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FEASIBILITY OF SHIPPING GOLDEN DELICIOUS APPLES IN TRAY-PACKED BOXES

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FEASIBILITY OF SHIPPING GOLDEN DELICIOUS APPLES IN TRAY-PACKED BOXES

By

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SUMMARY

Five shipping containers were tested to compare the costs of using each and to find out how well they protected Golden Delicious apples from bruising. These five shipping containers were (1) cell-packs with corrugated partitions; (2) cell-packs with chipboard partitions; (3) tray-packs with deep-cup molded-pulpboard trays; (4) tray-packs with shallow-cup molded-polystyrene-foam trays; and (5) tray-packs with shallow-cup molded-pulpboard trays.

Costs and charges for packing materials, direct labor for packing and handling, storage, and transport were higher for the cell-packs. These costs were \$2.39 per box for corrugated cell-packs, \$2.29 per box for chipboard cell-packs, \$2.09 per box for deep-cup molded-pulpboard tray-packs, \$2.04 per box for shallow-cup molded plastic tray-packs, and \$2.04 per box for the shallow-cup molded-pulpboard tray-packs.

More of the apples were bruised in shallow-cup pulpboard tray-pack boxes—27 percent—than in deep-cup pulpboard tray-pack boxes, shallow-cup plastic tray-pack boxes, corrugated cell-pack boxes, and chipboard cell-pack boxes—18, 19, 19, and 22 percent, respectively.

More of the shallow-cup plastic trays were damaged than either the deep-cup or shallow-cup pulpboard

trays on arrival in eastern markets. The plastic trays broke and tore under the pressures of shipments. Deep-cup pulpboard trays were easier to remove from the box and handle than shallow-cup pulpboard trays. Damage to the corrugated cell partitions was less than damage to the chipboard partitions.

Wholesale receivers usually preferred the “row-face” appeal of the cell-packs, but retailers usually preferred tray-packs for handling and display. Some retailers preferred deep-cup pulpboard tray-pack boxes because these trays protected the apples well and could be used for display.

Of the five shipping containers tested, deep-cup pulpboard tray-pack boxes offer the best combination of cost and performance for packing and transporting Washington State Golden Delicious apples.

Since this study was begun in 1964, tray-packs have been increasingly used for packing and shipping Washington State Golden Delicious apples. On an annual basis, these apples cost about \$500,000 less to pack and ship in 1969 than in 1964 because of the shift from cell-packs to tray-packs. It is estimated that if all of the apples now packed in cell-pack boxes were packed and shipped in deep-cup pulpboard tray-pack boxes, an additional \$380,000 could be saved annually.

INTRODUCTION

Many Golden Delicious apples produced in the Northwest are packed and shipped in cell-pack shipping containers. These containers are used because the cell-pack box, a corrugated fiberboard box with double-face corrugated fiberboard partitions and pads that form individual apple cells, is believed to protect

the soft-fleshed, easily bruised Golden Delicious apples better than other containers available. The cells are made to fit apples of different sizes and six different sizes of boxes are used. These containers cost more, require more labor to pack, waste more space in storage and transport vehicles, and cost more to handle

than do uniform-size tray-pack boxes (fiberboard boxes with molded trays).

The purpose of this study was to find out: (1) How much the cost of marketing Golden Delicious apples

could be reduced if they were packed and shipped in tray-pack boxes; and (2) if fruit bruising would be greater or less if the apples were packed in tray-pack instead of cell-pack boxes.

DESCRIPTION OF SHIPPING CONTAINERS

Five shipping containers, each holding 42 pounds of Golden Delicious apples, were studied—two types of cell-pack boxes and three types of tray-pack boxes. The five containers were: (1) Cell-packs with corrugated partitions; (2) cell-packs with chipboard partitions; (3) tray-packs with deep-cup trays molded from pulpboard; (4) tray-packs with shallow-cup trays molded from expanded polystyrene foam; and (5) tray-packs with shallow-cup trays molded from pulpboard.

Cell-Packs

The boxes used for the two cell-packs were two-piece full telescope, and were made from 200-pound test bursting strength (Mullen) corrugated fiberboard. Containers for the single-wall chipboard partitions were smaller in length and width, but not in depth, than containers for the double-face corrugated partitions. The inside dimensions of the cell-pack boxes varied with the size of the apples packed within. Boxes with corrugated partitions had inside dimensions measuring 19 by 12 5/8 by 12 5/8 inches and boxes with chipboard partitions had inside dimensions measuring 18 1/4 by 12 1/8 by 12 5/8 inches.

The principal difference between the two cell-packs tested was in the kind of partitions used. The corrugated partitions were double-face, special test, A-flute fiberboard, and the chipboard partitions were

single-wall, 0.050-inch-thick chipboard material (fig. 1). The components of the containers were:

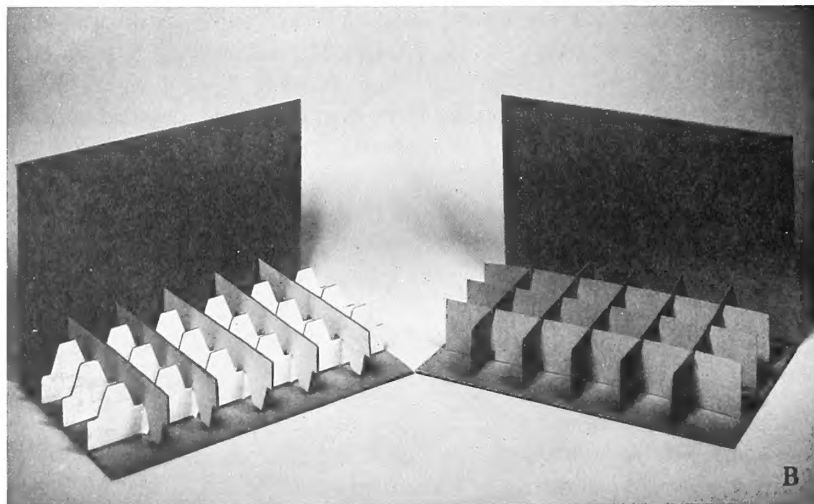
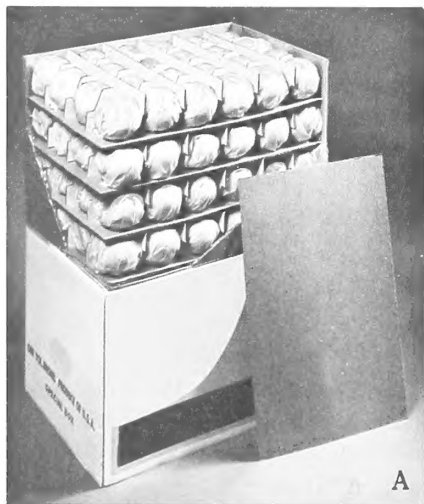
1. Two-piece, full-telescope box—half-slotted body and half-slotted printed outer cover.
2. Partitions—four sets of unassembled corrugated partitions, 28 to 40 pieces, depending on size of apple packed; four sets of assembled chipboard partitions.
3. Five B-flute, nontest double-face corrugated pads.
4. Paper wraps.
5. Polyethylene-film box liner.

Tray-Packs

Containers for the three tray-packs were two-piece, full-telescope boxes. The inside boxes were constructed of board with a 350-pound test bursting strength (Mullen) and the outer cover was constructed of 250-pound test-strength board. The inside dimensions were 19 3/4 by 12 by 11 3/4 inches.

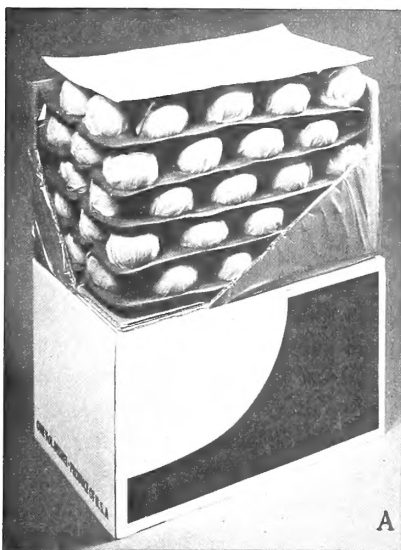
The components of these tray-packs, shown in figure 2, were:

1. Two-piece, full-telescope box—half-slotted body and half-slotted printed outer cover.
2. Five trays.
3. One top pad or one molded-pulpboard top “cap.”
4. Paper wraps.
5. Polyethylene-film box liner.

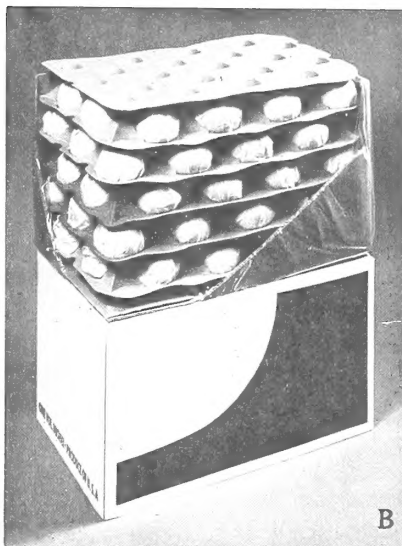


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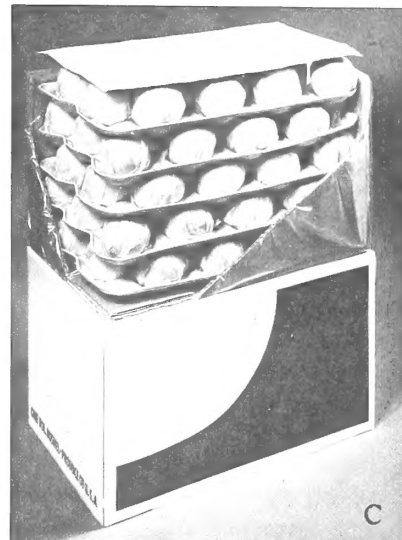
Figure 1.—Cell-pack boxes. *A*, Corrugated cell-pack box. *B*, *Left*, corrugated partitions and pad; *right*, single-wall chipboard partitions and pad.



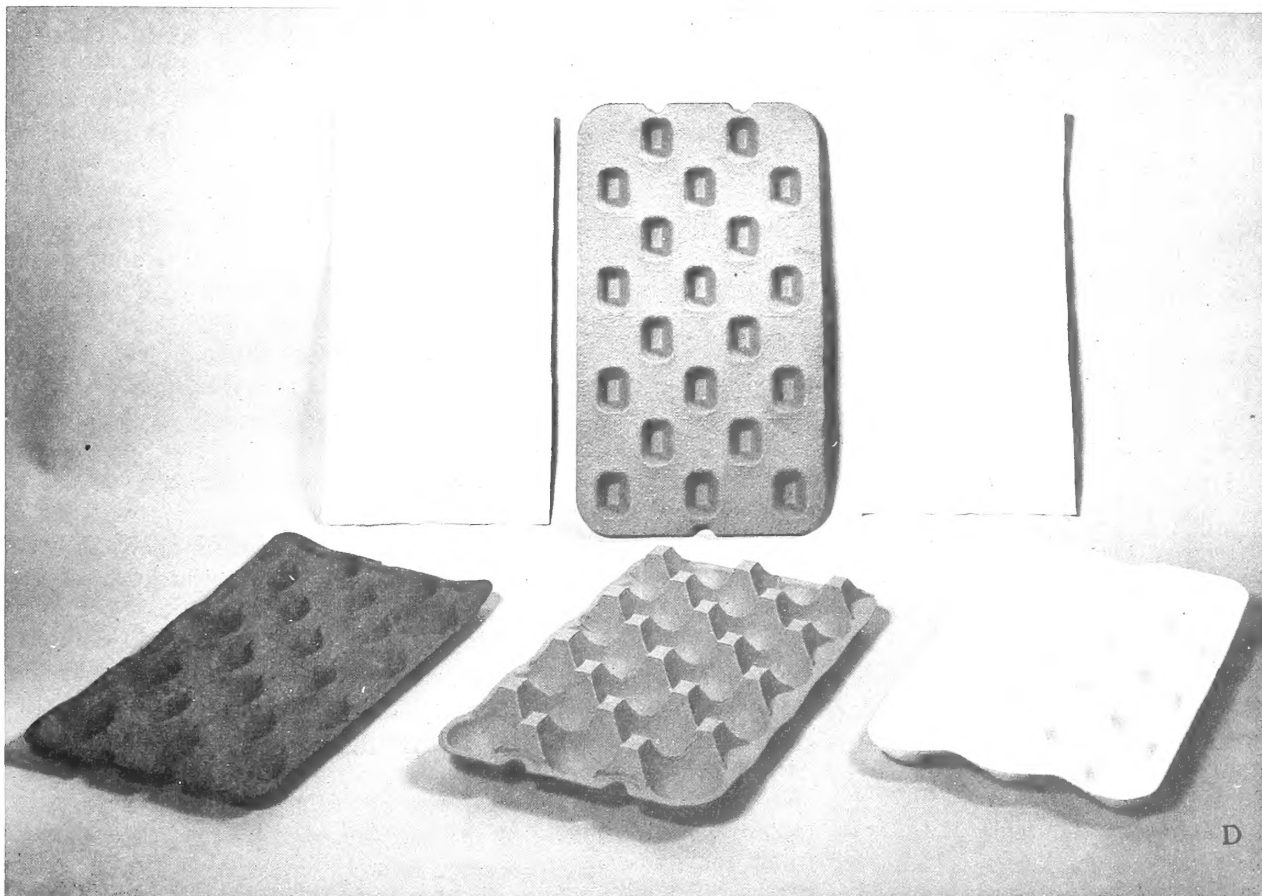
A



B



C



D

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Figure 2.—Tray-pack boxes. *A*, Shallow-cup pulpboard tray-pack box. *B*, Deep-cup pulpboard tray-pack box. *C*, Shallow-cup plastic tray-pack box. *D*, *Left to right*: Shallow-cup pulpboard tray with pad, deep-cup pulpboard tray with "cap," and shallow-cup plastic tray with pad.

PROCEDURE

Packaging-material costs for the five packs were obtained from manufacturers and suppliers. All packaging-material costs are based on price per thousand units for carlot orders.

Direct labor costs for packing apples into the boxes were obtained by conducting time studies in four apple packinghouses. Labor costs for performing other operations on the packing line, such as weighing and stamping, were not included in this study because they were the same for both the cell-packs and the tray-packs. A \$2-per-hour wage rate was used to calculate packing labor costs.

Direct labor costs for handling, stacking, and loading apple boxes in the apple packinghouses were obtained by conducting time studies. Costs for unloading and handling at the receivers' warehouses were based on data from Marketing Research Report No. 622.¹ A \$2-per-hour wage rate was used to calculate labor costs at the packinghouse and a \$3-per-hour wage rate was used to calculate labor costs at receivers' warehouses.

Storage costs at shipping point were obtained from the owner of a Northwest packinghouse design firm and packinghouse owners or managers. Cost per square foot for packinghouse storage was based on a 60-day storage period. Storage costs at terminal point were based on data from Marketing Research Report No. 622 (see footnote 1, p. 4). Cost per square foot for receiver-warehouse storage was based on a 4½-day storage period.

Transport charges were determined by calculating rail and refrigeration charges for shipping Golden Delicious apples in cell-pack and tray-pack boxes from Washington to the cities that received these apples during the 1967-68 apple season.² The U.S. average transport charge was calculated by weighting the transport charge to each city by the relative quantities of Golden Delicious apples shipped to each city.

Cost of receiving, precooling, equipment, supervision, sales, fieldmen, and other overhead were not included in this study.

Twelve test shipments of Golden Delicious apples were made from Yakima, Wash., to various eastern

markets in 1965. Bruising studies were made on cell-pack size 96 and the equivalent tray-pack size, 100. All test shipments were made in refrigerated cars. A randomized complete-block experimental design was used. Each shipment contained two boxes of each of the two types of cell-packs and three types of tray-packs. All boxes were packed and placed in storage. Packing was done the first week of January 1965, and the first shipment was made January 11. The last shipment was made April 28, 1965. Bruising was recorded in three categories: slight, damage, and serious.³

In 1966, after reviewing the results of the test shipments in 1965, the inside dimensions of the fiberboard box for the deep-cup tray-pack were changed from 20 3/4 by 12 3/8 by 12 1/4 inches to 20 1/4 by 12 1/4 by 12 inches. In addition, the box was changed from A-flute to a thinner B-flute fiberboard. These two changes made the outside dimensions of the box for deep-cup trays almost the same as the outside dimensions of the box for shallow-cup trays.

In 1969, to reduce further the required box size, the deep-cup trays were trimmed, in both length and width, to fit the same box (A-flute) used for the shallow-cup trays—19 3/4 by 12 by 11 3/4 inches inside dimensions. Laboratory tests were conducted to test differences in bruising between Golden Delicious apples packed in the full-size deep-cup trays and in the trimmed deep-cup trays. A split-plot experimental design was used to test these differences. Three packed boxes of each type of container and two sizes of apples were subjected to a series of laboratory tests. Each box was subjected to deadweight load test, 200 pounds for 15 minutes; incline-impact test, impact on each end of box at 4 feet; four drop tests, box of equivalent weight dropped on top of each test box from 6 inches; vibration test, box placed on vibrator machine at 190 revolutions per minute for 20 hours; one drop test, box of equivalent weight dropped on top of each test box from 12 inches; and finally, upright drop test, box dropped on its bottom in upright position from 12 inches. All apples from each box were then inspected for bruising.

¹Ferris, R. T., and Bogardus, R. K. Storing Fruits and Vegetables on Pallets in Wholesale Warehouses. U.S. Dept. Agr. Market. Res. Rpt. 622, 38 pp., illus. 1964.

²Washington State Apple Advertising Commission. Where Washington Apples Are Marketed. Supplement No. 21, 17 pp. Wenatchee, Wash. 1969.

³Degrees of bruising are: Slight—bruising injury between 1/4 and 1/2 inch in diameter and less than 1/8 inch in depth; damage—bruising injury between 1/2 inch and 1 inch in diameter and less than 1/8 inch in depth; serious—bruising injury over 1 inch in diameter or more than 1/8 inch in depth.

COSTS AND CHARGES

Costs of Materials

Cell-Packs

The cost of packaging materials was 10.1 cents more for the corrugated cell-pack than for the chipboard cell-pack (table 1). This difference was caused by the cost of the corrugated partitions.

Tray-Packs

The cost of packaging materials was 4.2 cents more for the deep-cup pulpboard tray-pack than for the shallow-cup plastic tray-pack or for the shallow-cup pulpboard tray-pack (table 1). This difference was caused by the additional cost of the deep-cup pulpboard trays and pad or cap. The cost of paper wraps for the deep-cup pulpboard trays average 0.1 cent less than for the other tray-packs because the deep-cup trays hold only 135 apples, whereas the shallow-cup trays hold 138.

Labor Costs

Packing

The cost of direct labor to pack was \$0.214 per box for the corrugated cell-pack and \$0.208 for the chipboard cell-pack (table 2).

The cost of direct labor to pack was \$0.129 per box for the deep-cup pulpboard tray-pack; \$0.117 for the shallow-cup plastic tray-pack; and \$0.117 for the shallow-cup pulpboard tray-pack (table 2).

Much more time (6.33 vs. 3.62 man-minutes per box) was required to pack the cell-pack boxes than to pack the tray-pack boxes. This difference in time was statistically significant at the 1-percent level. The higher labor requirement for handling 28 to 40 individual pieces of corrugated cell partitions instead of one tray per layer was the reason for the difference in cost in packing cell-pack and tray-pack boxes.

Handling

Cost of labor required for moving packed boxes into and out of storage, loading and unloading, and moving into terminal storage was \$0.09 per box for the cell-packs and \$0.08 per box for the tray-packs (table 3).

Handling labor costs were about 12 percent greater for the cell-packs than for the tray-packs. The principal cause of the difference was that the cost of labor for loading cell-packs with several box dimensions into an individual railcar was higher than the cost of labor for loading a railcar with tray-pack boxes of uniform dimensions.

Table 1.—Cost of packaging materials required to pack Washington State Golden Delicious apples in cell-pack boxes and in tray-pack boxes, 1968¹

Type of box pack	Cost of packaging materials used for—					
	Box body and cover	Partitions or trays	Pads or cap	Paper wraps	Polyethylene box liners	Total
Cell-packs:	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Corrugated partitions	32.0	² 37.1	⁷ 10.0	9.0	4.2	92.3
Chipboard partitions	32.0	³ 27.0	⁷ 10.0	9.0	4.2	82.2
Tray-packs:						
Deep-cup pulpboard trays . .	37.0	⁴ 22.0	⁸ 3.8	9.0	4.0	75.8
Shallow-cup plastic trays . .	37.0	⁵ 19.0	⁹ 2.5	9.1	4.0	71.6
Shallow-cup pulp trays	37.0	⁶ 19.0	⁹ 2.5	9.1	4.0	71.6

¹ Average costs of 4 cell-pack boxes and 6 tray-pack boxes. All costs based on price per thousand units per carlot order.

² For 4 sets of corrugated partitions.

³ For 4 sets of chipboard partitions.

⁴ For 5 pulpboard trays.

⁵ For 5 plastic trays.

⁶ For 5 pulpboard trays.

⁷ For 5 corrugated layer pads.

⁸ For 1 molded-pulpboard top cap.

⁹ For 1 paper-excelsior top pad.

Table 2.—Labor requirements and costs for packing Washington State Golden Delicious apples in cell-pack boxes and in tray-pack boxes, 1968

Type of box pack	Direct labor required to pack apples ¹	Cost per box ²
Cell-packs:	<i>Man-minutes</i>	<i>Cents</i>
Corrugated partitions	6.42	21.4
Chipboard partitions	6.25	20.8
Tray-packs:		
Deep-cup pulpboard trays . . .	3.86	12.9
Shallow-cup plastic trays	3.50	11.7
Shallow-cup pulpboard trays . .	3.50	11.7

¹Time required to place empty box on stand, insert liner, place and pack layers of apples, insert pads, close liner, close box, stamp size and packer's number on cover, and place finished box on conveyor belt. Includes 15-percent allowance for personal time and fatigue.

²Assumed \$2-per-hour wage.

Storage Costs

Packinghouse and receiver warehouse storage space cost 2.4 cents more for the cell-packs than for the tray-packs (table 4) because more tray-pack boxes could be stacked on 48- by 40-inch pallets.

Table 3.—Comparative labor requirements and handling costs for moving cell-packed and tray-packed Golden Delicious apples in packinghouses and in receiver warehouses, 1968

Handling operation and type of pack	Labor required per pallet ¹		Cost per box ²	
	Cell-packs	Tray-packs	Cell-packs	Tray-packs
At packinghouse:	<i>Man-minutes</i>	<i>Man-minutes</i>	<i>Cents</i>	<i>Cents</i>
Stack pallet and move into storage	18.50	19.50	2.1	1.9
Move from storage to loading dock	1.58	1.58	.2	.2
Load in railcar for break-bulk shipment	28.98	28.18	3.2	2.7
At receiver warehouse:				
Unload railcar, stack pallets, and move into storage. . . .	21.00	23.00	3.5	3.3
Total for packinghouse and receiver warehouse	70.06	72.26	9.0	8.1

¹30 boxes of cell-packs per pallet; 35 boxes of tray-packs per pallet.

²Direct labor costs for the time workers handle or stack boxes on pallets and the time forklift operators use for pallet-handling, including 15-percent allowance for fatigue and personal time. An average wage of \$2 per hour was assumed for the handling operations at packinghouse and \$3 per hour at receiver warehouse.

Transport Charges

The weighted average railroad transport charge per box of apples was 3 cents higher for the cell-pack boxes than for the tray-pack boxes (table 5). The reason for this difference was that because of individual box height, cell-pack box sizes 80 and 96 could not be stacked seven boxes high in a standard railcar. Because of this, it was impossible for carlot shipments containing mixed sizes of apples to qualify for the incentive freight rate to the eastern States.

Total Costs and Charges

The cost of packaging materials, labor to pack and handle, storage, and transport was 10 cents more per box of apples for the corrugated cell-pack box than for the chipboard cell-pack box (table 6). This difference is the result of the cost of packaging materials being about 10 cents less for the chipboard cell-pack than for the corrugated cell-pack.

The cost of packaging materials, labor to pack and handle, storage and transport was 5 cents more per box of apples for the deep-cup pulpboard tray-pack box than for either the shallow-cup plastic tray-pack box or the shallow-cup pulpboard tray-pack box. The differences were in the cost of packaging materials (4 cents per box) and cost of labor to pack (1 cent per box).

Table 4.—Cost of cold storage at packinghouse and receiver warehouses for Golden Delicious apples in cell-packs and in tray-packs, 1968¹

Type of pack	Floor space	Cost per box		Total cost of cold storage per box
	Per 2-pallet stack ²	Packinghouse, at \$2.26 per square foot for 60 days in storage ³	Receiver warehouse, at \$2.53 per square foot for 4.5 days in storage ⁴	
	<i>Square foot</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Cell-packs	17.76	0.188	0.011	0.199
Tray-packs	18.20	.165	.010	.175

¹ These are estimates of cost and not prices charged for commercial cold storage space.

² Based on average of 30 cell-pack boxes and 35 tray-pack boxes per pallet. Allows 2 inches side overhang for palletized tray-pack boxes and 1 inch for cell-pack boxes, and adds 30 percent aisle space for all pallets. Boxes stacked on 48- by 40-inch pallets.

³ The cost per square foot of \$2.26 is a yearly cost based on a 100- by 100-foot building costing \$85,000, plus refrigeration equipment costing \$45,000. Yearly costs for this coldroom space are: \$6,400 for 25-year building and 15-year refrigeration depreciation; \$2,600 for taxes and insurance at 2 percent of \$130,000; \$3,900 for interest computed at 3 percent of average investment; \$4,800 for operational costs of water, electricity, and refrigeration; \$1,300 for maintenance of equipment at 1 percent of \$130,000; and \$3,600 for operating labor. An average 60-day storage period over an average 214-day use period is assumed. Cost per square foot divided by 214 days times 60 days equals \$0.634 per square foot for 60 days. This cost times floor space divided by the number of boxes equals cost per box. These data were obtained from Food Industries Research Engineering, Yakima, Washington.

⁴ The cost per square foot of \$2.53 is a yearly cost based on the same capital investment for buildings and equipment as stated in footnote 3, with increases in operational costs to \$6,816 and to \$1,950 for maintenance at 1.5 percent. An average 4.5-day storage period over an average 306-day use period is assumed. Cost per square foot divided by 306 days times 4.5 days equals \$0.0372 per square foot for 4.5 days. This cost times floor space divided by the number of boxes per stack equals cost per box.

Table 5.—Railroad transport charges for Washington State Golden Delicious apples shipped in cell-packs and in tray-packs to eastern, western, midwestern, and southern markets, 1968

Type of pack	Gross weight per car ¹	Transport charges per box ²				
		Eastern	Western	Midwestern	Southern	U.S. weighted average
	<i>Pounds</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Cell-packs	40,420	1.25	0.56	1.03	1.07	0.97
Tray-packs	42,780	1.21	.54	1.00	1.04	³ .94

¹ Calculated at 47 pounds for the cell-packs and 46 pounds for the tray-packs. Boxes per car were: 860 cell-pack boxes and 930 tray-pack boxes.

² Weighted average charges for each city in each state of the 4 areas were based on the quantity of fresh Golden Delicious apples shipped to the above areas during the 1967-1968 marketing season, as reported by the Washington State Apple Advertising Commission (see footnote 2, p. 4). The weighted average charge per car was: (1) Eastern—\$1,074.36 for the cell-packs and \$1,123.92 for the tray-packs; (2) western—\$478.20 for the cell-packs and \$500.62 for the tray packs; (3) midwestern—\$883.13 for the cell-packs and \$927.50 for the tray-packs; and (4) southern—\$921.98 for the cell-packs and \$968.24 for the tray-packs. The weighted average transport charge for the U.S. was based on the quantity of fresh Golden Delicious apples shipped into each area.

³ The use of tray-packs reduced transport charges because charges were spread over a greater number of boxes per car.

Table 6.—Costs of packaging materials, labor, storage, and transport for cell-packs and for tray-packs of Washington State Golden Delicious apples, 1968

Type of pack	Packaging materials	Labor	Storage	Transport	Total costs ¹
Cell-packs:	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Corrugated partitions	0.92	0.30	0.20	0.97	2.39
Chipboard partitions . . . . .	.82	.30	.20	.97	2.29
Tray-packs:					
Deep-cup pulpboard trays . . . . .	.76	.21	.18	.94	2.09
Shallow-cup plastic trays . . . . .	.72	.20	.18	.94	2.04
Shallow-cup pulpboard trays . . . . .	.72	.20	.18	.94	2.04

¹ Does not include cost of receiving, precooling, equipment, supervision, sales, fieldman, and other overhead.

Costs and charges for the corrugated cell-pack were \$0.30 greater than for the deep-cup pulpboard tray-pack and \$0.35 greater than for the shallow-cup tray-packs. For the chipboard cell-pack, they were \$0.20 greater than for the deep-cup pulpboard tray-pack and \$0.25 greater than for the shallow-cup

tray-packs. The higher cost of the packaging materials used for the cell-packs was the principal reason for the difference in costs. The next most important reason was the higher labor cost for packing and handling the cell-packs.

BRUISING

Transcontinental Shipping Tests, 1965

Bruising was greater for the apples packed in the shallow-cup pulpboard tray-pack boxes than for those packed in the other four box packs (table 7). The differences in the amount of bruising in the corrugated

cell-pack (19.2 percent), chipboard cell-pack (22.2 percent), deep-cup tray-pack (18.1 percent), plastic tray-pack (18.8 percent), and shallow-cup pulpboard tray-pack (27 percent) were statistically significant at the 5-percent level.

Table 7.—Percentages of bruising in Washington State Golden Delicious apples shipped in cell-pack boxes and in tray-pack boxes to eastern terminal markets, 1965¹

Type of pack	Bruising slight ²	Bruising damage ²	Bruising serious ²	Total bruising
Cell-packs:	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Corrugated partitions	17.4	1.6	0.2	19.2
Chipboard partitions	20.1	1.6	.5	22.2
Tray-packs:				
Deep-cup pulp trays	16.8	1.1	.2	18.1
Shallow-cup plastic trays	16.6	1.7	.5	18.8
Shallow-cup pulp trays	³ 22.6	³ 3.6	.8	³ 27.0

¹ Average of 12 shipments, each containing 2 boxes of each of the 5 types of containers. All apples were inspected from each box.

² Degrees of bruising are: Slight—bruising injury between 1/4 and 3/4 inch in diameter and less than 1/8 inch in depth; damage—bruising injury between 3/4 and 1 inch in diameter and less than 1/8 inch in depth; serious—bruising injury over 1 inch in diameter or more than 1/8 inch in depth.

³ Significantly higher than for the cell-pack with corrugated partitions and the tray-packs with deep-cup pulp trays and shallow-cup plastic trays at the 5-percent level.

Laboratory Tests, 1969

Laboratory tests were conducted in January 1969 to compare the performance between the full-size deep-cup trays packed in the 20 1/4- by 12 1/4- by 12-inch boxes and the trimmed deep-cup pulpboard trays packed in smaller 19 3/4- by 12- by 11 3/4-inch boxes in protecting the apples from bruising.

Bruising was about the same for the apples packed in the trimmed deep-cup pulpboard tray-pack boxes

and for those in the full-size deep-cup tray-pack boxes, except for damage and serious bruising for the size-80 apples (table 8). The reason for the greater amount of damage and serious damage for the size-80 apples packed in the full-size deep-cup trays is not known. However, these apples fitted less snugly in the larger boxes and may have jostled about more during the vibration test.

Table 8.—Percentage of bruising at three levels for size-80 and size-100 Washington State Golden Delicious apples packed in full-size and in trimmed deep-cup pulpboard trays, 1969

Apple size and type of pack ¹	Bruising: slight ²	Bruising: damage ²	Bruising: serious ²	Total bruising
Size 80:	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Full-size deep-cup pulpboard trays	47.1	³ 24.6	³ 6.3	78.0
Trimmed deep-cup pulpboard trays	56.7	13.8	3.8	74.3
Size 100:				
Full-size deep-cup pulpboard trays	43.3	5.3	1.0	49.6
Trimmed deep-cup pulpboard trays	40.7	2.7	0	43.4

¹Data represent averages for 3 replications of each type of box pack.

²Degrees of bruising are: Slight—bruising injury between 1/4 and 1/2 inch in diameter and less than 1/8 inch in depth; damage—bruising injury between 1/2 inch and 1 inch in diameter and less than 1/8 inch in depth; serious—bruising injury over 1 inch in diameter or more than 1/8 inch in depth.

³Significantly higher than for the trimmed deep-cup pulpboard trays at the 5-percent level.

APPEARANCE AND CONDITION OF BOXES

Cell-Packs

In the 1965 transcontinental test shipments, the corrugated cell-pack boxes arrived in eastern markets in good appearance. Little damage was recorded for either the boxes or the partitions.

The appearance upon arrival of the chipboard cell-pack boxes ranged from poor to fair to good. This variance occurred because the single-wall partitions crushed or shifted more under top-to-bottom and side-to-side pressures than the double-face corrugated partitions. The shifting allowed apple movement and disarrangement, and also resulted in more pressure marks on the layer pads in the chipboard cell-packs than in the corrugated cell-packs.

Tray-Packs

Deep-Cup Pulpboard Trays

The appearance upon arrival of deep-cup pulpboard tray-packs was good. Little tray damage was evident, and the trays were easy to remove, to handle, and to stack outside the box. The cups in the bottom layer of trays were creased by the ends of the flaps on the bottom of the box (fig. 3).

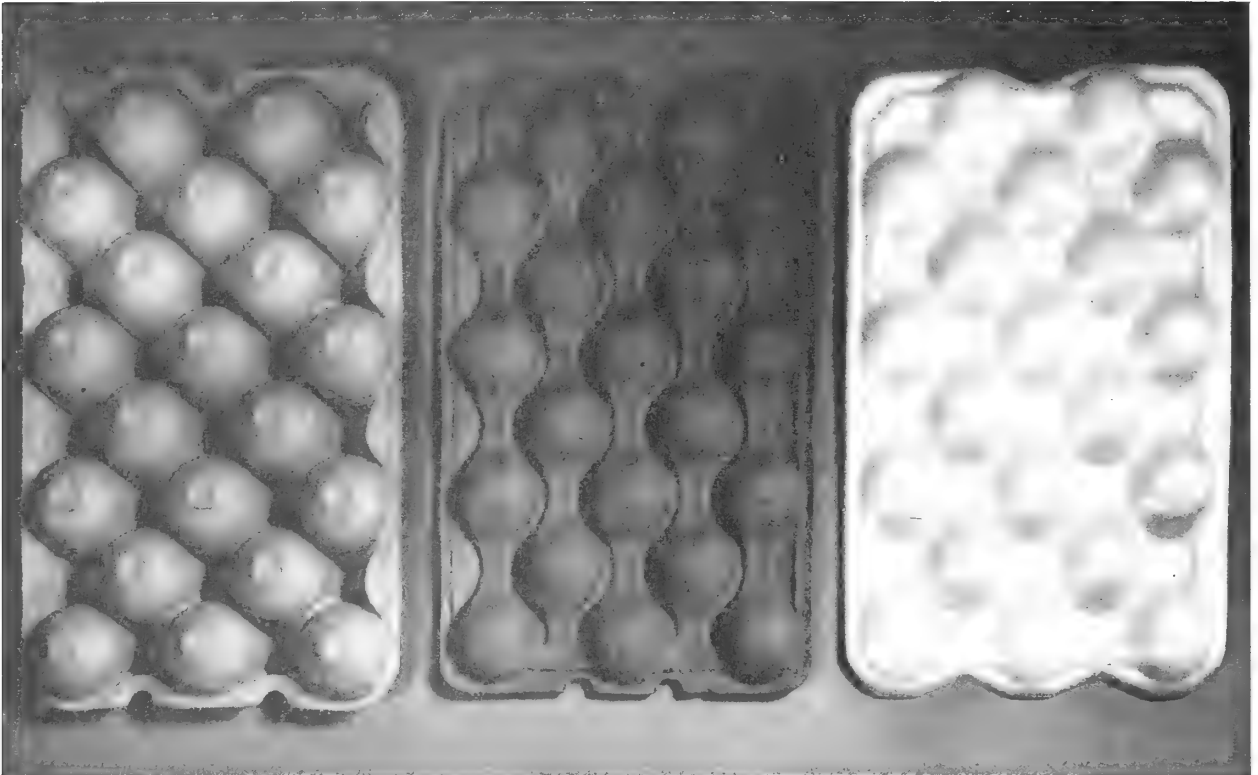
Shallow-Cup Plastic Trays

The appearance of the shallow-cup plastic trays upon arrival ranged from poor to good. Some packs were one-fourth inch above the height of the inside

box, and pressure marks were noticed on the underside of the top pad upon arrival. Forty-two percent of the plastic trays arrived broken or torn. Seven percent were so badly torn that they could not be removed intact from their boxes. The cups in the bottom layer of trays were creased by the ends of the flaps on the bottom of the box. More moisture condensation on the film liner was apparent in this pack than in the other four packs.

Shallow-Cup Pulpboard Trays

The appearance on arrival of tray-packs with shallow-cup pulpboard trays was good. A few pulpboard trays were torn, or tore when being lifted from the box, but the apples in the trays could still be removed from the boxes intact. The cups in the bottom layer of trays were creased by the ends of the flaps on the bottom of the box (fig. 3).



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Figure 3. Deep-cup pulpboard, shallow-cup pulpboard, and shallow-cup plastic foam trays show cup damage caused by end flaps of inner box.

TRADE REACTION

Wholesale receivers usually preferred the “row-face” appeal of the cell-packs to the tray-packs. Some reacted unfavorably to “shifted and crushed” chipboard partitions in the chipboard cell-packs. Retailers preferred tray-packs because an entire layer of apples could be handled at the same time and apple trays could be used for display.

Examples of comments by wholesalers and retailers are as follows:

(1) “These plastic trays have a fresh, clean and a nice aesthetic appearance.”

(2) “These trays [shallow-cup plastic trays] break when we try to remove them from the box—some apples are dropped and bruised because of this.”

(3) “I prefer the ‘pocket-cell’ [deep-cup] pulpboard trays because they are the easiest to handle and stack outside the box for inspection or display.”

Examples of comments from 1967 reports of Washington State Apple Commission fieldmen on wholesale and retail trade reaction to the deep-cup tray-pack boxes are as follows:

(1) "Canadian markets prefer Washington Goldens over B.C.'s [British Columbia apples] but this season B.C. moved strongly to the 'pocket-cell' tray and received wide approval from all chain and distributive handlers."

(2) "I made quite an extensive survey on the subject of the 'pocket-cell' [deep-cup] pulpboard trays, both at headquarters level and out in the retail stores, and can attest that it did deliver Goldens with much

less bruising. Retail produce men display the fruit right in the trays, usually two trays deep. I have heard retail managers ask if they are in the 'pocket-cell'—and order twice as many as they would otherwise."

(3) "Shipments of Goldens in the new 'pocket-cell' [deep-cup] tray have arrived here in excellent condition, and have made a favorable impression with this tray. It seems to me that the industry should begin taking a long, hard look at our cell-pack with its resulting higher cost all along the line."

(4) "There is no question but that we should be able to move more Goldens if we can get away from our cell carton with its higher cost."

DISCUSSION

As a result of this study, and related commercial experiments in which researchers on this study cooperated, more Golden Delicious apples are now shipped in tray-pack boxes than when this study was begun in 1964. At that time, about three-fourths of the Washington State Golden Delicious apples marketed fresh were shipped in corrugated cell-pack boxes (2,835,000 boxes). However, in the 1967-68 season only about one-third of Washington State Golden Delicious apples were cell-packed (1,280,000

boxes). About two-thirds of the apples were tray-packed in deep- and shallow-cup molded pulpboard and shallow-cup plastic trays. The shippers using tray-packs often use the deep-cup pulpboard tray-pack for their best fruit only. This shift from cell-packs to tray-packs has resulted in lowering annual costs about \$500,000. An additional \$380,000 could be saved if all of the Golden Delicious apples that are now shipped in cell-packs were shipped in the less expensive deep-cup pulpboard tray-packs.

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