NEW SHIPPING CONTAINERS FOR FRESH WESTERN CHERRIES–

Costs, Performance, and Trade Acceptance

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NEW SHIPPING CONTAINERS FOR FRESH WESTERN CHERRIES— Costs, Performance, and Trade Acceptance

By Robert Tom Hinsch and James B. Fountain, *agricultural economists*, and Roger E. Rij, *agricultural marketing specialist*, Transportation and Facilities Research Division, Agricultural Research Service

Summary

Fiberboard and expanded polystyrene foam boxes that were test marketed in 1969 need some changes in design before they are used to market fresh western cherries, but they offer promise of reducing the costs of packing and shipping cherries. In this study, the costs of packaging and palletizing materials, direct labor to pack and palletize, and charges for air transport to ship 18 pounds of California cherries from San Francisco to New York were $2.71 for cherries shipped in wood boxes, $2.42 for those in fiberboard boxes, and $2.44 for those in polystyrene foam boxes. These costs for shipping 20 pounds of Washington cherries by rail from the Yakima area to eastern, western, midwestern, and southern markets were $1.28 for the wood box and $1.11 for both the fiberboard box and the polystyrene foam box. The lower cost of packaging materials and the reduced tare weight, which resulted in lower transport charges, were the principal factors accounting for the lower costs of using fiberboard and polystyrene boxes.

In the air and rail shipments, 11.1 percent of the cherries were bruised in the wood box, 16.4 percent were bruised in the fiberboard box, and 8.4 percent were bruised in the expanded polystyrene foam box on arrival at eastern and midwestern markets.

It required 24 hours for cherries packed in fiberboard boxes to cool from 72° F. to 56°, 13 hours for cherries packed in wood boxes, and 9 hours for cherries packed in polystyrene foam boxes.

If 25 percent of the western cherry crop were shipped by airfreight and 75 percent by rail, about $530,000 could be saved annually if the cherries were packed in either fiberboard boxes or in polystyrene boxes instead of in wood boxes.

Introduction

Approximately three-fourths of the sweet cherry crop sold fresh in the United States is produced in California, Washington, and Oregon.[1] The jumble-filled wood box has been the most commonly used container for shipping fresh cherries to market since 1960. Traditionally, California has packed this box with 18 pounds of cherries and Washington and Oregon have packed it with 20 pounds of cherries. The Washington and Oregon cherry industry uses a polyethylene box liner to extend the market life of their cherries.

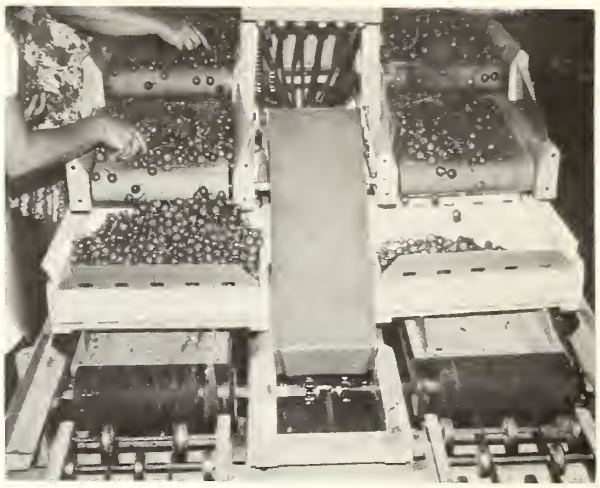
Research results published in 1960 on the feasibility of jumble-packing fresh cherries in 20-pound wood boxes showed that this method (fig. 1) resulted in less damage to cherries on arrival at terminal markets and that it was less costly than double-row-facing cherries in 15-pound wood boxes.[2]

[1] Agricultural Statistics 1969, p. 220, U.S. Department of Agriculture.

[2] Fountain, J. B., and Chapogas, P. G. evaluation of shipping containers for washington cherries. U.S. Dept. Agr. Market. Res. Rpt. 426, 26 pp. 1960.

Rising costs of wood boxes prompted cherry growers to request research on the feasibility of using other types of shipping containers for fresh western cherries. Research on shipping containers for fresh table grapes has shown that it is less costly to market them in fiberboard boxes and in expanded polystyrene foam boxes than in wood boxes.[3]

The purpose of this study was to find out (1) how much the cost of marketing fresh western cherries by air and by rail could be reduced if they were packed and shipped in fiberboard and polystyrene foam boxes instead of in wood boxes and (2) whether the injury to cherries would be greater or less by packing them in fiberboard boxes and in polystyrene foam boxes than by packing them in wood boxes.



BN–37335

FIGURE 1.—Loose-packing fresh cherries in wood boxes.

Description of containers and pallets

The jumble-packed cherry shipping containers tested were wood boxes, two types of fiberboard boxes, and expanded polystyrene foam boxes. The pallets and stacking patterns for these boxes were different for the experimental air shipments than for the experimental rail shipments. For the Washington and Oregon rail shipments, a 1¼ mil polyethylene film bag liner was used.

Wood box

A six-piece nailed wood box with a one-piece chipboard liner was used (fig. 2 and table 1). For the California air shipments, tissue paper was placed on top of the packed box before closing. Sixty wood boxes were stacked on a 35- by 42-inch disposable pallet having a four-way entry. Six boxes were stacked per layer (fig. 3). Two veneer corner protectors ("V" boards) were used on the top layer of boxes, and five nylon straps were placed vertically around the pallet (fig. 4). For the Washington and Oregon rail shipments, a chipboard pad was used. Fifty-four wood boxes were stacked on a 44- by 33-inch disposable pallet having a four-way entry, with six boxes stacked per layer. "V" boards were used, and the pallets were strapped like those for the air shipments.

Fiberboard box

Two types of two-piece printed fiberboard boxes were tested (fig. 2 and table 1). These boxes did not require accessory packaging materials.

The box tested for air shipments from California (box A) was a part-telescope box with seven ventilation slots in each side of the body. It was constructed of 250-pound Mullen test board. The body of the box was curtain coated inside with wax and had a wax-impregnated medium. The outside of the body was untreated. Both the inside and the outside of the cover were curtain coated with wax. These boxes were assembled manually without staples or glue. Sixty boxes were stacked on a 35- by 42-inch disposable wood pallet having a four-way entry. Six boxes were stacked per layer. Four veneer corner protectors were used on the top layer of boxes, and five nylon straps were placed vertically around the pallet.

The box tested for rail shipments from Washington and Oregon (box B) was a full-telescope box without ventilation slots. The cover was made from 250-pound Mullen test board, and the body was made from 275-pound Mullen test board.

[3] HINSCH, R. T., and RIJ, R. E. FEASIBILITY OF SHIPPING CALIFORNIA TABLE GRAPES IN FIBERBOARD AND POLYSTYRENE FOAM BOXES AND IN POLYETHYLENE MESH BAGS. U.S. Dept. Agr. Market. Res. Rpt. 871, 12 pp. 1970.

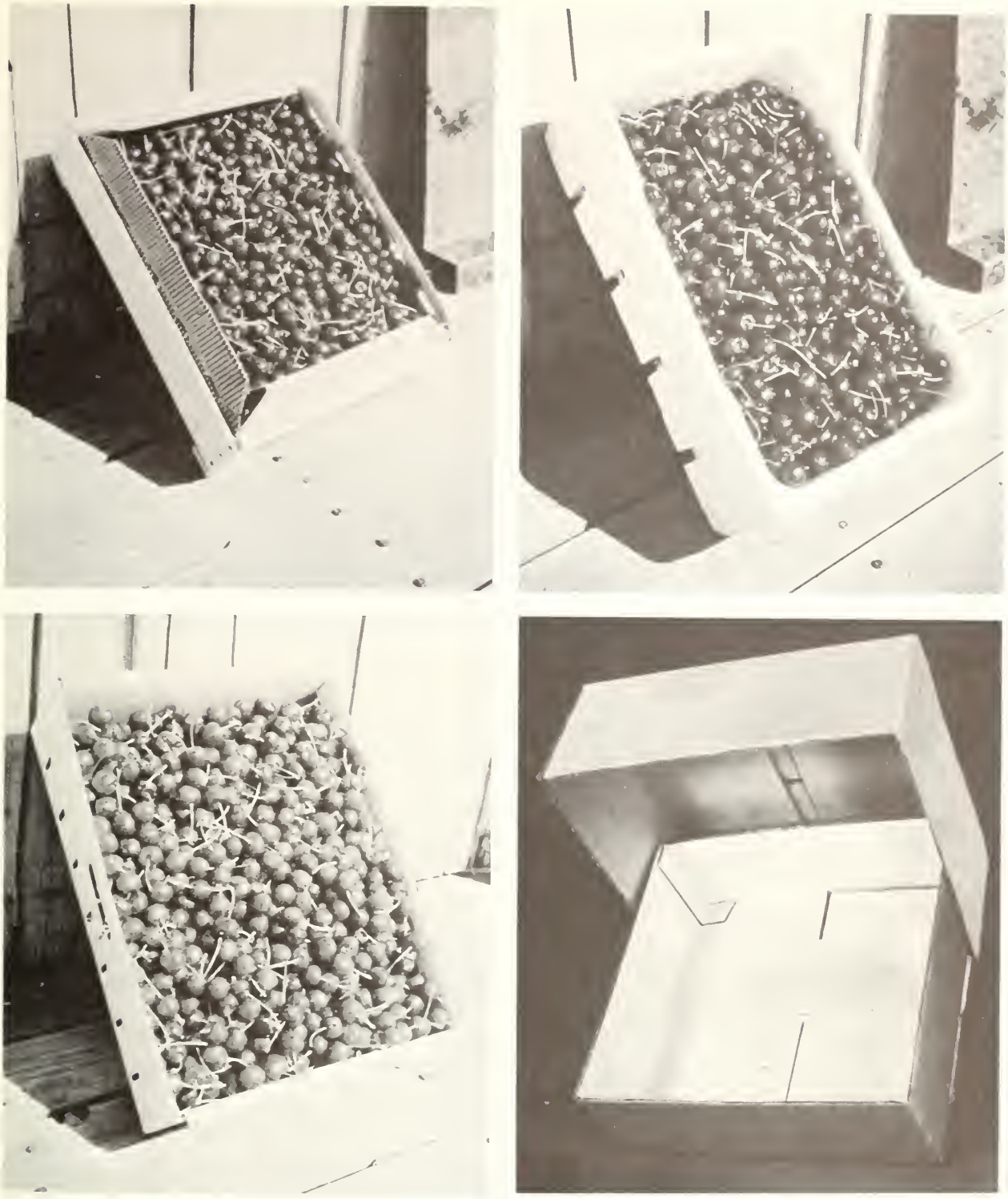


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FIGURE 2.—Types of loose-pack boxes for shipping fresh western cherries: *Top left*, wood box; *top right*, polystyrene box; *lower left*, ventilated fiberboard box (box A); *lower right*, nonventilated fiberboard box (box B).

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FIGURE 3.—Wood, polystyrene, and fiberboard boxes palletized and loaded in an airline cargo container.

The corrugated medium of the body was wax impregnated. These boxes were assembled by either stapling or gluing. Fifty-four boxes were stacked on a 46- by 31-inch disposable pallet having a four-way entry. Six boxes were stacked per layer. Four veneer corner protectors were used on the top layer of boxes, and five nylon straps were placed vertically around the pallet.

Expanded polystyrene foam box

The molded expanded polystyrene foam box tested had a density of 1.75 pounds of foam per cubic foot. The boxes were delivered to the packinghouse prefabricated. The cover was fiberboard curtain coated with wax (fig. 2 and table 1). Four ventilation slots were molded in each side and two were molded in each end of the box. Accessory packaging materials were not used in this box. For the air shipments, 48 boxes were stacked on a 36- by 40-inch disposable pallet having a four-way entry (fig. 3). Six boxes were stacked per layer. Four veneer corner protectors were used on the top layer of boxes, and five nylon straps were placed vertically around the pallet. For the rail shipments, 80 boxes were stacked on a 48- by 40-inch disposable pallet having a four-way entry. Eight boxes were stacked per layer.

Hereafter, the expanded polystyrene foam boxes will be referred to as polystyrene boxes.

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FIGURE 4.—Strapping palletized wood boxes for shipment.

TABLE 1.—*Tare weight, outside and inside dimensions, volume, and capacity of wood boxes, fiberboard boxes, and polystyrene foam boxes; dimensions of pallets; and boxes of cherries stacked on pallets shipped by air from California and by rail from Washington and Oregon, 1969*

Item	Wood boxes		Fiberboard boxes		Polystyrene foam boxes	
	California	Washington and Oregon	Box A, California	Box B, Washington and Oregon	California	Washington and Oregon
Net weight of cherries--pounds	18	20	18	20	18	20
Tare weight--pounds	3.25	3.25	1.50	2.00	.75	.75
Outside dimensions--inches	17½×14×5	16½×14×5½	17½×13⅝×4¼	15¼×14¼×5¾	19½×11 13/16×6¼	19½×11 13/16×6¼
Volume--cubic inches	1,225.0	1,270.5	1,013.4	1,249.5	1,439.6	1,439.6
Inside dimensions--inches	16¼×13½×3¾	15⅝×13½×4½	16⅛×12⅜×4	14½×13¼×4⅜	17½×10½×5⅞	17½×10½×5⅞
Capacity--cubic inches	822.7	934.0	798.2	912.6	1,079.5	1,079.5
Palletization:						
Pallet size--inches	35×42	44×33	35×42	46×31	36×40	48×40
Boxes per pallet--number	60	54	60	54	48	80

Procedure

Five experimental air shipments were made from California, and four experimental surface shipments were made from Washington and Oregon. In California the cherries were packed in 18-pound boxes and in Washington and Oregon, in 20-pound boxes. After packing, the boxes were stacked on pallets. In California, 60 wood or fiberboard boxes or 48 polystyrene boxes were stacked on each pallet. It was necessary to stack fewer polystyrene boxes than wood or fiberboard boxes on a pallet to permit the pallet unit to fit in an airline cargo container. In Washington and Oregon, 54 wood or fiberboard boxes or 80 polystyrene boxes were stacked on each pallet. It was necessary to stack more polystyrene boxes on a pallet than wood or fiberboard boxes to meet minimum rail freight rates.

Packaging materials costs were obtained from manufacturers and suppliers in California, Washington and Oregon. These costs were averaged and were based on price per thousand units for carlot orders.

Direct labor costs for packing were averaged from data obtained in time studies in five California, Washington, and Oregon cherry packinghouses. A $2-per-hour wage rate was used to calculate labor costs.

Palletizing costs were based on 18-pound packs for California air shipments and on 20-pound packs for Washington and Oregon rail shipments.

Air transport charges were determined by calculating airfreight charges for shipping 18 pounds of cherries in each type of container on pallets from San Francisco to New York in airline cargo containers. Surface transport charges were determined by calculating rail and refrigeration charges for shipping 20 pounds of cherries in each type of container on pallets from Yakima Valley points to the cities included in the U.S. Department of Agriculture market news reports of unloads of fruits and vegetables in eastern, western, midwestern, and southern areas of the United States.[4] The calculated average transport charges to each of these four areas were weighted by the relative quantities of cherries shipped to each area.

Costs of equipment, receiving, precooling, storage, supervision, sales, and overhead were not included in this study.

Container damage, arrival condition of the cherries, and trade reaction data were collected on the following experimental shipments: Five palletized airfreight shipments of California Bing cherries, 11½-row size, shipped from the Stockton-Lodi area; two palletized piggyback

[4] UNITED STATES DEPARTMENT OF AGRICULTURE, CONSUMER AND MARKETING SERVICE, FRUIT AND VEGETABLE DIVISION, MARKET NEWS BRANCH. FRESH FRUIT AND VEGETABLE UNLOADS, CALENDAR YEAR 1968—EASTERN, 143 pp., WESTERN, 63 pp., MIDWESTERN, 135 pp., and SOUTHERN, 102 pp., CITIES—March/April 1969, Washington, D.C.

shipments of Washington Bing cherries, 12-row size and larger, shipped from the Yakima area; and two palletized rail shipments of Oregon Lambert cherries, 12-row size and larger, shipped from the Hood River area. The airfreight shipments were not refrigerated. All surface shipments were made in mechanically refrigerated vehicles. Fruit from the same lot was used in each shipment. Nine sample boxes of fruit (three boxes each from the top, middle, and bottom layers of each pallet) were inspected upon arrival in the terminal markets and the amount of bruised, punctured, and cut cherries was observed and recorded by packaging researchers. Bruising and stem punctures were recorded in three categories—slight, damage, and serious, based upon definitions of defects in the U.S. Standards for Sweet Cherries (CFR 7, sec. 51.2655). Analysis of variance was used to determine the statistical significance of the data.

All cherries were cooled in the boxes after they were packed but before they were shipped. The cooling rates for cherries packed in the wood, fiberboard, and polystyrene boxes were determined by placing Ryan recording thermometers in one packed cherry box of each type and placing this box in the center of the pallet. These recording thermometers remained in the cherry boxes until arrival at eastern and midwestern markets. The cooling study was replicated for three air shipments, two piggyback shipments, and two rail shipments.

Costs and charges

Materials and direct labor costs

The costs of packaging and palletizing materials and packing and palletizing labor for 18 pounds of California cherries were 63.8 cents for the wood box, 48.8 cents for the fiberboard box, and 56.8 cents for the polystyrene box (table 2). These costs for 20 pounds of Washington and Oregon cherries were 64.9 cents for the wood box, 49.9 cents for the fiberboard box, and 53.6 cents for the polystyrene box. The cost of packaging material was the principal factor accounting for the difference in costs of the three types of containers.

Palletizing materials and labor for the air shipments were higher for the polystyrene boxes than for the other two types of containers, because there were only 48 polystyrene boxes per pallet unit and 60 fiberboard and wood boxes per pallet unit. However, these costs were lowest for the polystyrene boxes shipped by rail, because there were 80 polystyrene boxes per pallet unit and only 54 wood or fiberboard boxes per pallet unit.

Transport charges

Air

Air transport charges, per box, for 18 pounds of fresh cherries were $1.93 when shipped in fiberboard boxes, $1.87 in polystyrene boxes, and $2.07 in wood boxes (table 3). The lower costs for the fiberboard and polystyrene boxes were due to the lighter weight of the containers.

Rail

Rail transport charges, per box, for 20-pounds of fresh cherries were 60.7 cents when shipped in fiberboard boxes, 57.4 cents in polystyrene boxes, and 63.4 cents in wood boxes (table 4). Lower costs for the fiberboard and polystyrene boxes were due to the lighter weight of the containers, and for the polystyrene boxes, to a lower per-box charge for refrigeration because of the increased number of boxes loaded in railcars.

Total costs and charges

The costs of packaging and palletizing material, packing and palletizing labor, and air transport charges for 18 pounds of California cherries were $2.71 for the wood box, $2.42 for the fiberboard box, and $2.44 for the polystyrene box (table 5). The costs of packaging and palletizing material, packing and palletizing labor, and rail transport charges for 20 pounds of Washington cherries were $1.28 for the wood box, $1.11 for the fiberboard box, and $1.11 for the polystyrene box.

Lower packaging material cost and less tare weight, which resulted in lower transport costs, were the principal factors accounting for the lower costs of marketing cherries in fiberboard and polystyrene boxes in comparison with the costs of marketing them in wood boxes.

TABLE 2.—*Costs, cents, of packaging materials, palletizing materials, and direct labor to pack and palletize fresh western cherries, for air and rail shipments, by type of container, 1969* [1]

Item	Air shipments (18-pound boxes)			Rail shipments (20-pound boxes)		
	Wood box	Fiberboard box	Polystyrene box	Wood box	Fiberboard box	Polystyrene box
Packaging materials [2]	49.0	35.0	42.0	49.0	35.0	42.0
Direct labor to pack:						
Assemble and supply box	2.5	1.8	1.1	2.5	1.8	1.1
Fill box	1.8	1.8	1.8	2.0	2.0	2.0
Close box	1.5	.9	.9	1.5	.9	.9
Total	54.8	39.5	45.8	55.0	39.7	46.0
Palletizing: [3]						
Materials	6.7	7.0	8.5	7.4	7.7	5.6
Direct labor	2.3	2.3	2.5	2.5	2.5	2.0
Total	9.0	9.3	11.0	9.9	10.2	7.6
Total cost, per box of fruit	63.8	48.8	56.8	64.9	49.9	53.6

[1] These are direct costs only and do not include costs such as for supervision, overhead, fieldmen, insurance, sales, and equipment. Labor calculated at $2 per hour.

[2] Cost of shipping containers and, for the wood box, cost of chipboard liner and pads. Accessory packaging materials were not required for the fiberboard and polystyrene boxes. Cost of a 1¼-mil polyethylene film box liner would add 2.1 cents for each 20-pound box.

[3] Cost includes pallet, strapping materials, "V" boards, and labor to stack and strap boxes on pallet. For air shipments, 60 wood boxes, 60 fiberboard boxes, or 48 polystyrene boxes were stacked on each pallet. For surface shipments, 54 wood boxes, 54 fiberboard boxes, or 80 polystyrene boxes were stacked on each pallet.

TABLE 3.—*Air transport charges for 18 pounds of fresh cherries, by type of container, from Stockton, Calif., to New York, N.Y., 1969*

Item	Wood box [1]	Fiberboard box [2]	Polystyrene box [3]
Gross weight [4] ----------pounds----	1,295	1,190	920
Net weight ----------pounds----	1,080	1,080	864
Transport charges:			
Per pallet:			
Stockton to San Francisco------dollars----	15.00	15.00	12.00
San Francisco to New York [5]----dollars----	109.43	100.56	77.74
Per box:			
Stockton to San Francisco-------dollars----	.25	.25	.25
San Francisco to New York [5]----dollars----	1.82	1.68	1.62
Total per box----------dollars----	2.07	1.93	1.87

[1] 60 boxes on 35- by 42-inch pallet.
[2] 60 boxes on 35- by 42-inch pallet.
[3] 48 boxes on 36- by 40-inch pallet.
[4] Includes 20.25 pounds for pallet and strapping material, plus tare weight of container.
[5] Airfreight rate from San Francisco to New York based on 10,000-pound shipments.

TABLE 4.—*Railroad transport charges for 20 pounds of fresh cherries, by type of container, from Yakima Valley stations, Washington, to eastern, western, midwestern, and southern markets, 1969*

Item	Wood box	Fiberboard box	Polystyrene box
Gross weight [1] ----------pounds----	39,480	36,240	37,400
Net weight ----------pounds----	33,615	32,400	35,640
Transport charges: [2]			
Per car: [3]			
Eastern ----------dollars----	1,032.33	988.49	1,015.52
Western ----------dollars----	841.07	809.15	831.89
Midwestern ----------dollars----	1,009.38	965.87	992.81
Southern ----------dollars----	1,020.76	976.89	1,004.05
Per box:			
Eastern ----------cents----	63.7	61.0	57.7
Western ----------cents----	51.9	50.0	47.3
Midwestern ----------cents----	62.3	59.6	56.4
Southern ----------cents----	63.0	60.3	57.1
U.S. weighted average [4] ----cents----	63.4	60.7	57.4

[1] Calculated at 24 pounds for the wood box, 22 pounds for the fiberboard box, and 21 pounds for the polystyrene box. Pallet weight was calculated at 20 pounds. Boxes per car were calculated as follows: 1,620 wood boxes on thirty 44- by 33-inch pallets; 1,620 fiberboard boxes on thirty 46- by 31-inch pallets; and 1,760 polystyrene boxes on twenty-two 48- by 40-inch pallets. The boxes were placed in a medium-size mechanically refrigerated railcar with inside dimensions of 535 by 102 by 104 inches.

[2] Freight rates per pound and charges for standard refrigeration were calculated for each type of container to the following cities: (1) eastern—Albany, Baltimore, Boston, Buffalo, New York, Philadelphia, Pittsburgh, Providence, and Washington, D.C.; (2) western—Denver, Los Angeles, and San Francisco; (3) midwestern—Chicago, Cincinnati, Cleveland, Detroit, Indianapolis, Kansas City, Louisville, Milwaukee, Minneapolis, St. Louis, and Wichita; and (4) southern—Atlanta, Birmingham, Columbia, Dallas, Fort Worth, Houston, Memphis, Miami, Nashville, New Orleans, and San Antonio.

[3] Weighted average rates and charges per car for each of the 4 areas were based on the quantities of fresh cherries shipped to the above cities during 1968 as reported by the Market News Branch, Fruit and Vegetable Division, Consumer and Marketing Service, U.S. Department of Agriculture.

[4] Average transport charge for the United States was weighted by the quantity of fresh cherries shipped into each area.

TABLE 5.—*Costs, dollars, of packaging and palletizing materials, labor, and transport for fresh cherries, by type of container, 1969*

Item	Air shipments (18-pound boxes)			Rail shipments (20-pound boxes)		
	Wood box	Fiberboard box	Polystyrene box	Wood box	Fiberboard box	Polystyrene box
Packaging materials and labor---	0.55	0.40	0.46	0.55	0.40	0.46
Palletizing materials and labor---	.09	.09	.11	.10	.10	.08
Transport ----------	2.07	1.93	1.87	.63	.61	.57
Total per box of fruit --------	2.71	2.42	2.44	1.28	1.11	1.11

Bruising, stem punctures, and cuts

Air shipments

California cherries packed in wood, polystyrene, and fiberboard boxes and shipped by air-freight are shown on arrival at the New York market in figure 5.

Bruising was less for the cherries marketed in the polystyrene box than for those in the wood box and the fiberboard box (table 6). Of the cherries packed in the polystyrene box, slightly less than 7 percent were bruised; of the cherries

BN-37342

FIGURE 5.—California cherries packed in polystyrene boxes, fiberboard boxes, and wood boxes on arrival at the New York market.

in the wood box, slightly less than 11 percent were bruised; and of the cherries in the fiberboard box, slightly more than 17 percent were bruised. The difference between the total bruising of the cherries in the fiberboard box and the other two types of boxes was statistically significant at the 5-percent level.

There were more stem punctures and cuts on the cherries marketed in the fiberboard box than on those in the wood box or polystyrene box (table 6). More than 1 percent of the cherries in the fiberboard box had stem punctures and cuts, but only 0.5 percent of the cherries in the wood box and 0.2 percent of the cherries in the polystyrene box had these injuries. The difference between total stem punctures and cuts in the cherries in the fiberboard box and the other types of boxes was statistically significant at the 5-percent level.

The fiberboard box had less cubic capacity than either the wood box or the polystyrene box which may have resulted in the high amount of bruising. In one shipment, three fiberboard boxes were packed with 17 pounds of

TABLE 6.—*Percentages of 11½-row-size Bing cherries injured in 18-pound wood boxes, fiberboard boxes, and polystyrene boxes, by type and degree of injury, 5 airfreight shipments from Stockton and Lodi, Calif., to Chicago and New York, 1969*

Type and degree of injury	Wood box	Fiberboard box	Polystyrene box
Bruised:[1]			
Slight	9.4	14.3	6.3
Damage	1.2	1.8	.3
Serious	.3	1.0	.2
Total[2]	10.9 a	17.1 b	6.8 a
Stem punctures and cuts:			
Slight	.2	.3	.1
Damage	.1	.4	.0
Serious	.2	.5	.1
Total[2]	.5 a	1.2 b	.2 a

[1] Degrees of bruising are: Slight, tissue breakdown, soft, bruise less than ¼ inch in diameter; damage, flattened, soft, and/or discolored, bruise more than ¼ inch in diameter and more than ⅛ inch in depth; serious, split caused by bruising, of no economic value.

[2] Values followed by different letters are statistically significant at the 5-percent level, based on Duncan's new multiple range test.

cherries and the percentage of bruised cherries was compared with the percentage of bruised cherries in the regular 18-pound pack. One shipment did not provide an adequate basis for statistically comparing the performance of the fiberboard container when it was packed with 17 pounds of cherries. The percentages of bruised cherries in the 17-pound and 18-pound fiberboard boxes were as follows:

	17-pound fiberboard box *Percent*	*18-pound fiberboard box* *Percent*
Slight bruising	7.6	17.0
Damage bruising	.6	2.0
Serious bruising	0	0
Total bruising	8.2	19.0

Rail shipments

In the four rail test shipments (table 7), the Washington and Oregon cherries packed in polystyrene boxes had less bruising and fewer stem punctures and cuts than those packed in wood boxes, but the differences were not statistically significant.

The Washington and Oregon cherries packed in fiberboard boxes had more bruising but fewer stem punctures and cuts than those packed in wood boxes (table 7), but the differences were not statistically significant.

TABLE 7.—*Percentages of 12-row-size and larger Bing and Lambert cherries injured in 20-pound wood boxes, fiberboard boxes, and polystyrene boxes, by type and degree of injury, 4 rail shipments from Yakima, Wash., and Hood River, Oreg., to eastern terminal markets, 1969*

Type and degree of injury	Wood box	Fiberboard box	Polystyrene box
Bruised:[1]			
Slight	8.2	11.0	7.6
Damage	2.5	4.0	2.1
Serious	.6	.7	.3
Total[2]	11.3	15.7	10.0
Stem punctures and cuts:			
Slight	.6	.8	.4
Damage	.6	.4	.5
Serious	.5	.4	.4
Total[2]	1.7	1.6	1.3

[1] Degrees of bruising are: Slight, tissue breakdown, soft, bruise less than ¼ inch in diameter; damage, flattened, soft, and/or discolored, bruise more than ¼ inch in diameter and more than ⅛ inch in depth; serious, split caused by bruising, of no economic value.

[2] Difference in injury to cherries between types of containers was not statistically significant.

Container damage

Upon arrival of the five air and four rail shipments at the terminal markets, the following container damage was recorded.

The wood boxes arrived with 0.1 percent of the boxes slightly damaged and 0.7 percent seriously damaged. Slightly damaged boxes were usable; whereas, seriously damaged boxes required repairing. Damage to the seriously damaged wood boxes was caused by the failure of a disposable pallet in one of the rail shipments (fig. 6).

The fiberboard boxes arrived with 0.9 percent of the boxes slightly damaged. These boxes were creased or scuffed but were usable. None of the fiberboard boxes were seriously damaged or unusable.

The polystyrene boxes arrived with 1.8 percent of the boxes slightly damaged. These boxes were chipped or cracked but still usable. None of the polystyrene boxes were seriously damaged or unusable. However, most of the shipments arrived with some damaged polystyrene boxes.

BN-37343

FIGURE 6.—Wood boxes broken as a result of broken disposable pallet, on arrival at eastern market.

Cooling and transit temperatures

Cooling rates

The cooling-rate results described are based on the California airfreight shipment studies. The cooling rates for Washington and Oregon cherries were similar to those rates in California. All containers were packed without a polyethylene bag. The cherries were cooled in the boxes after they were packed, but before they were shipped.

Cooling rates were slowest for cherries packed in fiberboard boxes and fastest for those packed in polystyrene boxes (fig. 7). It required 24 hours for cherries packed in fiberboard boxes to cool from 72° F. to 56°, 13 hours for cherries packed in wood boxes, and 9 hours for cherries packed in polystyrene foam boxes. The cherries packed in the polystyrene box cooled rapidly because ventilation slots were molded in the ends of the box. There were no ventilation slots in the ends of the fiberboard or wood boxes. The cherries packed in the fiberboard boxes cooled slowest because of insufficient ventilation.

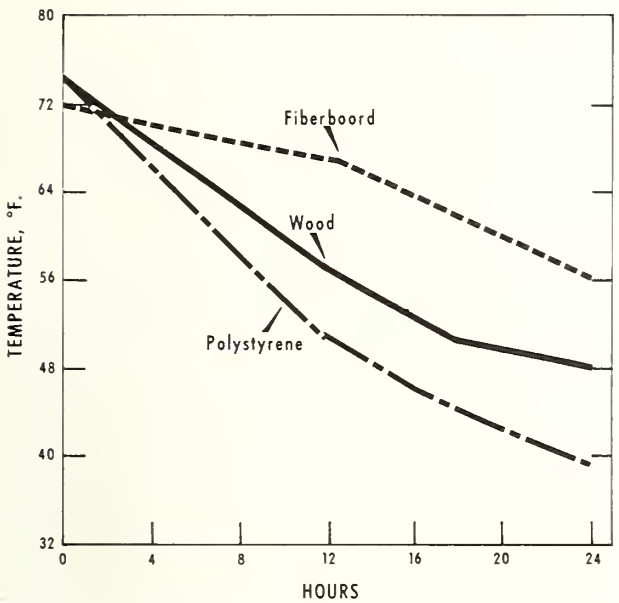

FIGURE 7.—Comparison of rate of cooling of California cherries packed in wood, fiberboard, and polystyrene boxes.

Transit temperatures

In the airfreight shipments, which were not refrigerated, the temperatures of the cherries were as follows (fig. 8): The cherries packed in the fiberboard box remained the same from the time they were taken out of cold storage in California until they reached the eastern markets. The cherries packed in the wood boxes warmed up 10° F. during transit, and the cherries packed in the polystyrene boxes warmed up 12° F. during transit. The temperatures of the cherries packed in the polystyrene boxes, with the end ventilation slots, had the greatest tendency to follow the temperature of the air surrounding the boxes.

In the Washington and Oregon rail shipments, the temperatures of the cherries in all three types of containers after cooling remained between 38° F. and 42° F. The air temperatures in the rail shipments were maintained by mechanical refrigeration.

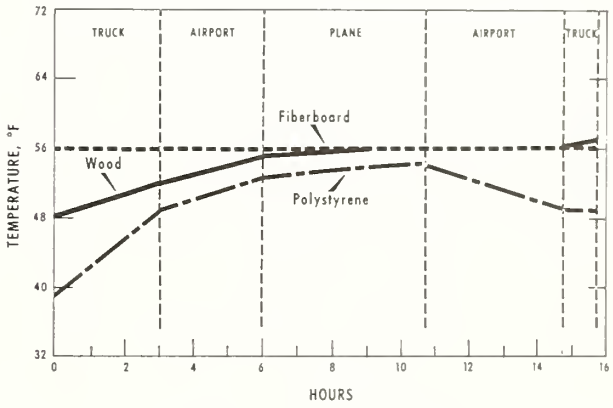

FIGURE 8.—Comparison of transit temperatures of California cherries packed in wood, fiberboard, and polystyrene boxes.

Advantages and disadvantages of the fiberboard and polystyrene boxes

The advantages and disadvantages of packing and shipping cherries in fiberboard boxes and polystyrene boxes, based on data obtained in this study and on the opinions of cherry shippers, wholesalers, and retailers who packed and shipped or distributed the cherries, follow.

Fiberboard boxes

Advantages:

1. Fiberboard boxes are cheaper than wood boxes.
2. They are easy to handle.
3. Their reduced tare weight results in lower transport costs.

Disadvantages:

1. Cherries cool more slowly in fiberboard than in wood boxes.
2. The fiberboard boxes tested are difficult to stack and palletize because of the top bulge after packing.
3. The covers come off easily, which makes pilfering easy.
4. More bruising occurred in the fiberboard box than in the wood box.

Polystyrene boxes

Advantages:

1. Polystyrene boxes are cheaper than wood boxes.
2. Their reduced tare weight results in lower transport costs.
3. They are easy to handle, stack, and palletize.
4. They fit a 48- by 40-inch pallet efficiently.
5. Cherries cool quickly in polystyrene boxes because of the end ventilation slots.
6. Less bruising occurred in the polystyrene box than in the wood box.

Disadvantages:

1. The covers come off easily, which makes pilfering easy.
2. More space is required to store the polystyrene boxes than the wood boxes because they are prefabricated and do not nest.
3. The box tested did not fit existing cherry packing line equipment.
4. Polystyrene boxes may be easily damaged when not handled carefully.
5. Disposal of these boxes at the retail stores may be a problem.

Discussion

Investigations of new shipping containers indicate that the costs of marketing fresh western cherries can be reduced by using less costly shipping containers.

Fiberboard boxes show promise, but improvements are necessary to reduce bruising. The fiberboard box does appear to protect cherries when it has adequate cubic capacity. Increasing the vertical stacking strength should also help to protect the cherries. The cooling rate needs to be increased by providing more ventilation in the box.

Polystyrene boxes need to be sturdy enough to prevent breakage. Although no polystyrene boxes were broken in this study, some were damaged. These boxes can be broken if they are not properly handled during transport and in distribution channels during normal handling conditions. The cover of the polystyrene box needs to be improved to discourage pilfering. Also, the polystyrene box studied does not fit existing cherry packing line equipment because of its size. However, the size of the polystyrene box can be changed so it will fit the packing line equipment.

In 1968, sales of fresh sweet cherries in California, Washington, and Oregon totaled 25,400 tons.[5] The cost of packing and shipping California cherries by air in wood boxes was 29 cents more than in fiberboard boxes and 27 cents more than in polystyrene boxes. It also cost 17 cents more per box to pack and ship Washington and Oregon cherries by rail in wood boxes than in either fiberboard or polystyrene boxes.

Although only 5 percent of the western cherry crop was shipped to market by airfreight in 1968 and 1969, the use of airfreight is increasing. If 25 percent of the western cherry crop were shipped by airfreight and 75 percent by rail, about $530,000 could be saved annually if the cherries were packed in either fiberboard boxes or in polystyrene boxes instead of in wood boxes.

[5] United States Department of Agriculture. agricultural statistics 1969. P. 220. U.S. Dept. Agr.

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