New York.

Superior Dairy Fresh Company, 2112 N.E. Broadway, Minneapolis, Minnesota.

Tapemark Company, 223 Marie Avenue E., W. St. Paul, Minnesota.

Winscott Glass Company, Box 1, Clarion, Pennsylvania.