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U.S. DEPARTMENT OF AGRICULTURE  
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CURRENT SERVICE

<sup>3</sup>  
**PACKAGING  
PRODUCE**  
**At**  
**The Central Warehouse** <sup>+3a</sup>

<sup>7a</sup>  
**Marketing Research Report No. 721**) //

<sup>5b</sup>  
**Agricultural Research Service,**  
**U.S. DEPARTMENT OF AGRICULTURE** //



## PREFACE

Most produce departments in supermarkets have reported that their operating costs were increased and that their percentage of total store sales has decreased. The layouts, equipment, materials, and improved operations described in this report present the industry an opportunity to lower substantially the costs of selling produce. It covers the results of research on those produce items that are typically placed in a bag at the central warehouse. This work was conducted under the general supervision of R. W. Hoecker, chief, Wholesaling and Retailing Research Branch.

Management of the following firms cooperated with the researchers in the use of their facilities for this study: Eagle Food Stores, Milan, Ill.; First National Stores, Kearney, N.J.; Fleming Stores, Topeka, Kans.; Food Fair Stores, Miami, Fla.; Giant Food Stores, Washington, D.C.; Publix Markets, Lakeland, Fla.; Red Owl Stores and

Super Vain Stores, Hopkins, Minn.; and Safeway Stores, Washington, D.C. The author would like to thank the many manufacturers of equipment and packaging materials who contributed time and materials.

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Special credit is due Gordon J. Flynn, Alan K. Greene, and Thad T. Uehling, who were formerly associated with the U.S. Department of Agriculture and who were responsible for major parts of the research.





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## SUMMARY

In 1964 the fresh produce industry was a \$5 billion business at retail and it annually sells approximately 4 billion consumer units of bagged potatoes, citrus, apples, and onions. There is a potential savings in industry costs of over \$100 million when these bagged items are received in pallet-type containers and packaged at the central warehouse in accordance with recommendations of this report. When the selling price of the bagged items is reduced through competition between retailers, there is a potential savings of 2.8 cents per unit if packaging of consumer units is done at the central warehouse.

Receiving produce in large pallet containers makes the largest contribution to the savings at the central warehouse. This ideal-size container has area dimensions of 42 by 47 inches, so it can be shipped either in rail cars or over-the-road trailers. The depth ranges from 23 inches for apples and citrus to 30 inches for potatoes. The 23-inch deep pallet boxes hold approximately 800 pounds and the 30-inch deep boxes 1,300 pounds.

Labor requirements for the receiving of produce at the central warehouse are reduced by as much as 91 percent when pallet containers are used. The use of pallet boxes to feed the packaging line reduced labor requirements by 65 percent when compared to feeding the line with conventional containers.

Pallet box shipment of produce probably will increase when (1) State barriers that limit the size of the load and the type of shipping containers are eliminated, (2) when the problem of ownership of the pallet boxes is resolved, (3) when freight rates for the return of the boxes are lowered, and (4) when improved containers and handling techniques further reduce bruising.

The equipment that has the greatest effect on line productivity is the bagging head where loose produce is unitized into consumer packages and the weight of the package is determined. The level belt or the hopper-type baggers are capable of handling a variety of items. If produce volume exceeds 80,000 bags per week, two or more lines are required. The alternatives are overtime or a two-shift operation. High volume will permit the use of more specialized equipment, such as the rotary bagger for potatoes, a brush and vacuum to remove loose onion skins, and extensively padded equipment and a water dump for apples.

Scales should be checked daily to insure correct weights; the tare weight should be incorporated in the scale. Use of a chart that lists the recom-

mended tare allowances for all commodities plus constant checking will result in good weight control of packages. Time requirements for bag filling were lowest on the hopper-type single-head bagger. In the bag-filling operation it is better to stress accuracy than speed, since the cost of the overpack and underpack is greater than the extra labor required to obtain the recommended weight.

The selling price, package size, price per pound, and commodity identification should be placed on the bag with special self-inking, adjustable band stamps prior to filling. A fixture was developed by researchers of the Agricultural Research Service to lower the cost of pricing the bag.

The wire closure is the cheapest for polyethylene bags. Other factors, such as ease of opening and coding, tend to favor a tape closure. The one-piece tape closure is more secure and easier to code than the two-piece tape. Coding of dates and other information are essential to protect both the warehouse and the store. Closing bags at a central point with a semiautomatic closing machine requires 0.037 minute less per bag. It is recommended that a central closer be used for a high-volume line and that manual tape closers be mounted at each filling head. The improved bag-filling operation, using the central closer, reduced labor requirements by 0.067 minute, which increased the capacity of the line by 51 percent.

The layout for a produce packaging line should provide for accumulation of product at each work station, should provide for expansion, should use mechanical equipment to reduce physical handling, and should provide for the orderly flow of product, containers, and salvage through the packaging operation.

A returnable master container is essential for the proper delivery of bagged produce to the store. Ideally this container should hold approximately 60 pounds of the product, nest and stack, fit on warehouse pallets, be lightweight, be readily cleaned, be able to handle a variety of produce items, utilize space effectively, be an integral part of the firm's overall delivery system, and have a long life. The master containers are typically handled 10 times from warehouse to store and return. This places a premium on ease of handling, utilization of space, and nesting ability. The thermoplastic container, which nests and stacks, weighs 6 pounds, and has an estimated 5-year life, was the lowest cost container tested.

The best insurance that the produce packaging line will have low operating costs is a system of

scheduling and cost control. Product and labor should be scheduled at least a week in advance to prepare for peak production periods and to minimize the number of short runs. Each day, estimates are taken from the weekly planning schedule and are posted, item by item, to the daily schedule. At the completion of each run the supervisor should check the performance of the line. Short product runs can be eliminated by combining projected runs set for 2 days, by using a single bagger away from the line, and by eliminating those items that late in the season have little volume. The length of time required for a product changeover can be minimized by assigning specific jobs to each crew member, by bagging different sizes of the same item in sequence, by providing a packaging facility for items that are not easily packaged on the bagging line, and by reducing the number of short runs.

Two systems for cost control were developed: A manual system and a program for electronic data processing. The EDP method utilizes a portable card punching system and can be extended to cover all central warehouse processing. Cost control includes the measuring of individual worker's performance.

Packaging costs are compared for produce purchased prepackaged, packaged at the central ware-

house, and packaged at the retail store. The "upcharge" for source packaging was the difference in cost to the buyer between the item in conventional containers and in packaged form and averaged 6.7 cents per consumer unit in polyethylene-type package. Produce packaged at the retail store costs 4.2 cents per consumer unit when bagged on a semiautomatic machine and using improved packaging techniques, and 5.8 cents when packaged by hand. The cost of central warehouse packaging was 4.2 cents per consumer unit. These costs were established for the actual operations of four firms and include labor, materials, depreciation, burden, and the cost of warehouse-to-store containers. If a firm were to adopt all of the improvements suggested in this study, average costs for central packaging would be 3.6 cents per package.

The final cost comparison of packaging at different locations included the cost of the shipping containers, freight (including return of empty containers), and labor to receive at central warehouse. The lowest cost location to the firm for packaging produce is at the central warehouse. There is a potential savings of over \$100,000 per year in a central warehouse that has an average volume of 70,000 units per week.

# PACKAGING PRODUCE AT THE CENTRAL WAREHOUSE

By PAUL F. SHAFFER, *marketing specialist, Transportation and Facilities Research Division, Agricultural Research Service*

## INTRODUCTION

In 1964, the retail fresh produce industry was a \$5 billion business. This growth was brought about by the revolution in food retailing that produced the modern supermarket with its foundation of self-service. The key ingredient of self-service is packaging. Although produce has lagged behind all the other major food store departments in both the extent of self-service and packaging, it is estimated that 77 percent of all produce departments are completely self-service and that 33 percent sell nearly all produce prepackaged (8).<sup>1</sup> What is more significant is that all produce departments, even those classified as bulk, sell some produce packaged. Almost invariably the packaged items include potatoes, onions, apples, and citrus fruit. In a recent survey it was determined that 75 percent of these items were packaged (table 1), or approximately 4 billion consumer units annually.

There is less agreement in the industry as to where produce items should be packaged than there is to whether they should be sold in bulk or packaged. An inspection of a typical produce department would likely reveal that some pack-

ages were prepared at the point of production or shipping point, some by a terminal packager, some at the central warehouse, and some in the produce preparation area of the retail store. It is estimated that pre-store packaging accounts for 58 percent of all produce sold in packaged form and that by 1970, 60 to 75 percent of all fresh fruits and vegetables will be packaged before reaching the retailer (14).

The purpose of this study is to compare alternative equipment, layouts, work methods, containers, and operating practices for packaging produce at the central warehouse and to develop improvements in central produce packaging. In a broader sense the objective of the study is to determine where produce should be packaged, particularly those items typically packed in bags—the central warehouse, the retail store, or a point of production or shipping point.

The objective of this research is for the consumer to obtain fruits and vegetables of high quality at the lowest possible cost. Cost reductions as a result of improved packaging will, through competitive pressures, be passed on to the consumer.

The study includes all operations relating to packaging—from receipt of produce at the central warehouse to delivery at the retail store. This includes the development of improved containers for receiving and store delivery, production cost and scheduling techniques, a review of store packaging costs, and an evaluation of the cost to the firm when produce is purchased prepackaged at the shipping point.

For the purpose of this report several terms that are typically used by the trade are defined. The term "source" relates to the point of production or grower-shipper. When produce is packaged in an area other than the marketing area, there typically is an "upcharge," which is the amount above the cost of the merchandise in a conventional shipping container that is added to the cost of the produce to cover the packaging function. Produce items are commonly packaged in several types of packaging materials: Mesh bags, polyethylene

TABLE 1.—*Percentage of selected produce items sold in packages, 1961<sup>1</sup>*

Commodity	Share of total produce sales	Extent of packaging
	Percent	Percent
Potatoes.....	10.58	91.1
Oranges.....	6.29	69.7
Apples.....	7.26	65.6
Onions.....	2.98	70.5
Grapefruit.....	2.86	63.8
Lemons.....	1.19	47.5
Average (weighted).....		74.7

<sup>1</sup> See reference (3).

<sup>1</sup> Italic figures in parentheses refer to Literature Cited, p. 98.

bags, kraft bags with a mesh window, and solid kraft bags. The most common material, and that which is used in this report, is clear polyethylene ("poly"). The term "bulk shipment" relates to a method of shipping produce where the carrier (rail car or trailer body) is the shipping container. The large pallet-size container, which is used to ship produce from the point of origin to the central warehouse, is called "pallet box" or "pallet bin."

Labor costs are based on the standard time to perform the job and the existing wage rates. The standard time is defined as the time for a skilled operator to perform a task, using prescribed methods, layout, and equipment. It includes a rating factor to adjust the average elemental times for the effective speed at which the operator worked. It also includes a 15 percent allowance for fatigue and personal time.

In several instances it was necessary to weight packaging costs by the relative movement of the

item. The bagged produce movement of several firms was averaged to obtain the following percentages used in the report:

<i>Packaged item</i>	<i>Percent</i>
Potatoes, 10 pounds-----	28
Potatoes, 5 pounds-----	20
Onions, 3 pounds-----	17
Apples, 4 pounds-----	19
Oranges, dozen-----	11
Grapefruit, 8-pack-----	5
Total-----	100

Not every firm packaged these items or the sizes listed above. They have been used throughout the report because they represent the most typical product and size mix.

Considerable produce packaging is performed by terminal packers in many metropolitan areas. Their equipment and packaging techniques are similar to those at the central warehouse but are beyond the scope of this report.

## RECEIVING PRODUCE AT THE CENTRAL WAREHOUSE

It is possible to define produce packaging as beginning when the product is obtained from warehouse storage and ending when the packaged produce in master containers is returned to storage. But this would not be a realistic picture of the function, for the cost of produce packaging is materially affected by the container in which it is received at the warehouse, the method of unloading, and the method of shipment to the store.

### Typical Methods of Receiving Produce

The produce industry has developed containers that are accepted as the standard for each item. An example is the 1½-bushel wirebound crate, the ½-bushel wirebound crate, and the two-piece ½-bushel telescoping corrugated carton, which is used for citrus. The number and size of the containers affect the receiving time. The number of handlings is doubled when the ½-bushel container is used, but it is lighter and, therefore, easier to handle. Produce received in standard containers is usually unloaded by hand.

The transporting equipment will affect labor requirements for receiving produce at the warehouse. When received by rail, the car is spotted at the receiving dock and the entire unloading is performed by warehouse personnel. When produce is received in trailers, the driver of the trailer stacks the containers on a pallet and the dock man moves them from the trailer to temporary storage, where the produce is checked. Warehouse labor requirements for receiving produce in standard containers range from 1.8 to 2.8 man-hours per load for rail cars and average 0.5 man-hour for

unloading trailers. The kind of commodity has little effect on warehouse labor required for unloading trailers, since the receiver only removes the loaded pallet with the pallet transporter or forklift truck. The number of containers per pallet and the number of pallets per load are the main considerations.

### Receiving Produce in Pallet Containers

There is constant pressure in all industries (1) to ship in larger containers to reduce handling costs, (2) to substitute one relatively inexpensive large container for several smaller containers, and (3) to reduce freight charges through the reduction of tare. The central warehouse packaging of produce presents an opportunity to lower costs through pallet container receiving, since the produce must be transferred from the receiving container to the consumer unit. The rewards are considerable, since over 600,000 carloads of potatoes, citrus, and apples are shipped each year.

Growers of fruits and vegetables were faced with increased handling costs when they harvested and stored produce in small field crates. They found a low-cost solution to their handling problem in the use of a larger pallet container, and it has become the typical container for many items (4).

It appears that shipping produce to their customers in pallet boxes would be a logical next step. Unfortunately, each grower and each local supplier of pallet boxes had a different conception of size and materials (7). The pallet boxes were built for harvesting and storing, not for cross-



country shipment. A different type of container was required—one that would be adaptable to rail cars and trailers, would recognize freight rates, could be handled at the central warehouse, and would adequately protect the produce. A study was conducted in cooperation with shippers, receivers, and box manufacturers to develop pallet containers that would be adaptable to the handling problems at all levels of distribution.

### ***Design and Construction of Pallet Containers***

*Dimensions.*—The principal limiting factors for pallet boxes are the rail car or over-the-road trailer and the racks in the produce warehouse of the receiver (central warehouse), where they should be temporarily stored to take advantage of vertical stacking height (air rights). Almost without exception, these produce racks are designed with a 40- or 48-inch opening. The 40-inch facing will accommodate any pallet that has a 40-inch dimension such as the 32- by 40-inch or the 40- by 48-inch pallets, which are typically used in the food industry. The 48-inch facing will only handle the 42- by 48-inch and 40- by 48-inch pallets. There is some tolerance in the opening to facilitate entry; for example, the 40-inch facing has an inside clearance of 45 inches and the 48-inch facing has an inside dimension of 54 inches. This permits a degree of freedom in designing the pallet. The length and width should not vary more than 2 inches from the 40-inch and 48-inch facing dimensions.

The pallet container may be shipped by either rail car or trailer, so it should have dimensions that will adapt to both carriers. The standard refrigerated rail car is 99 inches wide, so conceivably it could accommodate two pallets, 49 inches wide (or long) side by side. The typical long-haul, refrigerated over-the-road trailer has an inside width of 88 inches and theoretically could transport two 44-inch wide (or long) pallets side by side. Neither vehicle will handle pallets this large because there must be an allowance to permit loading and unloading and because most pallet containers have some bulging of the side panels when loaded. The extent of the bulging depends on the materials used, the depth of the container, the width of the span, and whether the side panels are restricted by strapping. In the tests conducted upon receipt of pallet boxes at the warehouse, 20-inch-deep corrugated pallet containers with 600-pound test weight corrugated liners had a bulge that ranged from 0.71 to 0.90 inch. Three inches should be allowed for the bulge on 40-inch plus span on two sides of two pallet containers and 2 inches should be allowed for maneuvering pallet containers in and out of the rail car. Thus, the usable width of a 99-inch-wide car is 94 inches, or 47 inches per bin (fig. 1).

Most refrigerated trailers have inside width of 88 inches so the pallet container will be loaded sideways (fig. 2). The bulge on four sides of two

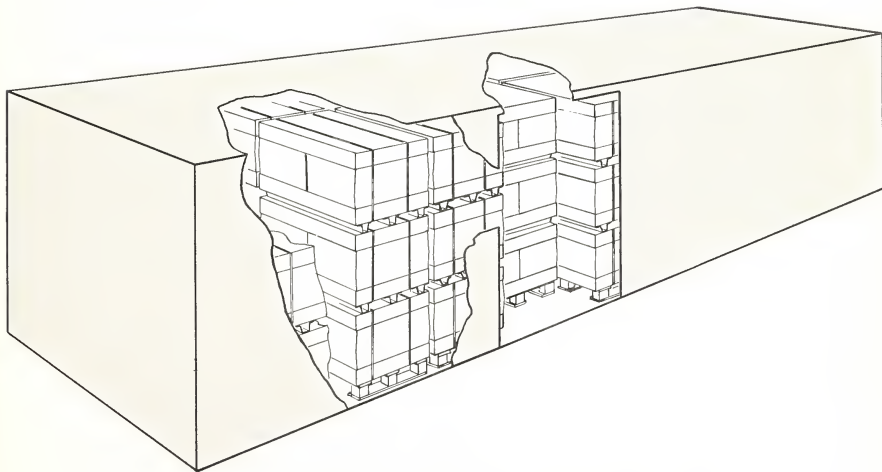


FIGURE 1.—A rail car loaded with pallet boxes stacked 3-high.



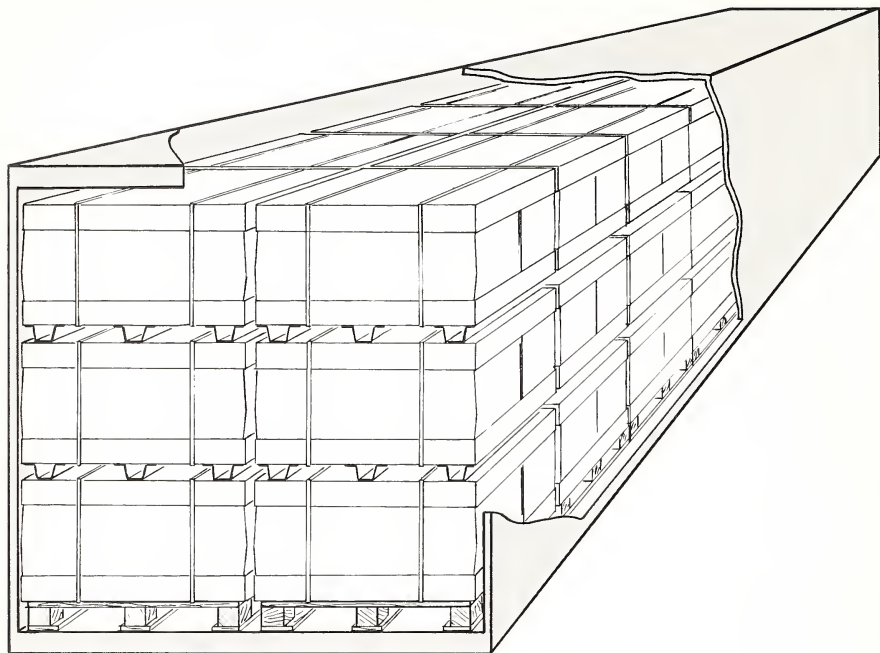


FIGURE 2.—An over-the-road trailer loaded with pallet boxes.

pallet containers is about 3 inches, which leaves 85 inches for the two containers plus room to maneuver. A pallet container 42 inches wide has been used for numerous tests and routine shipments. If a 40-inch pallet box is used, a space of 3 to 4 inches is lost in the trailer.

The interior width of over-the-road trailers will range from 80¾ to 88 inches. The 42-inch-wide pallet container will not fit in the narrower trailers, but these trailers usually are not used on the cross-country hauls that is normal for loads of pallet boxes.

The 42- by 47-inch pallet container is interchangeable for rail car or trailer, can be stored in warehouse racks, will fit on a 40- by 48-inch grocery pallet for storage, is acceptable for the producing area, and will most effectively utilize space in the carrier. A wooden pallet will have less bulge on the sides, but it is more difficult to maneuver in the trailer because of the rigidity of the material. Thus, the area dimensions 42 by 47 inches are optimum for all standard carriers and

for corrugated fiberboard or wooden pallets.

The depth of the pallet container is determined by (1) the degree of bruising of the product at various depths, (2) the usable stacking height in the transport vehicle, and (3) load limitations by State and carrier. Potatoes have been shipped in pallet containers with a depth of 45 inches without damage. Citrus has been shipped in pallet containers to a depth of 30 inches; oranges ship much better than grapefruit. During the tests, apples were shipped in containers 20 inches deep. Routine shipments of apples have been made in bins 23 inches deep. It is the feeling of many in the industry that 24 inches is the maximum depth for apples.

Both refrigerated cars and trailers have heights of 88 inches, but the usable storage height depends on the type of refrigeration. In rail cars with ice bunkers, an overhead clearance of 12 to 18 inches is left between the top of the load and the vehicle ceiling. In rail cars and trailers with mechanical refrigeration, a 6-inch air space is needed for

TABLE 2.—*Determination of depth of pallet containers*<sup>1</sup>

Item	Forced-air circulation (trailers and mechanical refrigerated rail cars)		Ice bunker rail cars	
	3-high stacks	2-high stacks	3-high stacks	2-high stacks
Inside height of carrier.....	<i>Inches</i> 88	<i>Inches</i> 88	<i>Inches</i> 88	<i>Inches</i> 88
Space for air circulation.....	6	6	15	15
Wood pallet base (on floor).....	6	6	6	6
Spacer channels to separate upper boxes.....	7	4	7	4
Total lost space.....	19	16	28	25
Available space for pallet box.....	69	72	60	63
Maximum outside depth per pallet container.....	23	36	20	31½

<sup>1</sup> See appendix table 51, for pallet capacity for alternative depths.

forced-air circulation and for forklift operation in the vehicle. If the pallet containers are stacked three high, the maximum outside depth is 23 inches in carriers with forced-air circulation and 20 inches in ice bunker cars. When pallet boxes are stacked two high, the maximum depth is 36 inches in vehicles with forced-air circulation and 31½ inches in ice bunker refrigerator cars (table 2).

To qualify for more favorable freight rates, the transport vehicle should carry a maximum load. Sometimes it is not necessary to utilize the full depth potential of the pallet box, since various restrictions limit the size of the load. For over-the-road trailers, these typically are local total weight or axle restrictions. On loads from parts of the Southeast to the North Central States, the maximum net load is 34,285 pounds.<sup>2</sup> This is considerably below a potential capacity of 48,000 pounds, which a trailer with 23-inch-deep pallet boxes of oranges would weigh (fig. 3). A trailer load of apples from the Northwest has a restriction of 72,000 gross pounds as it passes through certain States. There is no restriction on load weight for refrigerated rail cars, and the only restriction on "piggyback" trailer loads is the legal load limit in the State where loaded and the State where unloaded.

There is a trend toward increasing the legal load limits. All States except one have maximum load limits of 70,000 pounds, and 16 States have approved a maximum gross weight of 73,280 pounds, which is the recommendation of the American Association of State Highway Officials (2). This liberalized maximum weight will permit net loads

of 44,000 pounds (including tare and excluding weight of tractor and trailer).

*Materials for pallet containers.*—The type of material used in the pallet box container determines the average number of round trips for the life of the container, which in turn affects the cost per trip. The boxes that are fully returnable (make approximately 50 round trips) are made of wood or wood in combination with some other material. An example would be a wooden box with corrugated liner and base pad. Partly returnable boxes or throwaway boxes are usually made of corrugated fiberboard material. A fully returnable box, though it has a low material cost per trip, may not be the lowest cost box because of freight rates. The combined effect of material cost and freight charges per pallet trip is illustrated by the shipment of potatoes from Idaho to the upper Midwest.

The additional freight on the heavier wooden pallet boxes more than offset the lower material cost. In fact, the freight for returning the pallet base is so high that it is more economical to throw it away and use a new base each trip. The cost of material and freight for the wooden pallet box is \$6.27 per trip as compared to \$3.32 for the corrugated box, with a savings of \$106 per carload. A recent proposal for an adjustment in the rail return rates for pallet containers would narrow the gap between wooden and corrugated pallets to \$25 per carload.<sup>3</sup>

The choice between wooden and corrugated materials for pallet containers is also affected by special freight allowances negotiated by the receiver and the carrier in the local or regional

<sup>2</sup> The maximum load is 63,285 pounds; tractor and trailer together weigh 29,000 pounds gross weight.

<sup>3</sup> For an explanation of costs, refer to table 9, p. 16.

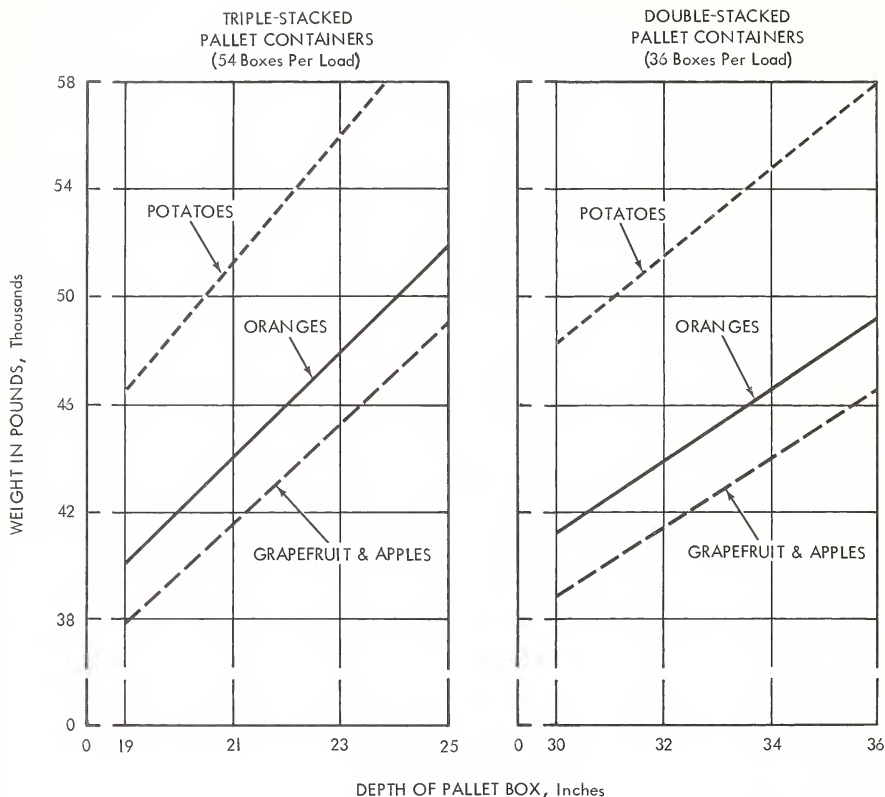


FIGURE 3.—Shipping weight of produce vs. depth of pallet box for double and triple stacking in 37- to 40-foot trailers and 33-foot refrigerated rail cars (includes tare of container).

marketing area. Nearly every section of the country has a supply of local or regional potatoes that accounts for a high percentage of their potato sales. As a rule, these sales are short hauls; hence, the potatoes are frequently transported by over-the-road trailers. The freight charge, like the cost of the potatoes, is subject to negotiation. In many instances, the potatoes are shipped in pallet containers on a net weight basis, with free return of the empty containers. In such a situation, where there is no freight charge, the cost of materials is the key factor and the wooden contain-

ers have the lowest cost as is shown in the following tabulation:

	Wooden	Corrugated
Pallet container.....	\$0.33	\$0.60
Pallet base.....	.....	.12
Strapping.....	.....	.26
Total materials.....	.33	.98

Under the present freight rate structure, the corrugated container will generally have the lowest total cost. A decision on whether to use wooden or corrugated containers cannot be based

entirely on considerations of material and freight costs—additional factors are the degree of bruising of the produce, capital requirements, and handling characteristics.

*Design principles.*—The pallet container must be designed to accommodate the material handling facilities of the grower-shipper, the receiver, and the carrier's transportation equipment. This is in contrast to the pallet container used by the grower, which is only used for harvesting and storage and therefore need only be adaptable to his handling facilities.

1. The shipping container should be easy to assemble and disassemble without the use of specialized tools.

2. When used for apples it should be a one-cell box in order to use with the automatic box filler (fig. 4).

3. When collapsed, the container must not be too unwieldy to handle. A one-cell box with a reverse fold and that collapses to 47 inches long is most adaptable for warehouse and packing plant handling (fig. 5).

4. A wooden pallet box used for apples, and possibly citrus, should be padded with corrugated material to minimize bruising.

5. The dimensions of the container should be such that it can be shipped both in rail cars and over-the-road trailers.

6. A corrugated pallet container should be of sufficient strength to support the second and third bins in the stack, which together will weigh approximately 1,800 pounds. A container this strong is rather expensive for one trip and, in fact, can be used for three to five trips. This almost rules out the use of expendable pallet containers for produce.

*The pallet box base.*—The pallet base for at least the bottom container of a stack should provide for 4-way entry to accommodate both forklift trucks and pallet transporters. It should be designed to permit use of the same pallet containers (and pallet bases) in both rail cars and over-the-road trailers.

During the study, tests were made on lightweight aluminum channels to serve as spacers between the upper pallet boxes (fig. 6). They were designed to nest for ease of handling and to save space.

The combination of the spacers for the top two containers and the modified wood pallet for the bottom of the stack was the lowest cost method of supporting corrugated pallet containers (table 3). Their cost was \$1.18 per container as compared to \$1.71 for complete use of the modified pallet base and \$5.23 for the hardwood 40- by 48-inch warehouse pallet. Furthermore, the use of the channels will permit deeper pallet containers. Three wooden pallets 5.75 inches high occupy a vertical space of 17.25 inches as compared to 11.75 inches

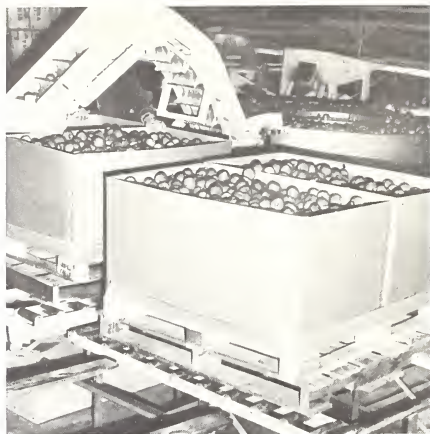


FIGURE 4.—Automatic box filler used to fill one-cell pallet containers with apples.

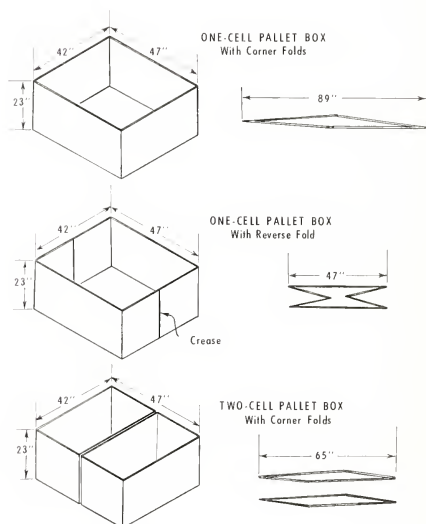


FIGURE 5.—Folding techniques for three types of corrugated pallet boxes.

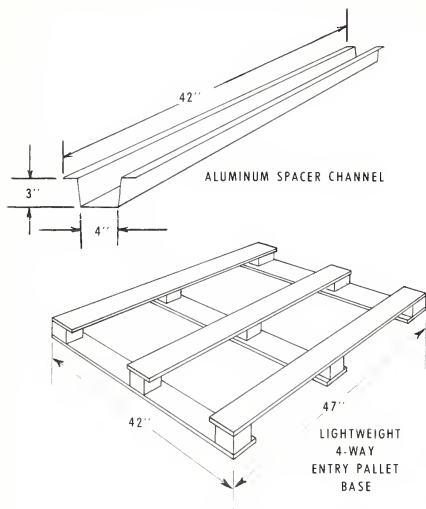


FIGURE 6.—Two types of lightweight pallet bases that reduce tare weight.

for one modified wood pallet and two sets of 3-inch-high channels.

*Strapping the pallet container.*—When corrugated pallet boxes are used for receiving produce, it is essential that they be banded to minimize bulging and to protect the box during loading, transit, and unloading. One strap in each direction will usually suffice. Two types of strapping were used in the shipment— $\frac{1}{2}$ -inch steel and  $\frac{5}{8}$ -inch-wide rayon cord strapping. Both materials had sufficient strength and did not

stretch during shipment. The rayon cord strapping is more expensive if a strap wider than steel is used, as shown below:

	$\frac{1}{2}$ -inch- wide steel Cents	$\frac{5}{8}$ -inch- wide rayon cord Cents
Straps, 40 feet.....	15	23
Clips (3).....	2	3
	17	26

The higher cost of the rayon cord strapping is compensated for by its ease of handling. The straps are manually secured with a buckle (fig. 7). When the boxes are opened, the rayon cord straps are cut with a knife or scissors; they are tossed in a trash barrel and can be burned. Whereas steel strapping is stronger and cheaper, it has some disadvantages: (1) A strapping machine is required to apply the bands, (2) more time is required to



FIGURE 7.—Strapping the pallet container with a rayon cord. Pulling the two ends increases tension.

TABLE 3.—Cost per alternative types of bases for pallet containers used in the shipment of apples from the State of Washington to the upper Midwest

Item	Wooden warehouse pallet	Modified warehouse pallet	Combination of modified ware- house pallet and metal channel spacer
	Dollars	Dollars	Dollars
Material cost.....	<sup>1</sup> 0. 15	<sup>2</sup> 0. 12	<sup>3</sup> 0. 17
Incoming freight at \$1.51 per cwt.....	1. 21	. 38	<sup>4</sup> . 24
Return freight at \$4.84 per cwt.....	3. 87	1. 21	. 77
Total material and freight.....	5. 23	1. 71	1. 18

<sup>1</sup> At \$3 and 20 round trips, weight 80 pounds.

<sup>2</sup> At \$1.20 and 10 round trips, weight 25 pounds.

<sup>3</sup> See footnote 5, table 59, appendix.

<sup>4</sup> 16 pounds per pallet.



apply and remove the bands, and (3) storage and disposal of the discarded bands is a problem.

Strapping is most effective if the pallet containers are filled in a form and the straps applied while the box is in the form. An alternative to the filling form is a temporary strip of pressure-sensitive or monofilament tape across the top in each direction. This will hold the sides in place during filling and dumping (fig. 8).

### **Tests of Pallet Boxes for Produce Shipments**

During the study several rail cars and over-the-road trailers were loaded with potatoes, apples, or citrus to measure the handling characteristics and the relative bruising of produce in different types of pallet containers.

Typically, each load contained two to four types of pallet containers and several standard shipping containers, all of which were loaded with the same item. Upon receipt at the warehouse a sample was taken from each container to measure relative bruising. The containers were evaluated on ease of loading and unloading, side and bottom bulging, evidence of material failure, ease of assembly and disassembly, and general handling characteristics.

The design principles previously discussed were to some extent incorporated in most of the pallet containers in the test. The area dimensions did not vary more than 1 inch. The depth of the boxes

ranged from 18 to 30 inches, depending on the item shipped and the type of refrigeration. There were considerable differences in the bases for the containers. The number of rail trips varied for the expendable containers and the wooden box, which had a life expectancy of 50 trips.

*Types of pallet boxes used in the tests.*—Four of the wooden pallet containers are illustrated in figure 9. They were all one-cell boxes, and the pallet base was an integral part of the box. The corrugated pallet containers had one, two, and four cells, and the pallet base typically was not attached to the box top. Several of the corrugated containers are illustrated in figure 10.

*Bruising.*—Probably the most important objective in the design and handling of pallet containers is the reduction of product bruising. A high level of bruising will offset the considerable cost advantages of receiving produce in pallet containers. In one study over 100,000 Red Delicious apples from Washington State were shipped in "tray-pack" cartons and in various types of pallet containers. The 2-piece tray-pack carton had 82.7 percent bruise-free apples, as compared to 72.5 percent for pallet containers (table 4). Although there were fewer bruises (both  $\frac{1}{2}$ -inch and  $\frac{3}{4}$ -inch and larger) per 100 apples in the tray-pack cartons, 83 percent of the bruises in the pallet containers were  $\frac{1}{2}$  inch or less, and therefore, would not lower the grade of the fruit.

A second study was conducted to measure the relative bruising of both Washington Winesap and Red Delicious apples in four types of containers:

1. Pallet boxes;
2. Tray-pack cartons;
3. Loose-pack cartons (the 2-piece telescoping corrugated 40-pound carton where the apples were packed without wrappings or divider cells); and
4. Apples packaged in poly bags by the grower and shipped in 1-piece corrugated cartons with vertical divider cells to minimize bruising, each carton holding twelve 3-pound or ten 4-pound bags.

Two carloads of both varieties of apples in the four treatments were inspected for bruising upon arrival at the warehouse. The apples were checked for—

1. Slight bruising (one-half inch or less), which would not affect the grade;
2. Larger bruises, which would lower the grade; and
3. Cuts and stem punctures, which would also place the apples "out-of-grade."

The tray-pack carton for Winesap apples had the lowest percentage of bruises and the grower-packed poly bag the highest percentage of out-of-grade apples (table 5). The loose-packed 2-piece carton had the highest percentage of slight bruising and the grower-packed poly bag the smallest percentage. The pallet container had both an

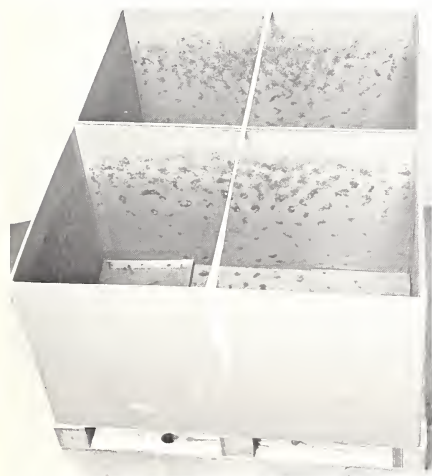


FIGURE 8.—Temporary taping of pallet containers during filling to restrict bulging.

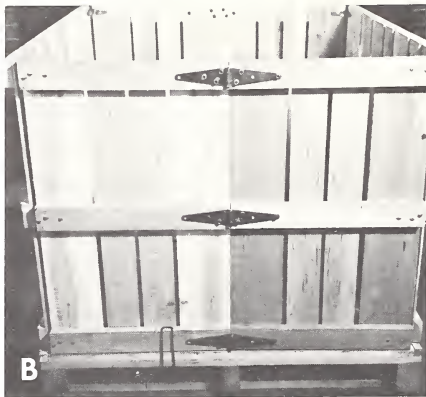


FIGURE 9.—Wooden pallet boxes. *A*, Wirebound with modified pallet base, the box is difficult to assemble and disassemble and is too long when collapsed. *B*, This 2-piece box collapses to 42- by 47-inches. A wooden flange holds the sides in place and 2 metal clips prevent the top from becoming disengaged from the base. *C*, Similar to box in *B*, its top is attached to the base with U-type metal clip. This box is used entirely for local haul of potatoes. *D*, This box has 4 plywood sides that are hinged together by 3 metal clips. The base is also attached to the top with metal clips.

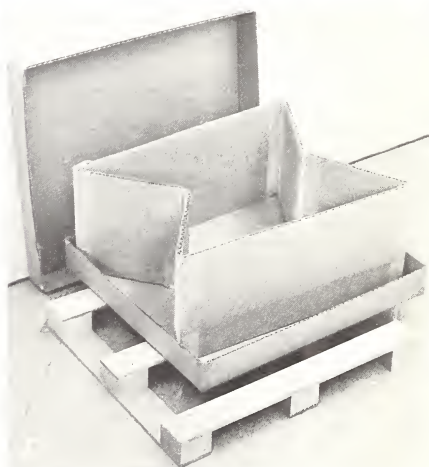
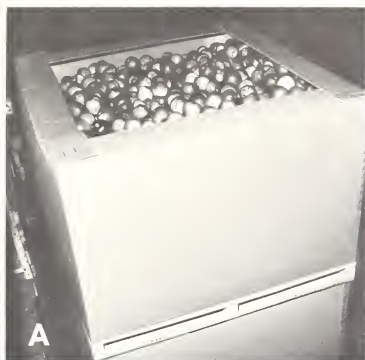


FIGURE 10.—Corrugated pallet containers: *A*, One-piece expendable box; *B*, double-wall box with 4-inch wide wooden slots between corrugated tubes at center of each side provide stacking strength and minimize bulging; *C*, two-cell box with identical top and base caps, a base pad, and lightweight reversible pallet base; *D*, one-cell triple wall container with the short side scored so the box will collapse for ease of handling.



TABLE 4.—*Bruises on Washington State Red Delicious apples shipped in pallet containers and in 2-piece tray-pack containers*

Container type	Bruises per 100 apples			Proportion of sound apples
	½-inch	¾-inch and larger	Total	
Pallet boxes.....	<i>Number</i> 27. 1	<i>Number</i> 5. 7	<i>Number</i> 32. 8	<i>Percent</i> 72. 5
Tray-pack cartons <sup>1</sup> .....	17. 7	1. 5	19. 2	82. 7

<sup>1</sup> This is a 2-piece corrugated telescoping carton, with 4 or 5 pulp cell-type dividers, which holds 40 pounds of apples.

TABLE 5.—*Percentage of apples bruised, by variety and by shipping container<sup>1</sup>*

Apple variety and shipping container	Slight bruising	Out-of-grade
	<i>Percent</i>	<i>Percent</i>
Winesap:		
Pallet container.....	6. 1	3. 2
Tray-pack carton.....	5. 5	1. 5
Loose-pack carton.....	9. 2	2. 0
Grower-pack poly.....	5. 3	4. 5
Average.....	6. 5	2. 8
Delicious:		
Pallet container.....	16. 0	4. 4
Tray-pack carton.....	9. 2	1. 0
Loose-pack carton.....	13. 8	4. 0
Grower-pack poly.....	18. 0	5. 5
Average.....	14. 2	3. 7

<sup>1</sup> This study was conducted in January and February 1961.

average level of slight bruising and out-of-grade apples.

This test was rather late in the season and the Delicious apples had become less firm, which probably explains why the level of bruising was higher than the previous test. The tray-pack carton had the lowest percent of slight bruising and out-of-grade apples. The grower-packed poly bags had

the highest percent of damaged apples in both categories. The poly bags were shipped in a cell-type container to prevent excessive bruising. The test observers felt the percentage of damage for the poly bag apples was due to the movement of apples in the poly bag. If apples are packed too tight, they require a larger shipping container and occupy more display space. If they are packed too loosely in the poly bags, bruising is increased.

The second phase of the bruise study was to package at the central warehouse all the apples in the two test shipments except those previously packaged at the packing house in poly bags. Normal care was exercised in placing the apples on the feed belt and in filling the poly bags. The apples were shipped to the stores in 60-pound-capacity containers and were checked the following morning. Although the level of bruising increased in all containers and for both varieties of apples, there was no pattern either by variety or type of shipping container (table 6).

The limited tests on apples do not permit the conclusion that one container is far superior to all others. The tests do indicate that the level of bruising and out-of-grade apples in pallet containers is higher than the tray-pack cartons and somewhat lower than the loose-pack cartons and the grower-packed poly bags. Certain varieties of apples, such as MacIntosh, cannot be shipped in pallet containers; and Red Delicious will bruise heavily late in the shipping season when the firm-

TABLE 6.—*Percentage of apples damaged on receipt at warehouse and at retail stores*

Item	Winesap		Red Delicious	
	Slight bruising	Out-of-grade	Slight bruising	Out-of-grade
	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Damage on arrival at retail store.....	11. 9	4. 5	21. 8	9. 8
Damage on arrival at warehouse.....	6. 5	2. 8	14. 2	3. 7
Increase.....	5. 4	1. 7	7. 6	6. 1

TABLE 7.—Percentage of citrus fruit bruised in shipment, by type of container

Kind of fruit and shipping container	Slight bruising	Out-of-grade bruising
Oranges: <sup>1</sup>		
½-bu. 2-piece corrugated container-----	Percent 9.9	Percent 5.0
Pallet container-----	8.6	4.1
Grapefruit: <sup>2</sup>		
1½-bu. wirebound crate-----	6.0	6
Pallet container-----	5.1	0

<sup>1</sup> Sample size of test was 2,400 oranges.<sup>2</sup> Sample size of test was 1,500 grapefruit.

ness drops below 12 pounds in the Magness pressure test. Pallet-box shipment of apples will increase only if the additional bruising is more than offset by savings in handling, freight, and materials.

Limited tests were also conducted to determine the bruising of oranges and grapefruit shipped in two types of pallet containers, the standard 1½-bushel wirebound crate, and the 4½-bushel 2-piece corrugated telescoping carton. Two truckloads were shipped from Florida to the upper Midwest. There was no significant difference in bruising or damage between pallet containers. There was slightly less bruised and out-of-grade fruit in the pallet containers than there was in the standard 1½-bushel crate (table 7).

The only information on bruising of potatoes shipped in pallet containers was the observations made by persons involved in the test shipments. It was generally agreed that the quality of the potatoes in pallet containers exceeded that of potatoes shipped in burlap bags. These observations were not subject to measurement.

### **Comparison of Receiving and Line Feeding Costs for Standard Containers and Pallet Containers**

**Receiving.**—Produce received in standard shipping containers is typically unloaded by hand. Warehouse labor requirements depend on whether the produce in standard containers is shipped by rail or in over-the-road trailers. When received by rail, the car is spotted at the receiving dock and the entire unloading operation is performed by warehouse personnel. When produce is received in trailers the unloading is performed by the driver. Warehouse labor requirements for receiving of produce in standard shipping containers range from 1.8 to 2.8 man-hours per load for rail cars and average 0.5 man-hour for trailers.

The pallet container substitutes as one handling by a forklift truck to separate handling of 13 bags

of potatoes and approximately 35 boxes of apples, oranges, or grapefruit.

When produce is received in pallet containers, unloading time is 18 man-minutes for trailers; unloading from railcars was 24 man-minutes.<sup>4</sup> Slightly less time is required for trailer unloading, because the forklift-truck operator has a straight path into the trailer. In the rail car he must turn 90° upon entering and leaving the car.

Probably the greatest economy in the receiving operation is in the time the dock and equipment are tied up when pallet containers are used. With the faster turnaround, less dock space is required and traffic bottlenecks are reduced. The over-the-road carrier will save about 2 hours of dock time. With depreciation on equipment and the cost of labor estimated to be \$12 per hour, the saving is \$24 per load. Actual warehouse labor requirements are decreased by as much as 91 percent for rail receiving and 50 percent for trailer receiving.

**Line feeding.**—When produce is received in standard shipping containers it is manually emptied onto the feed belt of the packaging line. Individual containers are lifted up to the feed belt or the pallet load of containers is placed on a platform level with the feed belt. Either method is time-consuming and fatiguing. Another problem in feeding the line with standard containers is the disposal of the empty containers. For example, a pallet load holds 20 apple containers. These boxes must be opened and the lids set aside. The boxes are then emptied. If they are tray-pack cartons, 80 or 100 pulp layers must be removed. The boxes must be reassembled for future use in the warehouse or 40 separate pieces moved to a disposal area.

The problems of work-place arrangement and container handling are, in large part, resolved when produce is received in pallet containers. Warehouse labor requirements for line feeding are reduced by an average of 65 percent when produce is fed onto the line in pallet boxes.<sup>5</sup>

### **Bulk Shipment and Receiving of Produce**

The ultimate in bulk shipment is the use of the rail car or the trailer as the container—this eliminates all containers. Potatoes have been shipped from Maine to various points on the east coast in specially designed rail cars. For loading, the car has a belt conveyor (running the length of the car) which rises during the loading to minimize bruising. Two belt conveyors are below openings in a V-shaped trough which runs the length of the car. Each of these conveyors feeds potatoes onto a third conveyor, which runs across the width of the car

<sup>4</sup> For additional details see appendix tables 52 and 53.<sup>5</sup> For details, see appendix tables 54 and 55.

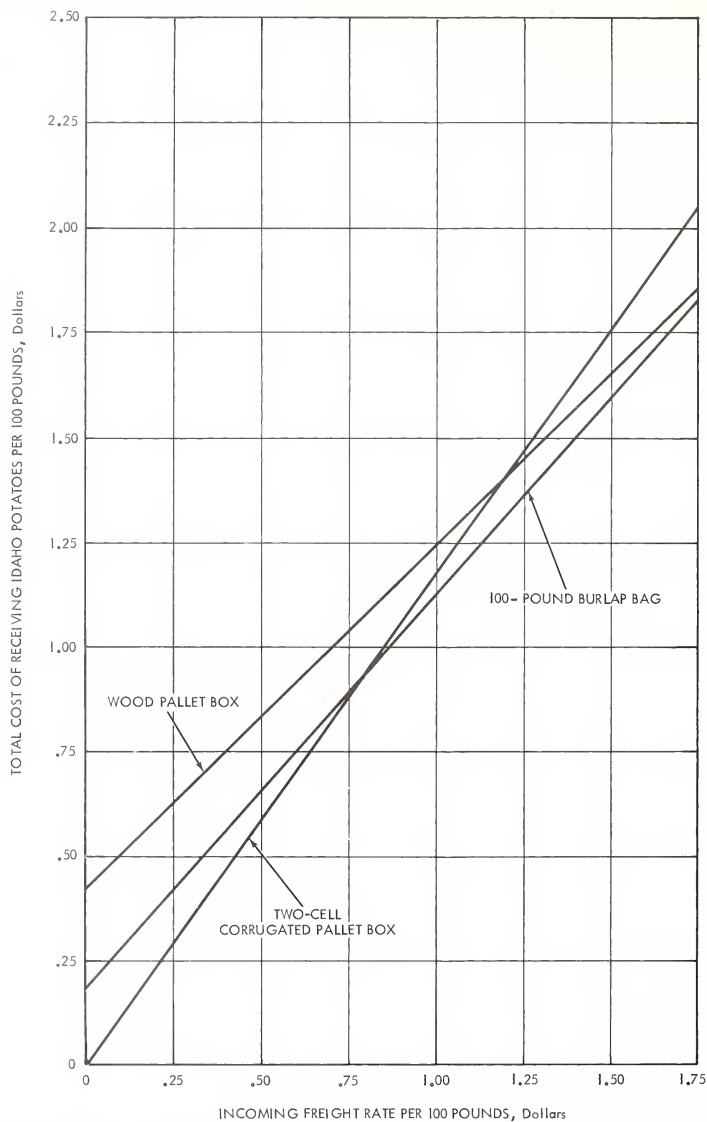


FIGURE 11.—Total cost of receiving Idaho potatoes by rail car in alternative containers vs. incoming freight car rate. (Refer to table 56 for computations of the straight-line relationship.)

and which permits unloading on either side of the car. The limitations of this system are the cost of modifying the equipment; the length of time to turn the car around, which limits the number of round trips; and the relatively few warehouses that are equipped to handle the bulk rail cars. The bulk rail cars will on the average transport 65,000 pounds of potatoes.

Another type of bulk loading is the shipment of oranges in trailers. The size of the load depends on whether the oranges are shipped piggy-back or over highway on trailers. Typically, the oranges are unloaded by elevating the front of the trailer and either feeding the oranges by conveyor to the packing line or dropping them into pallet-type bins. For unloading into bins, total labor requirements are 4 to 5 man-hours. For feeding onto the packing line, the time requirements depend on the line output. If the line output is twenty-five 5-pound bags per minute, unloading takes between 5 and 6 hours for one man who feeds the line.

Both rail and trailer bulk loading lack flexibility. Usually the bulk loads are limited to one size of one item. Another limitation is the lack of studies on bruising in bulk loads. Tests should be conducted to determine relative bruising at different load depths and for alternative systems of loading and unloading.

### Comparative Costs of Receiving and Handling Selected Produce Items in Standard Shipping Containers and in Pallet Containers

The standard containers that are most frequently used for the bagged items were compared

with both wooden and corrugated containers under different conditions. For each commodity, straight-line curves incorporating labor, freight, and material costs were constructed for alternative freight rates. The freight factor includes the weight of the empty container as received and returned to the grower. This permits the reader to find the cost for each item in alternative containers for the freight rates that apply to his area.

#### Cost Comparison for Potatoes

The cost of receiving potatoes into the central warehouse is approximately the same when they are shipped in 100-pound sacks and in partly returnable corrugated pallet containers. The cost includes receiving container, freight (including return of empty container), and receiving labor for potatoes shipped from Idaho to the upper Midwest (table 8).

The lowest cost method of shipping potatoes at any freight rate can be calculated by using the straight-line curves in figure 11. The only assumption is that the ratio of the incoming freight rate to the return rate for collapsed pallet containers is constant. In this study, where the incoming rate for potatoes is \$1.08 per cwt. and the return rate on the empty container is \$1.23 per cwt., the total cost per round trip for a wooden pallet box is \$1.26 per cwt. (from fig. 11,  $y = 0.035 + 1.20x$ ). When the incoming rate is \$2.00 per cwt., the total cost for the wooden pallet box would be \$2.44 per cwt. Where the rates are high, the 100-pound burlap bag is the lowest cost container. As the rates decrease, the permanent box becomes more advantageous.

TABLE 8.—*Cost of receiving potatoes shipped by rail car from Idaho to Minneapolis-St. Paul, Minn., by type of container, 1964<sup>1</sup>*

Cost item	Standard containers		Pallet containers (1,300-lb. capacity)		
	100-lb. burlap bag	50-lb. baler bag	2-cell corrugated		Wooden pallet
			1 trip	5 trips	
Cost per container:	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Material.....	0.13	0.08	4.46	0.98	0.34
Freight.....	1.09	.56	14.62	15.28	16.82
Labor (receiving and line feeding).....	.04	.03	.11	.11	.11
Total.....	1.26	.67	19.19	16.37	17.27
Cost per earload (46,800 pounds).....	590	627	691	589	622
Cost per 10-pound bag.....	<i>Cents</i> 12.6	<i>Cents</i> 13.4	<i>Cents</i> 14.8	<i>Cents</i> 12.6	<i>Cents</i> 13.3

<sup>1</sup> For further details see table 57, p. 101.

In every region, local potatoes usually account for a high percentage of the firm's annual movement. An example is the Red River Valley, which supplies over 50 percent of the potatoes shipped into the Minneapolis-St. Paul area. Typically, the warehouse is only a few hours' travel from the source. This tends to favor over-the-road shipment since the turnaround time is so short. Although freight rates on potatoes are fairly well fixed, rates for containers are subject to negotiation. Often the arrangement is for net-weight receiving and free return of the collapsed empty container. The cost of receiving potatoes in pallet boxes is \$203 per carload and \$267 in 100-pound burlap sacks, a reduction of 24 percent (table 9). The wooden pallet container is the highest cost method of shipping local potatoes when freight is paid for the container in both directions and the rate is above 22 cents per cwt. It is the lowest cost method with net-weight shipment and free return. Under existing rate structures, the 2-cell corrugated box is more costly than the standard 100-pound sack at any rate (fig. 12).

### Apples

The lowest cost method of receiving apples at the central warehouse is in partly returnable pallet containers. The potential savings are \$51 per carload, as compared to the standard tray-pack carton (table 10). This is equivalent to a savings of 4.8 cents per 4-pound bag of apples.

There will be additional savings available to the retail store through central warehouse packaging and to the shipper through use of pallet containers: (1) Individual packing of the tray-pack cartons will be replaced with automatic pallet box fillers with a savings of 12 cents per carton, or \$129 per carload (equivalent to a 54-pallet-box load); (2) less space is required for packout; and (3) loading into car or trailer is reduced from 3 man-hours to 30 minutes.

The return of the empty container is a major problem for the receiving of apples in pallet containers. The return freight rate is 3.2 times higher than the incoming rate.<sup>6</sup> This is the reason light-weight spacer channels were used for the top two boxes of a stack. If the return freight rate is lowered, the wooden pallet box will probably gain in favor because it has fewer handling problems for shipper, carrier, and receiver. If the return rates were the same as the fruit rate, shipping in wooden pallet boxes would cost \$834, and in corrugated pallet boxes (5-trips) \$798 per load. At present rates, the wooden pallet box is a lower cost container than either the loose-pack carton or the expendable corrugated container when the incoming freight rate is less than \$1.70 and \$1.55, respectively (fig. 13).

<sup>6</sup> In Minneapolis-St. Paul, the incoming rate from Washington State is \$1.51 per cwt. (incentive rate) and the return rate on the empty containers is \$4.84 per cwt.

TABLE 9.—*Cost of receiving potatoes shipped from Red River Valley to Minneapolis-St. Paul, Minn., by type of container, 1962*

Cost component	100-lb. sack	5 trip 2-cell corrugated box (1,300-lb. cap.)		Wooden pallet box (1,300-lb. cap.)	
		Freight rates	Shipped net weight and free return	Freight rates	Shipped net weight and free return
Cost per containers:					
Material:					
Container-----	Dollars 1 0.13	Dollars 0.60	0.60	Dollars 0.34	0.34
Base-----	.12	.12	.12	-----	-----
Strapping-----	.26	.26	.26	-----	-----
Freight:					
Product <sup>2</sup> -----	.40	5.20	5.20	5.20	5.20
Container (in-coming)-----		.71	-----	.48	-----
Return of empty container <sup>3</sup> -----		<sup>4</sup> 1.46	-----	<sup>5</sup> 3.24	-----
Labor:					
Receiving-----	.02	.03	.03	.03	.03
Line feeding-----	.02	.08	.08	.08	.08
Total-----	.57	8.46	6.29	9.37	5.65
Cost per carload (46,800 pounds net)-----	267.00	305.00	226.00	337.00	203.00

<sup>1</sup> Cost of 100-pound bag closed is 18¢ less a salvage value of 5 cents.

<sup>2</sup> Freight rate, 40 cents per cwt.

<sup>3</sup> Freight rate, \$2.70 per cwt. for empty boxes.

<sup>4</sup> 54-lb. box.

<sup>5</sup> 120-lb. box.

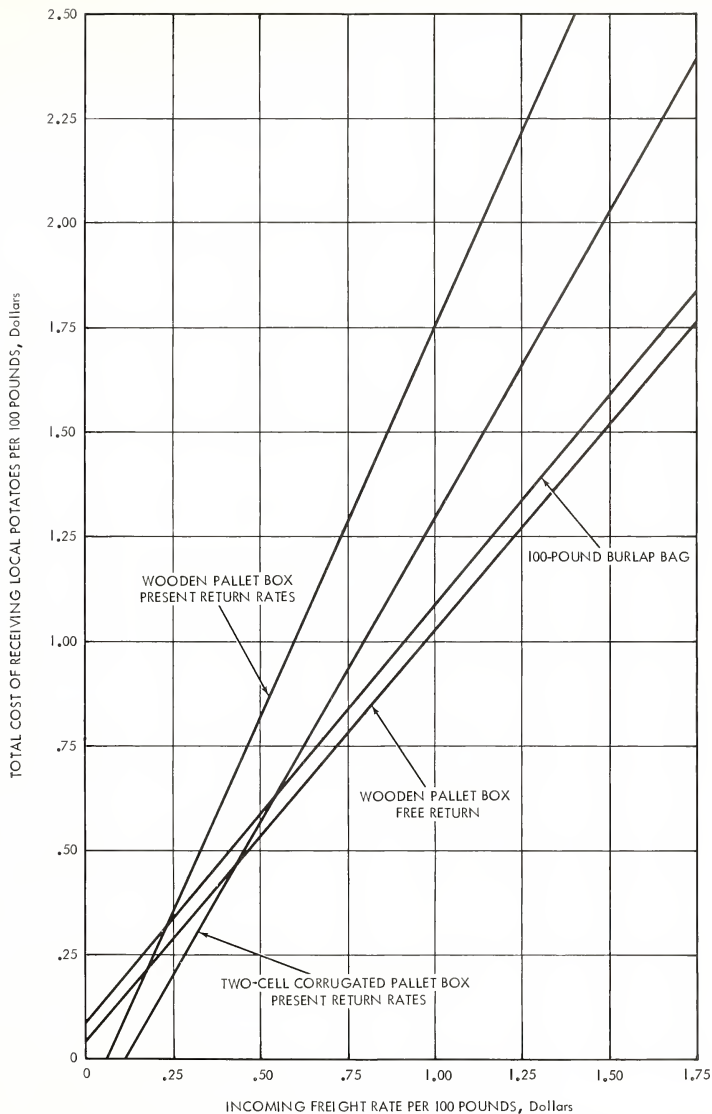


FIGURE 12.—Cost of receiving local potatoes in alternative containers vs. incoming freight rate. (Refer to table for computations of the straight-line relationship.)

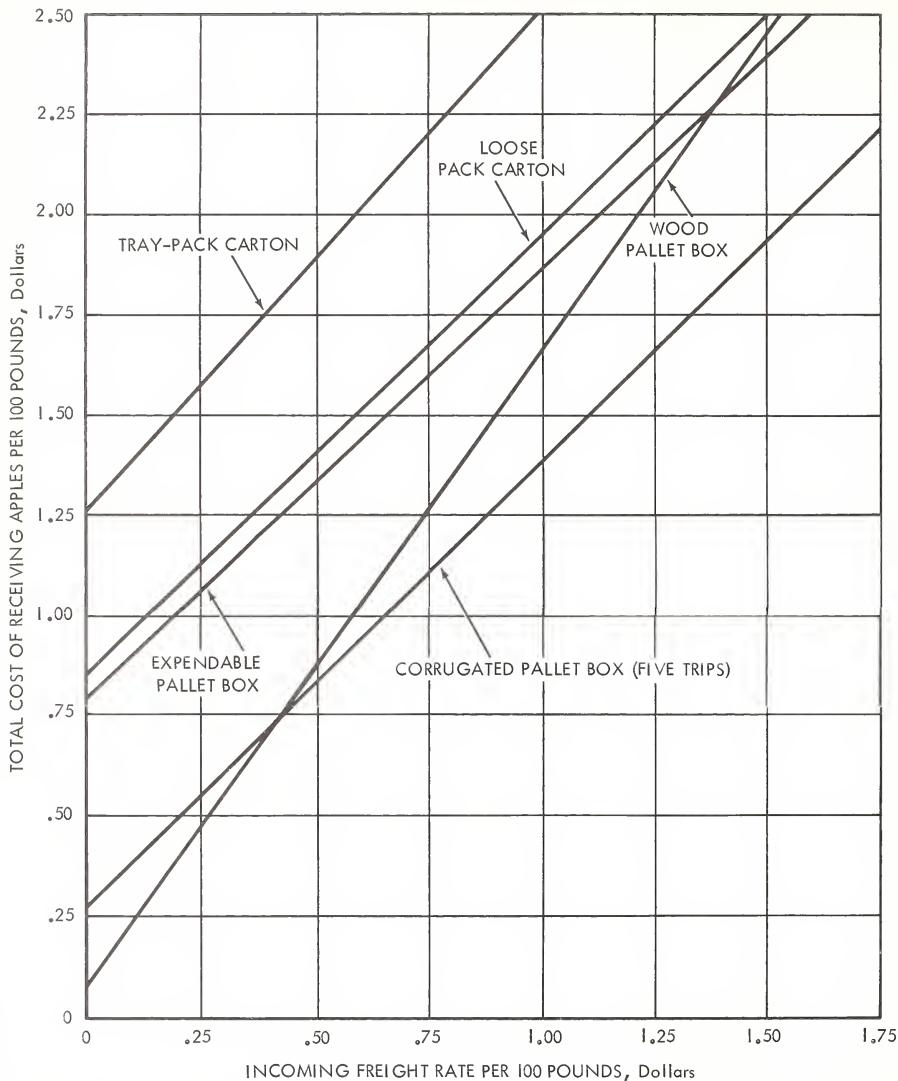


FIGURE 13.—Total cost of receiving apples in alternative containers vs. incoming freight rates. (Refer to appendix table 57 for computations of the straight-line relationship.)



TABLE 10.—*Cost of receiving apples shipped from State of Washington to Minneapolis-St. Paul, Minn., by type of container, 1964*<sup>1</sup>

Cost component	Standard cartons		1-cell corrugated pallet box <sup>2</sup>		Wooden pallet box
	Tray pack	Loose pack	1 trip	5 trips	
Cost per container:	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Material.....	0. 53	0. 31	5. 86	1. 27	0. 51
Labor, receiving, and line feeding.....	. 03	. 03	. 14	. 14	. 14
Interest.....	-----	-----	-----	. 13	. 09
Freight.....	. 74	. 73	11. 81	14. 79	18. 76
Total.....	1. 30	1. 07	17. 81	16. 33	19. 50
Cost per carload (42,930 lb. net weight).....	1, 395	1, 148	1, 048	882	1, 148
Cost per 4-lb. bag.....	<i>Cents</i> 13. 0	<i>Cents</i> 10. 6	<i>Cents</i> 9. 8	<i>Cents</i> 8. 2	<i>Cents</i> 10. 7

<sup>1</sup> For additional details and explanation, see appendix table 58.<sup>2</sup> This one-piece, triple-wall container meets the specifications as required by PPP-B-640c, dated July 7, 1964, and published by Federal Supply Service, General Services Administration.

### Oranges

The lowest cost method of receiving oranges is in a bulk trailer load. Savings, as compared to the ¾-bu. 2-piece telescoping corrugated carton, are \$319 per carload, or 2.5 cents per dozen size (3.5 pounds average) consumer unit. The next lowest cost shipping method is the 1-cell triple-wall corrugated container that makes five round trips (table 11).

Since oranges have rather thick skins and are therefore not so susceptible to bruising as apples, there is no reason that shipping of oranges in pallet containers and bulk loads should not increase. Bulk loads are readily adaptable to the packaging operations of large terminal packers

and central warehouses that have more than one packaging line. These larger facilities will have handling equipment to accommodate the bulk loads.

Receiving in pallet containers is more flexible, as it will permit mixed loads, and pallets can be received into any warehouse that has a forklift truck or pallet transporter. Present freight rates for return of the empty container are 2.3 times higher than the incoming freight rate and put pallet containers at a disadvantage. It costs \$101 to return a load of 54 corrugated containers. The wooden pallet box, though extremely easy to handle, is severely restricted by freight charges. It costs less to use than the 1½-bu. wirebound container at freight rates below \$1.15 per cwt. (fig. 14).

TABLE 11.—*Cost of receiving oranges shipped from Florida to Minneapolis-St. Paul, Minn., by type of container, 1964*<sup>1</sup>

Cost component	Standard containers		One-cell corrugated pallet containers			Wooden pallet container (collapsible)	Bulk trailer loads
	1½-bu. wirebound	¾-bu. 2-piece corrugated	1 trip	3 trips	5 trips		
Cost per container:	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Material.....	0. 38	0. 25	5. 86	1. 86	1. 27	0. 51	20. 93
Labor.....	. 04	. 03	. 14	. 14	. 14	. 14	22. 30
Interest.....	-----	-----	-----	. 08	. 05	. 10	-----
Freight.....	1. 62	. 75	14. 65	17. 63	17. 63	19. 49	812. 21
Total.....	2. 04	1. 03	20. 65	19. 71	19. 09	20. 24	855. 44
Cost per 45,630-lb. load.....	1, 095	1, 175	1, 222	1, 064	1, 031	1, 198	856
Cost per dozen (3½-lb. bags).....	<i>Cents</i> 8. 4	<i>Cents</i> 9. 0	<i>Cents</i> 9. 4	<i>Cents</i> 8. 2	<i>Cents</i> 7. 9	<i>Cents</i> 9. 2	<i>Cents</i> 6. 6

<sup>1</sup> For additional details, see table 59, p. 103.



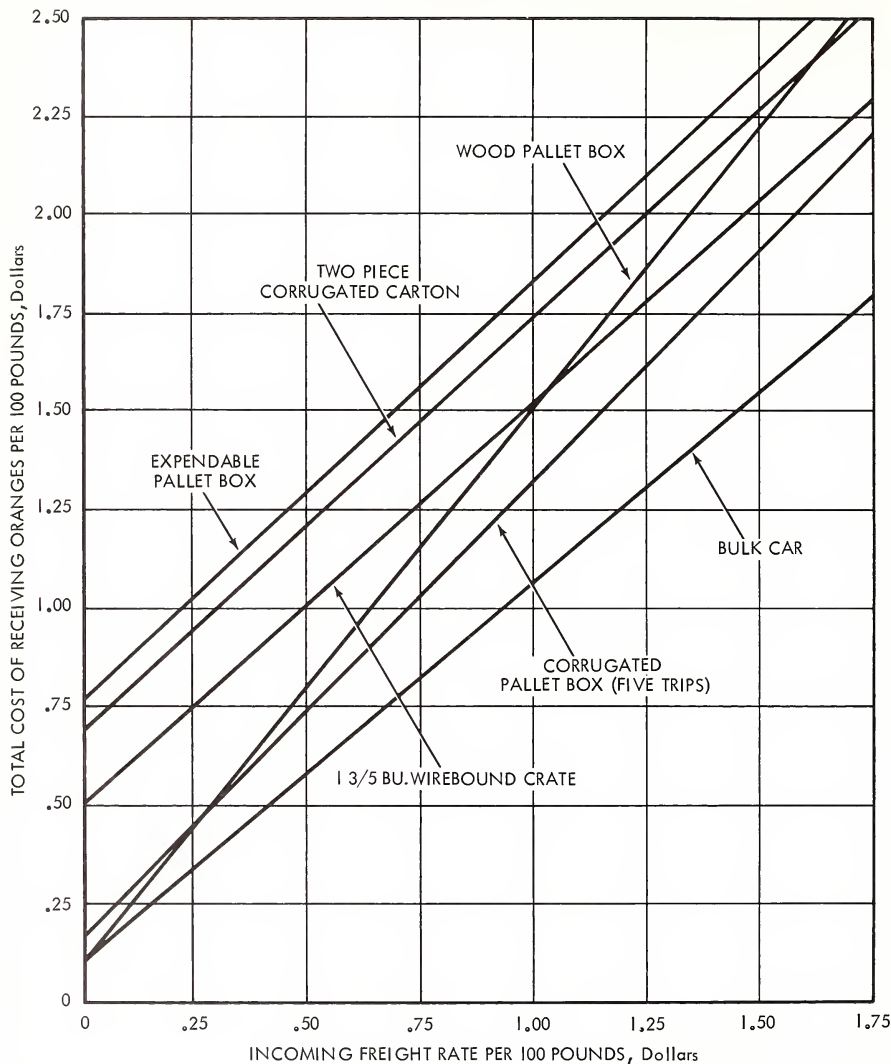


FIGURE 14.—Total cost of receiving oranges in alternative containers vs. incoming freight rates. (Refer to table 57 for computations of the straight-line relationship.)

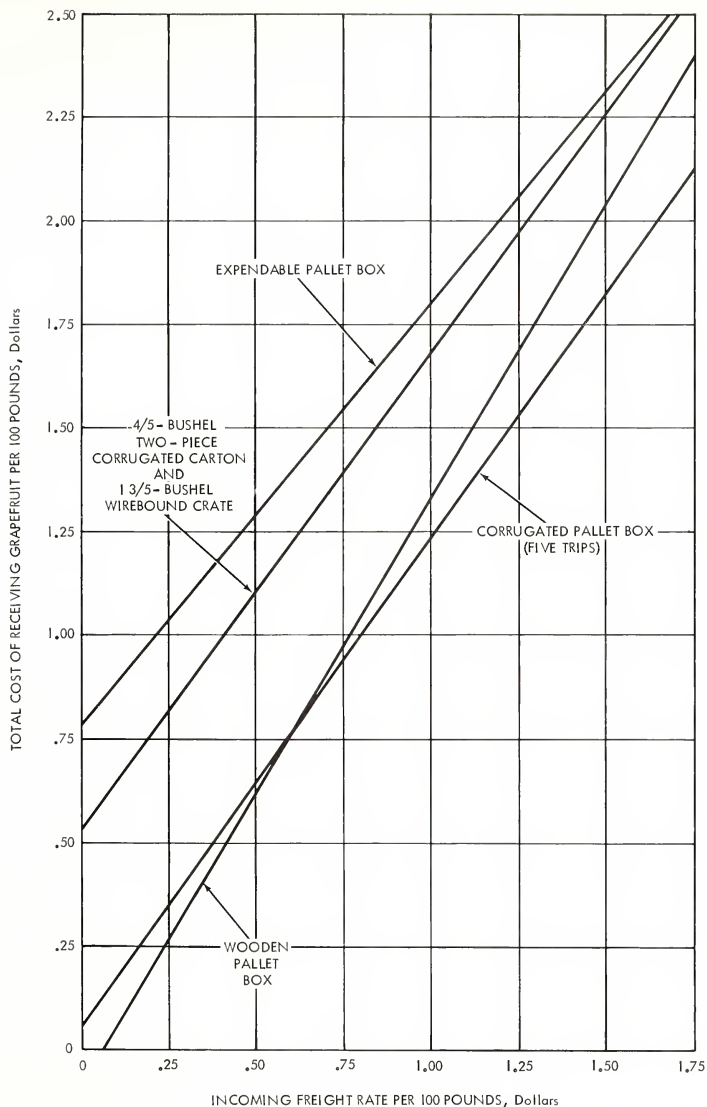


FIGURE 15.—Total cost of receiving grapefruit in alternate containers vs. incoming freight rates. (Refer to table 57 for computations of the straight-line relationship.)

TABLE 12.—*Cost of receiving grapefruit shipped from Florida to Minneapolis-St. Paul, Minn., by type of container, 1964<sup>1</sup>*

Cost component	Standard shipping container		Corrugated pallet container			Wooden pallet box
	1½-bu. crate	¾-bu. carton	1 trip	3 trips	5 trips	
Cost per container:	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Material.....	0.38	0.25	5.86	1.86	1.27	0.51
Labor.....	.04	.03	.14	.14	.14	.14
Interest.....				.08	.08	.10
Freight.....	1.50	.72	13.92	16.82	16.82	18.76
Total.....	1.92	1.00	19.92	18.90	18.31	19.51
Cost per carload (42,930 pounds).....	1,056	1,130	1,171	1,021	989	1,148
Cost per consumer unit (eight 6.5-pound packages).....	<i>Cents</i> 16.0	<i>Cents</i> 17.1	<i>Cents</i> 17.7	<i>Cents</i> 15.5	<i>Cents</i> 15.0	<i>Cents</i> 17.4

<sup>1</sup> For additional details see table 60, page 103.

### Grapefruit

The lowest cost method of receiving grapefruit into the central warehouse packaging operation is in partly returnable corrugated containers. Potential savings, as compared to the ¾-bu., 2-piece container, are \$141 per carload (table 12).

Problems of shipping grapefruit in pallet boxes are similar to those of shipping oranges, with one exception; grapefruit is more susceptible to damage than oranges and therefore should not be shipped in bulk loads or deep pallet boxes. As with oranges, the principal area of savings is the reduction of material costs, but again this is partially offset by freight costs for returning the empty pallet containers. The return of the wooden pallet is \$238, which at present rates, limits their use. Only when the freight rate is under \$1.55 per cwt. will the wooden box be less expensive than the standard ¾-bu. carton (fig. 15).

### Advantages and Total Savings of Pallet Boxes for Shipment of Produce for Central Warehouse Bagging

The food industry is constantly striving to lower the costs of selling produce. Pallet-box shipment of produce is a new technique, which, though not fully tested and not widely used, affords warehouses an opportunity to lower costs. Lower costs in turn will increase volume and provide a saving to the consumer. For example, if apples cost 42 cents per 4-pound bag and have a gross margin of 30 percent, they will retail at 55 cents. If pallet-box receiving reduces the cost per 4-pound bag of apples by 5 cents, then with the same gross margin they would retail at 48 cents. If the saving is

passed on to the consumer, she will pay 7 cents less per bag. The retailer will benefit through a higher net profit resulting from increased sales. The grower will benefit by selling a larger percentage of his crop at a relatively high price.

In the hypothetical produce-packaging installation that would be a composite of those studied, potential yearly savings through the use of lowest cost pallet containers amounted to \$52,502 (table 13). Approximately two-thirds of the savings are realized for apples and one-fifth are for 5- and 10-pound packages of potatoes. To realize these savings, a firm must install only a pallet box tipper and a conveyor to feed the pallet boxes into and out of the tipper—an investment of approximately \$1,200.

The net savings are based on a central warehouse that ships an average of 70,000 packages per week. This is the average volume for the firms observed during the study. The percentage of movement of each item shown in the study is also the average for all firms studied. Three firms shipped an average of 750 packages (bagged items) for every \$1,000 of produce sales at retail. When the firm ships 70,000 packages per week, the annual produce volume is approximately \$2,730,000. The savings per item at volumes from 1 to 6 million packages per year are shown in table 13 and can be calculated for varying volumes from figure 16.

Several problems in receiving produce in pallet boxes require additional research and testing. (1) Who will own the pallet boxes—the shipper, carrier, or receiver? Perhaps pallet box pools will make this shipping method available to more firms and reduce the overall investment in pallet containers. (2) Reduction of bruising must be a

TABLE 13.—*Savings in a central produce plant packaging 70,000 packages per week when specified produce is received in pallet containers instead of shipping containers, 1964 prices*

Produce and size of consumer unit	Consumer units packaged per year	Receiving cost per consumer unit		Savings	
		Standard container	Pallet box	Per package	Per year
Potatoes, 10 pounds <sup>1</sup> .....	Thousands 1, 019	Cents 9. 2	Cents 8. 4	Cents 0. 8	Dollars 8, 152
Potatoes, 5 pounds.....	728	4. 6	4. 2	. 4	2, 912
Apples, 4 pounds.....	692	13. 0	8. 2	4. 8	33, 216
Oranges, dozen.....	400	9. 0	7. 9	1. 1	4, 400
Grapefruit, 8-pack.....	182	17. 1	15. 0	2. 1	3, 822
Total.....					52, 502

<sup>1</sup> The cost per consumer unit for potatoes is an average of Idaho and Valley shipments.

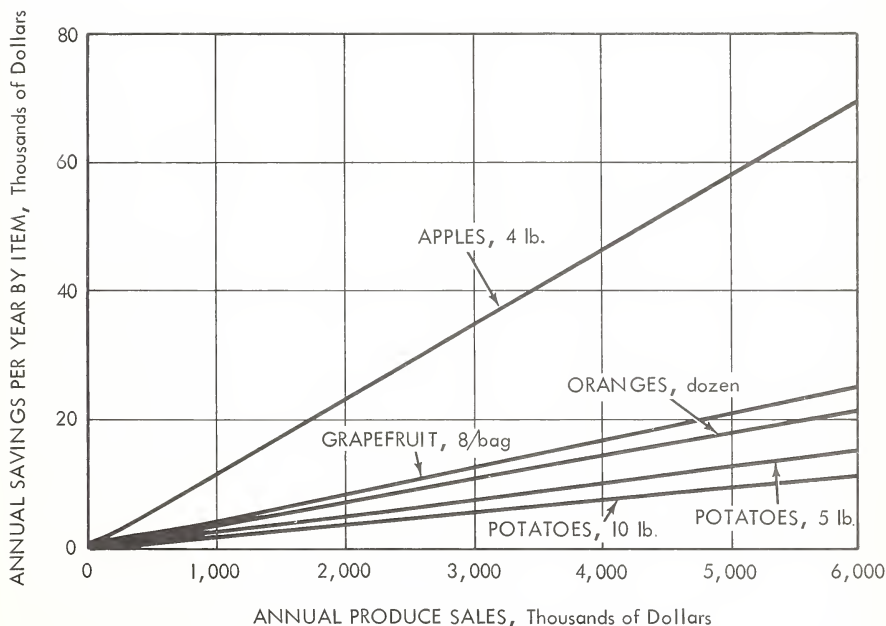


FIGURE 16.—Estimated savings by produce sales volume through receiving produce items in pallet containers. (For details, see appendix table 61.)

TABLE 14.—*Potential savings per year when potatoes, apples, and citrus fruit are shipped in pallet containers instead of standard shipping containers, 1964 prices*

Produce	Total cost per carload		Savings per carload	Loadings per year <sup>1</sup>	Savings per year
	Standard containers	Pallet box			
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Number</i>	<i>Dollars</i>
Potatoes.....	428	396	32	389, 000	12, 448, 000
Apples.....	1, 395	878	517	67, 000	34, 639, 000
Oranges.....	1, 175	1, 031	144	73, 000	10, 512, 000
Grapefruit.....	1, 130	989	141	42, 000	5, 922, 000
Total.....				571, 000	63, 521, 000

<sup>1</sup> Obtained from reference (1).

prime goal at all levels. (3) Adjustments in freight rates for the return of the collapsed container are needed to provide an impetus for increased pallet box shipments. (4) State limitations on load size for over-the-road trailers limit the possibility of incentive rates for larger loads. It is expected that these problems will be resolved as more firms gain experience in pallet box shipments.

The rewards to the produce industry are great if members can work together to solve these problems. There are an estimated 570,000 carloads of potatoes, apples, and citrus per year that could be shipped in pallet containers. If the savings and freight rates reported in this study are representative of the industry, the potential savings are \$63,521,000 per year (table 14).

### Pallet Containers Compared With Standard Shipping Containers

Pallet containers have the following advantages:

1. A considerable reduction in material costs.
2. Generally a larger load can be shipped in pallet boxes; hence, a lower freight rate can be obtained.
3. Less labor is needed for loading and unloading.
4. Tare weight is less for most commodities. (Potatoes are an exception.)
5. Bruising is reduced for some commodities.
6. The steady flow of product out of the pallet boxes onto the packaging line tends to increase line productivity.

Pallet containers have the following disadvantages:

1. The return of the empty pallet containers can be expensive, especially the wooden boxes.

2. The initial investment in pallet containers and related handling equipment is high as compared to standard containers.

3. Until the use of pallet containers becomes more prevalent, the freedom of choice of shippers and receivers will be restricted. This especially applies to the buyer who must select a supplier with the necessary facilities to fill and load pallet containers.

### Pallet Containers Compared With Bulk Loads

Advantages of pallet containers are as follows:

1. No special facilities are required for loading and unloading, since most shippers and warehouse receivers have forklift trucks.
2. There is no expensive modification of rail cars.
3. The pallet box requires very little labor for loading and unloading.

4. There is no demurrage or tieup of equipment and drivers at the receiving dock—the product can be unloaded and stored in the pallet box.

5. It is possible to ship mixed loads in pallet box containers. Different sizes and types of produce, either all in pallet containers or a combination of pallet boxes and standard containers, can be shipped in the same load.

Advantages of bulk loads are as follows:

1. Eliminates the cost of the shipping container.
2. Eliminates the physical handling in loading and unloading.
3. Lowers freight cost when tare is eliminated.
4. Produce can be conveyed directly to the packaging line without temporary storage.

## EQUIPMENT FOR CENTRAL WAREHOUSE PRODUCE PACKAGING

The determination of which equipment a central warehouse produce-packaging plant should use depends to a large extent on volume, especially anticipated volume, and the number of items the plant plans to package. A single bagging line operating 8 hours a day for 5 days should average 800,000 packages per week. Over this volume the firm will need two packaging lines, one or both of which can specialize; that is, one could be used for potatoes and onions and the second for citrus and apples. Alternatives are overtime or a second shift. If the firm packages only a limited line, such as potatoes and onions, a certain type of equipment suitable for only these products is acceptable. But if one line is used to package a variety of items, the line must be flexible and must adequately handle the most bruise-susceptible item, apples.

Certain pieces of equipment are basic to any warehouse packaging operation. They include (1) a receiving belt or hopper, (2) a roller-grader conveyor for inspecting the product, (3) a feed belt to distribute produce to the bagging heads, (4) the bagging heads, (5) a take-away conveyor to move filled bags from the bag filling area, (6) equipment for closing the bag, and (7) a packout table.

In addition, some firms incorporate highly specialized equipment in their packaging lines. Specialized equipment can increase productivity when volume is large enough to justify more than one bagging line. Bruisable items are bagged on a line equipped to handle produce with more care. Unnecessary drops are eliminated, and padding is placed on surfaces where items may bruise; a level-feed bagging unit would be preferred to a hopper-type bagging machine. A separate line for onions can incorporate a power brush and vacuum cleaner to remove loose onion skins. For potatoes, emphasis is directed towards bagging equipment that yields greater productivity.

The equipment that identifies a particular type of packing line is the bag fillers. Three types of bag fillers were studied: the level belt, the hopper type, and the semiautomatic rotary.

### Placing Produce on the Bagging Line

The method used on any bagging line to transfer produce from shipping containers onto the feed belt will depend to a large extent on the items packaged and the type of receiving container. Even if only potatoes and onions are packaged, there is a great variety of methods of transferring produce onto the line. They vary from dumping the product through a floor chute and onto a conveyor to using a platform level with the receiving

belt and dumping product down onto the belt (fig. 17). When a wide variety of items are packaged on the same line, bruising becomes a key factor. Apples and citrus must be handled more gently than potatoes and onions. Many firms wish to package a variety of items, but if volume justifies only one line, it should be geared to the items most susceptible to bruising.

### Manual Line Feeding

The work place for manually placing produce on a receiving belt must have the receiving belt at the same level as the container to be dumped. Both should be located at the height most convenient for the operator, or the height of his standing place should be adjusted. If the pallet height is adjustable, it is possible to have a work place where worker, equipment, and product are properly located. A pallet lift table can raise the product to the desired level as needed. In operation, the pallet load of shipping containers is conveyed onto the lift table, which is raised as each level of containers is placed on the line. The platform around the lift table gives the operator access to all containers on the pallet.

When improper arrangement of the line feeding area forces employees to lift heavy shipping containers, there is a tendency to add crew members. In one packaging installation the accumulation conveyor for moving pallet loads of unpacked produce was on the floor and the receiving belt was 38 inches high. One worker's sole function was to help lift 100-pound sacks and heavy wirebound crates. Forty-seven percent of the labor of the two-man crew that fed the line to package 10-pound units of potatoes was nonproductive. When a pallet lift table was installed, the element "pickup bag" was eliminated for the second man and the job became a one-man operation.

Produce is typically delivered to the bagging line on pallets by a forklift truck. A floor-level conveyor that will provide for an accumulation of four or five pallet loads will insure an adequate supply of the product, and the forklift operator will not have to wait for space to unload pallet containers.

The pallet lift table is the most economical method of manually placing produce on a receiving belt. The time requirements are similar to line feeding from a platform, but fatigue is decreased and there is no delay between removing an empty pallet and placing a full pallet on the platform (table 15). The lack of accumulation either ties down a forklift driver or the entire packag-





FIGURE 17.—Alternative methods of placing produce manually on a receiving belt: A, Into a floor chute; B, on belt from a raised platform; C, at belt height by two-man team; and D, from an adjustable lift platform.

ing-line crew has nonproductive time while waiting for him. The least productive line-feeding method is a combination of floor-level pallet and a receiving belt 34 to 40 inches high. This is typically a two-man operation and requires more than twice as much labor as the platform. The 100-pound sack of potatoes requires more labor than two 50-pound kraft-type paper containers.

When the volume of bagged produce exceeds the capacity of one line (approximately 80,000 bags per week), a second line must be installed. Items that are susceptible to bruising can be packaged on one line where great care is exercised in product handling. The second line will not be as concerned with bruising and can, therefore, mechanize more of the operations.

TABLE 15.—*Labor requirements for three methods of dumping potatoes onto a packaging line*

Work element	Dump 100-lb. sack onto belt 40 inches above floor level with 2-man crew		Dump 100-lb. sack onto belt from a platform that is level with the receiving belt	Dump 50-lb. kraft paper sack onto belt 36 inches above floor level
	Man 1	Man 2		
Pick up bag-----	<i>Minutes</i> 0.05	<i>Minutes</i> 0.05	<i>Minutes</i> 0.08	<i>Minutes</i> 0.09
Cut strings-----	.09		.07	
Open-----				.05
Dump and set aside empty bag-----		.10	.11	.08
Miscellaneous-----	.03	.03	.04	
Delays-----	.16	.15		
Total time-----	.33	.33	.30	.22
Total time per 100 pounds-----	.66		.30	.44
Personal and fatigue allowance (15 percent)-----	.10		.05	.07
Standard time per 100 pounds of potatoes-----	.76		.35	.51

### Line Feeding With Pallet-Box Tippers

When produce is received in pallet boxes, a pallet-box tipper must be incorporated into the line-feeding work station. There is less bruising, less strain on the motor, and a more constant flow of produce when the box tipper places the product on the end of the receiving belt than when the produce is fed onto the side of the belt. Most pallet-box tippers require a receiving belt at least 40 inches high. This height may make it difficult to

unload produce manually onto the receiving belt, but the problem can be solved by having the operator work on a 6- to 8-inch-high platform. There should be space to accumulate four to five pallet boxes on a conveyor leading to the tipper. A method of incorporating the pallet-box tipper in the line feeding area is illustrated by figure 18. The accumulation area for empty pallet containers is a continuation of the conveyor for filled pallet containers and this conveyor passes through the pallet-box tipper.

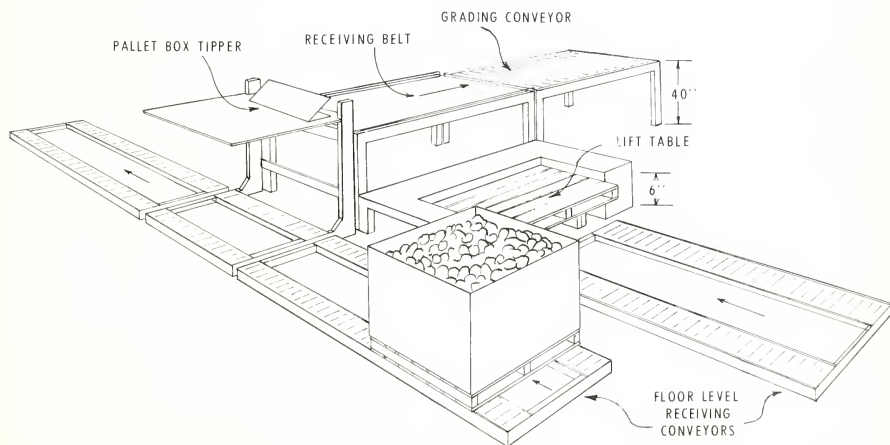


FIGURE 18.—A method incorporating a pallet-lift table in the line feeding setup of a central produce packaging line.



It is important that apples are carefully handled when fed onto the line with a pallet-box tipper. The top of the tipper should be padded, and the area between the discharge gate of the tipper and the receiving belt should also be padded and should have a gentle incline. The best way to transfer apples from any container to the receiving belt is with a water dump (9). This is only practical when there is more than one packaging line.

The lowest cost method of feeding produce onto the receiving belt is with large pallet containers. Compared with an improved manual line-feeding operation, pallet dumping will lower time requirements per 100 pounds of product from 0.356 minute to 0.130 minute for potatoes and from 0.870 minute to 0.285 minute for oranges.<sup>7</sup> It is not always possible to receive all produce in pallet containers, but the pallet-lift table can also handle those items that are received in conventional shipping containers.

### *Handling Empty Containers*

The line feeding function does not end when the product is placed on the conveyor. The empty containers must be collapsed or stacked and removed from the area. The pallet bases should be moved to the packout area where they can be used for the filled reusable master containers. Potato and onion sacks should be stacked as they are emptied. There will be more time to do this when the line is packaging lightweight units such as 3- or 5-pound bags. It becomes more difficult with 10-pound bags of potatoes or with bags of dozen oranges, where the proportion of packages to shipping containers is low. In this case it is better to assign someone to handle empty containers during product changeover rather than let the handling of empties slow down the packaging line. Wire-bound containers should be collapsed flat and stacked on a pallet, sacks should be tied in bundles, and two-piece telescoping cardboard containers should be nested "three in one" or reassembled. The top of wooden pallet containers can be collapsed and stacked on the same pallet as the base.

When corrugated pallet containers are being used, the top and bottom (and base pad if one is used) should be stacked on one pallet, the upright cells on another, and the modified pallet bases on a third. The pallet loads of empty containers should be removed from the packaging line as soon as possible to prevent congestion.

### *Inspection of Product*

There usually is a roller conveyor for grading and inspecting between the receiving belt and the feed belt. There should be good light over this area, and the employee should be standing at a height so he can reach all parts of the conveyor.

The labor used for inspection and grading depends upon the quality and size variations of the produce. Everyone who handles the produce on a packaging line should be aware of the need for quality control. If the quality appears to be good, an inspector may not be required, but if quality is below par, production will drop unless one or more crew members are added to remove off-quality produce. Sufficient containers should be available to handle the off-grade or off-size produce. Barrels on rollers are often used for trash, and the shipping container is suitable for the slightly off-grade produce that will be sold at a reduction.

## **A Comparison of Feed-Belt Systems**

In a bagging operation the feed belt is used to distribute produce among one or more bagging machines. A feed belt's performance is judged by the care with which it handles produce while providing each bagging machine with an adequate supply of produce. The volume demanded at each bagging unit will not necessarily be equal, since crew members who bag produce operate at varying speeds.

A feed belt is not essential for all bagging installations. When volume is low, it is difficult to keep one person busy feeding the line and it is not economical to use the specialized dumping equipment that is necessary to reduce the heavy lifting. For a small-volume packaging line of one to three hopper-type bagging machines, the produce should be dumped directly in the hopper. An example of such a line is illustrated by figure 19, where one person fills the three hoppers with products, supplies the bag fillers with empty containers, and stacks the filled shipping containers. The bag fillers close the bag and pack the containers. A feed belt is not used with the rotary-type baggers—produce is conveyed from the roller conveyor directly into the master hopper.

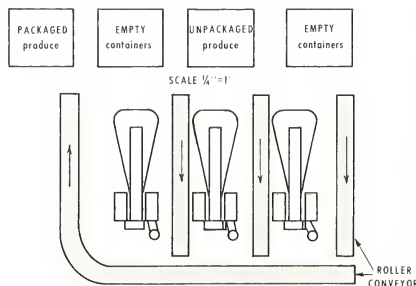


FIGURE 19.—Packaging line for a small-volume produce bagging operation in a central warehouse.

<sup>7</sup> For additional details, see tables 54 and 55.

The bagging equipment used on a line will often dictate the type of feed arrangement. Level-feed baggers with limited accumulation space can accept produce only while weighing scoops are being filled. The baggers, not being able to accept a continuous flow, will bypass some of the produce. As a result, level-feed baggers work best with a two-way feed-belt system where the bypassed produce can be returned for a second pass at the baggers. Rods placed diagonally across the top of the feed belt divert produce into the baggers. The flow of produce into the last bagging head is generally less than that into the first heads. This can be partially corrected by using small-diameter

rods to divert produce into the first bagging heads and progressively larger rods for the end heads. Bruising will increase with the larger diverter rods. The two-way belt effectively adjusts to varying output at the bagging heads, but during product changeover the entire two-way feed-belt system must be cleared of produce before a new produce run can begin. To speed up a change-over, an employee often helps divert product into the bagging units.

One-way feed-belt systems are commonly used with hopper-type baggers. The most common types of one-way feed-belt systems are (1) stationary plow, (2) adjustable diverters, (3) traveling shear, and (4) individual feeds (fig. 20).

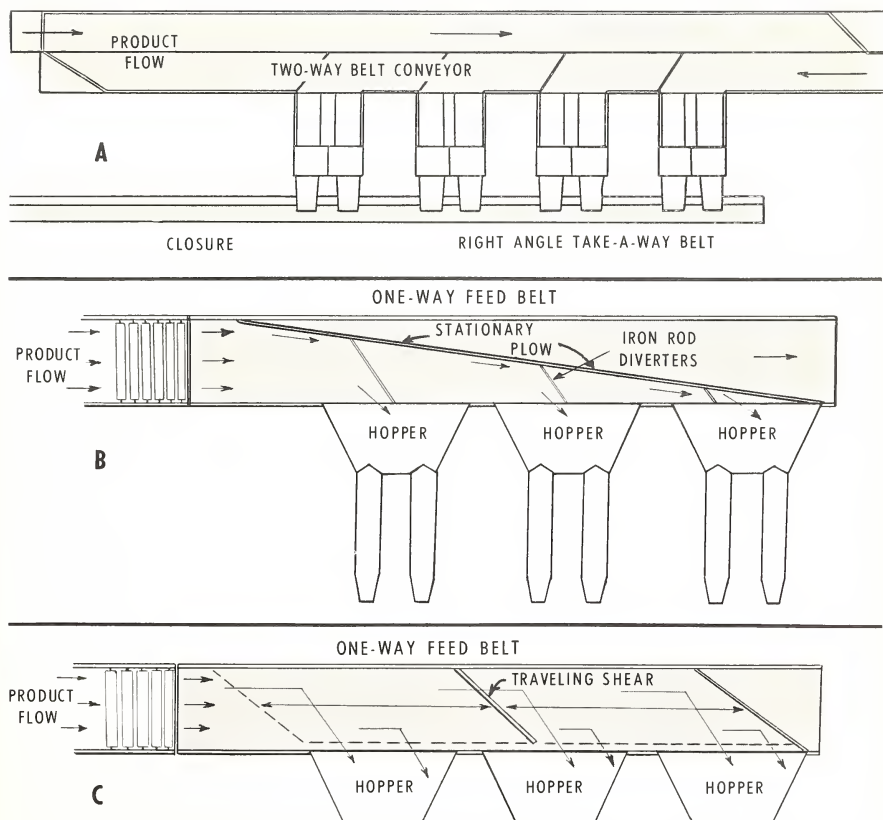


FIGURE 20.—Methods of moving produce from the feed belt into the bagging heads: A, Two-way belt with diverter rods; B, one-way belt with plow and diverter rods; and C, one-way belt and traveling shear.

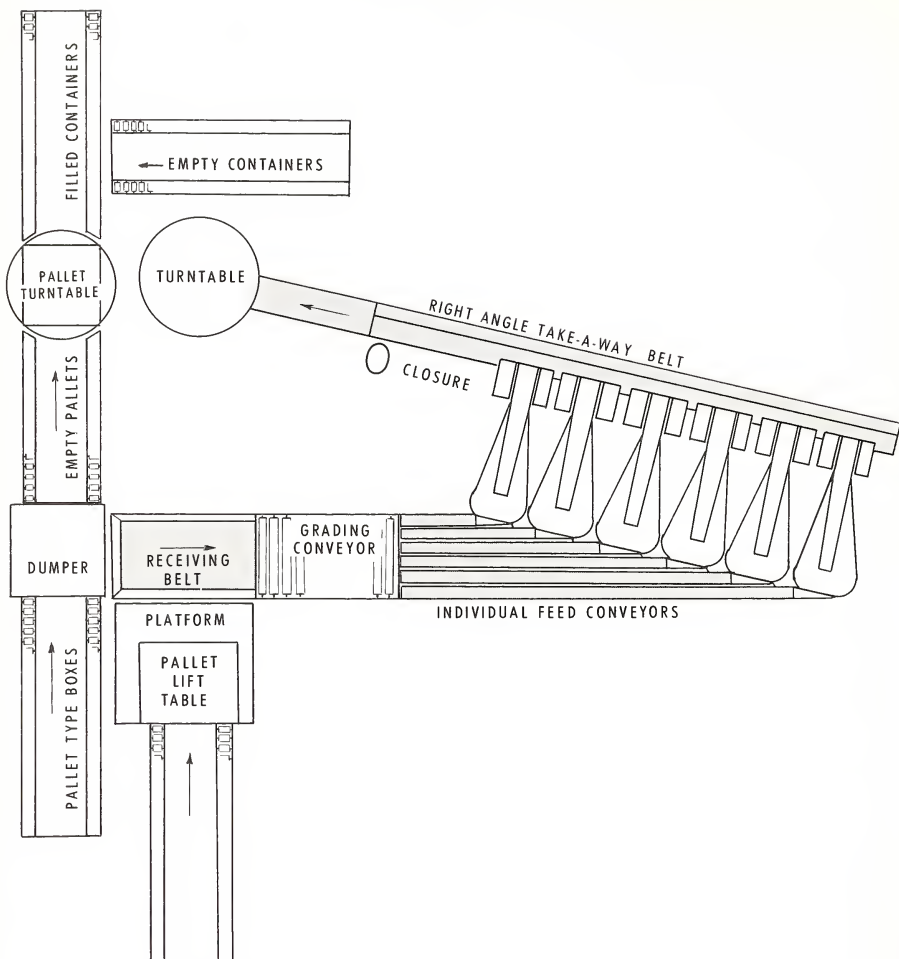


FIGURE 21.—Individual feed belts for distributing produce into the bagging heads.

A stationary plow is a permanent barrier extending diagonally across the feed belt for the length of the hoppers. Produce being carried on the feed belt is pushed into the hoppers. Variations in flow have an effect on which of the hoppers receive the product. With a diminished flow the produce will travel the full length of the hoppers before being pushed into a hopper. Produce items have different characteristics of flowing on a feed belt with the stationary plow: oranges roll freely, but potatoes are more reluctant and must be pushed. If this feed-belt system is to work well, there must be a constant flow of produce onto the belt. Iron rod diverters will help divert the product into the baggers, but they will not work effectively unless the belt is kept full.

Adjustable diverters on the feed belt are actually gates hinged at the entrance to each bagging hopper. The diverters sweep the product traveling along the belt into the hoppers. The gates are adjusted so that each hopper will get the desired amount of product. Frequent supervision is necessary to make sure each hopper is obtaining a satisfactory share of product. The system can be effective when a worker grading produce can also adjust the gates to provide flow into all hoppers.

The traveling shear is a motor-driven diagonal plow that moves up and down the feed belt pushing the product into the hoppers. In operation, the plow travels to the end of the feed belt and on the return trip it travels against the flow, pushing all the product it meets into hoppers. The traveling shear provides positive and equal flow to each bagger but at speeds that rule out its use for bruisable items.

In an experimental feed arrangement, separate belts carry the product to the hoppers. The individual feed belts carry an equal amount of produce, because the produce tends to spread out evenly as it passes over the roller grading conveyor. If one or more bagging heads are not operating, a corresponding part of the roller grading conveyor is blocked off. The discharge end of the feed belt must be level with the top of each hopper. This system offers the advantage of distributing product directly to each hopper with minimum bruising and without the need for any pushing or deflecting product into hoppers (fig. 21).

Other variations or combinations of the feed arrangements described will be found in practice. The effectiveness of any one of these feed systems depends on more than design and construction. Proper supervision and maintenance also control the productiveness of a feed-belt system. It is also essential that motors have sufficient power to move the belt even when it is temporarily overloaded. This is especially true when pallet-type boxes are used to place the product on the feed belt.

## Filling Consumer Units

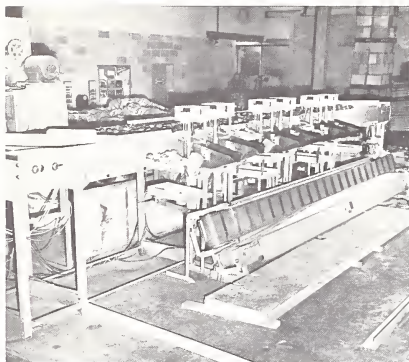
A production line is only as efficient as its least productive part. A bottleneck can occur because of inadequate flow onto the feed belt or because the central closure will not handle the bagged product fast enough. Production is most likely to be reduced because of some problem in the area where the most labor is used. A typical produce bagging line will have 10 crew members, of which 6 will probably be bag fillers. The tempo of the bagging line is largely established by the pace set at the bagging heads. It is here that loose produce is unitized into consumer packages and here that the greatest handling occurs. It is also here that the weight of the package and equipment and methods that will maximize productivity, while holding bruising to a minimum, will increase efficiency of the operation.

### *Equipment and Filling and Weighing Bags*

The type of bagging heads is the factor that distinguishes the packaging line; the dump area, feed belt, take-away belts, and packout equipment are similar for several packaging lines. The three basic types of bagging heads are illustrated in figure 22. Level-belt baggers (usually double-headed) have rods that divert produce from the feed belt onto the level belt of the bagging head and into the dump chute; hopper-type baggers (usually single-headed) have a capacity of up to 200 pounds of produce; and rotary baggers automatically feed the produce into the consumer bag. Some of the factors to be considered in evaluating bagging heads are versatility, bruise level, accuracy, maintenance, labor costs and capacity, and equipment cost.

The level-belt bagger will handle all types of produce to be bagged with a minimum of bruising. It will not fill the larger bags as fast as the hopper or rotary types, because it is difficult to divert a large and constant flow of product from the feed belt. When the operator of two-headed level-belt baggers uses only a single bagging head, there is invariably a delay for the scoop to fill. The hopper-type baggers have a reserve supply of product in the hopper. The produce is rapidly conveyed into the weighing scoops, which allows the bag fillers to work at a faster rate. A padded board, which blocks off the lower part of the hopper, will reduce the bruising as the produce falls into the hopper. This padding is especially important when bagging apples, for it allows them to roll gently down to the elevating conveyor and up into the weighing section. The rotary bagger is limited to produce items that will not bruise easily, because the individual units fall into the bag and many units miss the bag and fall onto the return conveyor.

A



B



C

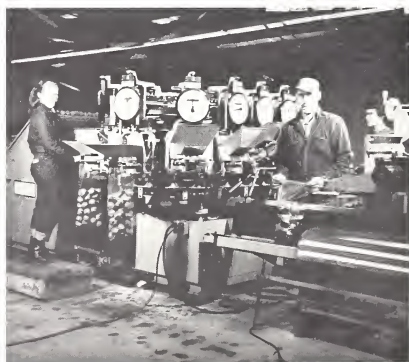


FIGURE 22.—Type of equipment for filling bags with produce; A, Level-belt baggers; B, hopper-type baggers; and C, rotary-type baggers.



The level-belt bagger will handle the largest number of items with a minimum of bruising, the hopper-type will handle most of the items and at a relatively high rate of production, and the rotary bagger will most effectively handle the items less susceptible to bruising (potatoes and onions).

The degree of accuracy depends more on the operating personnel than on the equipment. There are minor differences in the scale mechanisms of the various level-belt and hopper-type baggers, but constant checking of the scales is a more important factor than the equipment. It is especially important that the spring scales of the rotary baggers be checked after each run.

No attempt was made to evaluate the maintenance costs of different bagging equipment. However, it was observed that those lines which consistently had the highest productivity and the least downtime were those which had a maintenance program for checking equipment regularly. Some large plants assigned a full-time maintenance specialist to the line.

### *Productivity of the Bag-Filling Operation*

The bag-filling operation consists of the following steps that may occur in a different sequence, depending on the type of equipment:

Check weight of bag (or of produce in weighing section of bagging head).

Obtain empty bag and position on dump chute (or attach to filling head of rotary bagger).

Dump contents into bag.

Remove bag from chute (or attachment).

Close with tape if bags are closed at bagging heads.

Place on take-away conveyor.

The operator obtains an empty bag as she disposes of the filled bag and while the bagging chute is filling (on level-belt and hopper-type baggers). If necessary, the weight of product is adjusted in the weighing section; the empty bag is placed over the discharge end of the dump chute and the produce is dumped into the bag. If the bag is closed at the filling head, the operator twists the neck of the bag, moves the bag through the closer, and places the closed bag on a take-away conveyor. When the bag is closed at a central station, the operator merely places it on an L-type take-away belt.

On the rotary bagger the operator has a supply of empty bags that have been ruffled to facilitate the selection of a single bag. The bags are on a shelf conveniently located in relation to the filling heads as they rotate. The employee with the greatest manual dexterity should be assigned the job of filling bags. The employee who checks and adjusts the weight of the bag should have containers of different-sized produce close by and at the same level as the top of the bag-filling chute. This will make it easier to add or remove the produce. It is

recommended that the scales be set to underweigh rather than overweigh, since it is easier to add than remove produce. The filled bag can be automatically positioned onto the L-type take-away conveyor where the operator feeds it into a tape or wire semiautomatic bag closer, or it can be removed from the weighing chute by the operator and fed into the closer. When it is automatically fed onto the L-belt, the machine sets the pace of the line. There is less danger of bruising when the operator removes the bag from the machine.

The output of the individual bag fillers is determined by (1) the flow of produce into the bagging head, (2) whether the employee operates one or two bagging heads, (3) whether the bag is closed at the bagging head or at a central closure, (4) the design of the workplace, and (5) the skill and attitude of the operator.

In one study the bag fillers spent 24 percent of their time waiting for produce to arrive at the bagging heads when they were packaging 10-pound bags of potatoes. To avoid delays, there must be an adequate flow of produce into the bagging head and it must move into the weighing section (or dump chute) quickly. Output per employee can be increased on some items if workers alternately operate the bagging heads on twin-headed baggers. This allows time for the produce to flow into one head while the contents in the bagging chute of the second head are dumped into the bag. Time is materially reduced for filling 10-pound bags of potatoes (and two dozen oranges packaged by weight) on both types of twin-headed baggers and is slightly reduced for 5-pound bags of potatoes on the twin-headed hopper-type equipment, but time is increased on smaller bag sizes (table 16).<sup>8</sup>

Although the labor cost per bag is decreased when the operator uses two bagging heads to fill alternately the larger size bags, the line output is reduced. Line production is 30 percent higher when an average crew uses a single head than when each member of a small crew uses two heads (table 17). A hopper-type bagger that delivers an adequate supply of produce to the heads and thereby eliminates delays for the product will result in high output and low cost.

Often, minor changes in equipment design will increase productivity. The supply of empty poly bags typically is kept in a shallow container or on a shelf near the weighing station or the bagging chute. The operator often obtains an empty bag while adjusting the weight of the produce ready to be bagged. It is difficult to pick up the bag from most storage containers, and frequently extra

<sup>8</sup> The time to fill bags as reported in table 16 is not an exact measure of the relative efficiency of different types of bagging heads. It represents controlled studies in different plants where the same operator first used two heads and then a single head for several items.

TABLE 16.—*Time required to fill bags with selected produce items, by type of bagging equipment and number of bagging heads used<sup>1</sup>*

Bagged items	Level-belt double-head baggers		Hopper-type double-type baggers		Hopper-type single-head baggers
	1 head	2 heads	1 head	2 heads	1 head
Potatoes, 10 pounds.....	<i>Minute</i> 0.264	<i>Minute</i> 0.165	<i>Minute</i> 0.251	<i>Minute</i> 0.167	<i>Minute</i> 0.147
Potatoes, 5 pounds.....	.141	.146	.166	.148	.131
Oranges, dozen.....	.169	.174	.165	.160	.132
Onions, 3 pounds.....	.133	.145	.130	.136	.121

<sup>1</sup> For a detailed breakdown by elements, see table 62, appendix.

bags are removed that must be returned to the shelf. This storage area was modified with a fixture that is adjustable to the width of the bag and has a tapered edge at the front which makes it easier to select only one bag (fig. 23).

Some bag fillers tuck a supply of empty bags under their belt. Others use such devices as a cardboard holder for 25 bags that folds over the belt (fig. 24). The open end of the bag has a large cutaway on one side to make it easier to grasp.

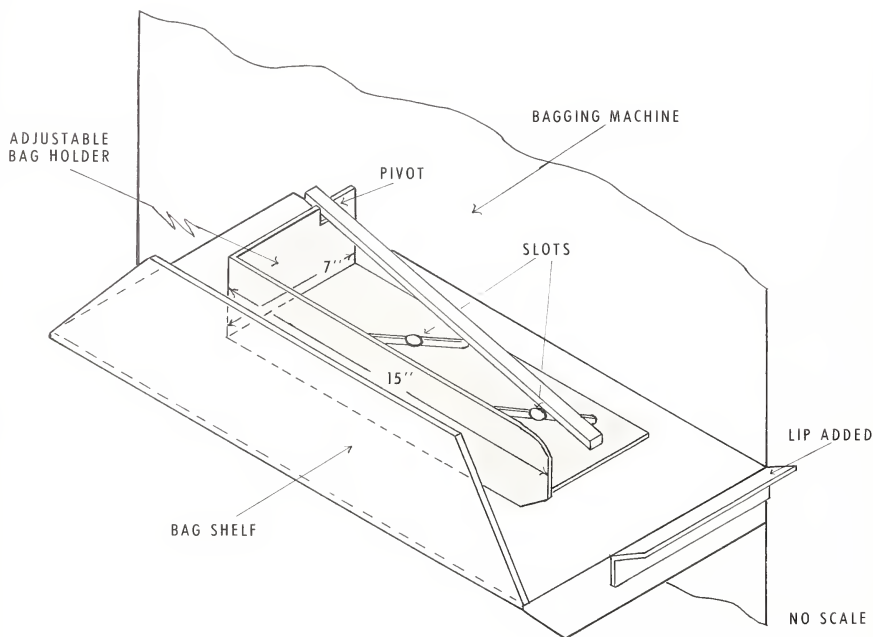


FIGURE 23.—Bag storage with adjustable width and length.

TABLE 17.—Line output of 10-pound bags of potatoes, by size of crew, type of bagging equipment, and number of bagging heads operated per worker

Line equipment and crew size	Bagging heads per worker		Line output
	One <sup>1</sup>	Two <sup>2</sup>	
3 double-head baggers:	<i>Workers</i>	<i>Workers</i>	<i>Pags per minute</i>
6 workers	6		23.4
5 workers	4	1	21.6
3 workers		3	18.0
4 double-head baggers:			
8 workers	8		31.2
7 workers	6	1	29.4
6 workers	4	2	27.6
5 workers	2	3	25.8
4 workers		4	24.0

<sup>1</sup> 3.9 bags filled per minute.

<sup>2</sup> 6 bags filled per minute.

The bagging head should be located so the operator is working with her hands at waist level or slightly lower. The dump chute when depressed should not be so low as to force the operator to bend. On one type of bagging head the gate was modified to open as soon as the dump chute was depressed. This reduced the distance the chute had to be depressed. The height of the bagging heads should be planned for the taller workers and platforms should be installed for the shorter workers. All work places should have floor mats. Rotating jobs on the bagging line and other packaging lines will lessen fatigue and boredom.

The rotary bagger will generally have a consistently higher output than belt-fed lines, since the speed of the machine paces the line. The labor cost for each type of equipment depends mainly on the output of the individual bag filler, but it also depends on the output of other crew members. For example, the rotary bagger has an effective output of 30 to 40 bags per minute. If one person can hang the bags, a second person check weights, and a third person close the bag, the total bagging costs are very low. If, on the other hand, one person cannot handle each of these individual jobs at a high rate of production, output is reduced to a level that the crew can handle, or an extra person is added to each job and the crew will increase from five to eight.

Equipment is not available that will automatically fill and weigh bagged produce items. The limiting factors are the lack of uniformity in size of product when items are packed by weight and the potential for bruising as produce falls into a bag.

### Control of Package Weights

The output of the line is partly determined by the care with which the bag fillers adhere to the recommended tare allowances. When the emphasis is on speed, the chances of incorrect package weights are increased. There should be sufficient additional product in the bag so the unit will have the minimum specified weight at the point of sale. The amount of the tare allowance is determined by several factors:

1. Requirements of State or local regulations on weights and measures.
2. Amount of shrinkage before anticipated sale.
3. Cost of labor.
4. Value of product.

The price of labor is fairly constant, but cost of product, especially potatoes, fluctuates during the year. The cost of bagging potatoes in 10-pound units was measured when the emphasis was alternately placed on speed and accuracy. Precise weighing, on the average, reduces the extra produce in the bag by 1 ounce and takes an additional 2 seconds per bag. As indicated by figure



FIGURE 24.—Holder for empty poly bags.



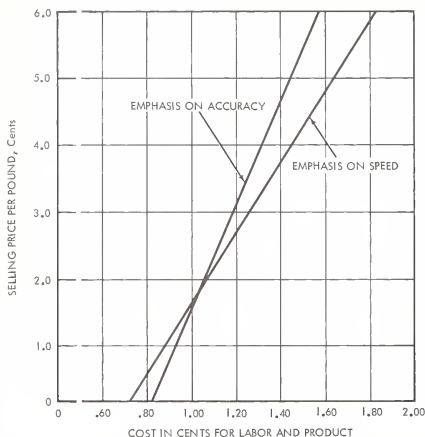


FIGURE 25.—Speed versus accuracy in the bagging of 10 pounds of potatoes with semiautomatic packaging equipment at the central warehouse.

25, it is best to stress accuracy when potatoes sell for over 16 cents per pound.

In most areas the inspector for weights and measures regulations insists only that the bag contain the specified weight. If a bag is underweight, the inspector will probably order the entire display taken down and reweighed. It is, therefore, important to know the expected weight loss and compensate for this loss during packaging. Onions and potatoes are most susceptible to shrinkage, and it varies during the season. Newly harvested potatoes in poly bags with 48 holes of  $\frac{1}{4}$ -inch diameter will lose between 1 and 2 percent

TABLE 18.—*Weight loss of newly harvested and mature potatoes packaged in perforated 10-pound poly bags (48  $\frac{1}{4}$ -inch holes)*

Storage period	Weight loss of —	
	Newly harvested potatoes	Mature potatoes
	Ounces	Ounces
3 days.....	1½	1¼
4 days.....	2	1½
5 days.....	2½	1¾
6 days.....	2¾	1¾
7 days.....	3¼	2

in weight, depending on storage conditions and length of time on display (table 18). Mature potatoes lost from 0.8 to 1.3 percent in weight (5). It is not likely that potatoes or onions will be in storage at warehouse or store for more than 7 days.

A chart of tare allowances will assist bagging line personnel in maintaining adequate but not excessive weight in the consumer package. The tare setting for oranges will vary with the consistency of size and the juice content. There is considerable weight variation during the season. The supervisor should check-weight each shipment and make necessary adjustments in the tare allowance. This is especially important if oranges are sold by count (two or three dozen) and management wants to fill by weight.

Two procedures are commonly followed in obtaining a desired bag weight. In the first, a tare is set in the scales and employees are instructed to weigh bags with the dial indicator approaching a zero scale reading and yet never going under the zero. In the second method, the scale is set to read zero with an exact bag weight. Employees allow for tare on the scale reading without going below the minimum tare allowance or above the maximum tare allowance.

The first procedure is recommended on rotary baggers where only a few types of produce are run. One person, preferably the supervisor, is made responsible for setting and maintaining scale tares. Employees who check weights find it convenient to adjust the weight to a well-defined zero-scale reading. A weight checker is inclined to be more concerned with scale readings under zero than with scale readings under a tare allowance and still over zero.

The second method lends itself to operations bagging many different types of items on individual bagging machines. Each item bagged has its own tare allowance. The employees at each bagging head are instructed to allow a certain tare for each item they bag. If it were practical to have weights representing all the alternate minimum tares, the most effective system would be to read the scale at zero. The tare allowances illustrated in table 19 are a useful tool to obtain accurate weights. In the final analysis, the weight of the produce in the bag depends on the accuracy of the scales, the care and skill of the employees, and, finally, constant checking of package weights by supervision.

The importance of maintenance, personnel, and constant supervision is illustrated by a scale-accuracy study conducted on the rotary packaging line in one firm. Scale readings on 5- and 10-pound packages of potatoes revealed that 1 percent of the bags were under the required weight and 17 percent of the readings on 10-pound packages were 7 ounces over 10 pounds (table 20). Often the actual weight was considerably higher than

TABLE 19.—*Recommended tare allowances for 2 procedures of weighing produce packages*

Product	Pack- age size	Tare set in scales <sup>1</sup>	Tare allowed by employee <sup>2</sup>	
			Mini- mum	Maxi- mum
Packaged by weight:				
Potatoes:	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Ounces</i>
New -----	10	2	2.5	4.5
Mature -----	10	2	1.5	3.5
Potatoes:				
New -----	5	1	1.5	2.5
Mature -----	5	1	1.0	2.0
Onions:				
Wet -----	3	2	1.5	3.0
Dry -----	3	1	1.0	2.0
Apples -----	3	3	1.0	4.0
Apples -----	4	<sup>3</sup> 3	1.0	4.0
Oranges (size 138) -----	5	<sup>4</sup> 4	1.0	5.0
Packaged by count:				
Oranges <sup>5</sup>	<i>Dozens</i>			
Size 113 -----	1	5	4.06	4.38
Size 126 -----	1	4	3.62	3.92
Size 138 -----	1	4	3.25	3.50
Size 163 -----	1	4	2.88	3.12
Size 126 -----	2	5	8.12	8.50
Size 138 -----	2	4	7.25	7.50
Size 163 -----	2	4	6.50	6.75

<sup>1</sup> Employee weighs bag as near to zero as possible, but never under zero.

<sup>2</sup> Scale is set for specified package weight; employee adds necessary tare.

<sup>3</sup> The weight of an apple (size 163).

<sup>4</sup> The weight of an orange (size 138).

<sup>5</sup> The tare allowances are given to illustrate a method of charting the allowances. The tare should be periodically checked and changed if necessary.

the scale reading.<sup>6</sup> In one test of 100 10-pound bags the packages averaged 4.3 ounces heavier than the scale reading. When the scales were carefully checked, the overweight was reduced. One crew had an average overpack of 2.3 ounces over the tare weight on 5-pound bags, whereas 7 percent of the bags were under the prescribed minimum. A second crew had an average overpack of 3.5 ounces and no bags below minimum weight. It is evident that crew members differ in accuracy and that the scale readings are often inaccurate. It is therefore important that consistent and reliable personnel check the weights and that the scales be checked frequently.

### Control of Bruising

There is danger of bruising the more fragile produce when it is moved into the consumer package. When the hopper-type bagger is used to bag apples, it is essential that a padded board be

<sup>6</sup> The scale reading allowed a 4-ounce tare so that 10-pound potato bags actually weighed 10 pounds, 11 ounces.

TABLE 20.—*Variations in scale readings for packaging potatoes at central warehouse*

Scale readings under or over desired weight (ounces) <sup>1</sup>	10 pounds		5 pounds	
	Pack-ages	Per-centage distribution	Pack-ages	Per-centage distribution
	<i>Number</i>	<i>Percent</i>	<i>Number</i>	<i>Percent</i>
-1	2	1.1	1	0.8
0	4	2.3	5	4.2
+1	13	7.4	15	12.5
+2	19	10.8	14	11.7
+3	31	17.7	30	25.0
+4	37	21.1	34	28.3
+5	32	18.3	6	5.0
+6	7	4.0	3	2.5
+7	19	10.9	6	5.0
+8	8	4.6	4	3.3
+9	3	1.7	2	1.7
Total <sup>2</sup>	175	100.0	120	100.0

<sup>1</sup> Does not include tare set in the scale.

<sup>2</sup> 10-pound packages averaged 4.09 ounces overweight; 5-pound packages averaged 3.40 ounces overweight.

used to cover part of the hopper. The dump chute for apples should be padded to avoid bruising as the apples drop into the bag. A slope board under the dump chute will allow the fruit to roll into the bag. On the rotary bagger all produce that misses the bag falls onto a return belt. The return conveyor should be padded and should move produce out of the drop area immediately so the produce will not fall on produce. The filled bag should not be dropped onto the take-away belt. When the bags are closed at the bagging head, there is a tendency for the operators to allow the bag to fall from the tape closer to the belt.

### Pricing the Consumer Package

Prices should be marked on the poly bags before they are filled, as it is difficult to stamp a filled bag at the retail store. The price can be placed on the tape closure, but is difficult for the customer to read. The price can be placed on the bag with the same impression that gives the weight or count, the type and variety of produce, and sometimes other information or codes. Several firms purchase poly bags on which all the information except the price and date code is preprinted. When a firm packages several varieties of each item the inventory of preprinted bags becomes rather costly.

During the study a stamp manufacturer designed an adjustable band-type self-inking stamp, which in one impression placed the weight (or count), commodity identifications, selling price, and the code (if desired) on the poly bag. It is

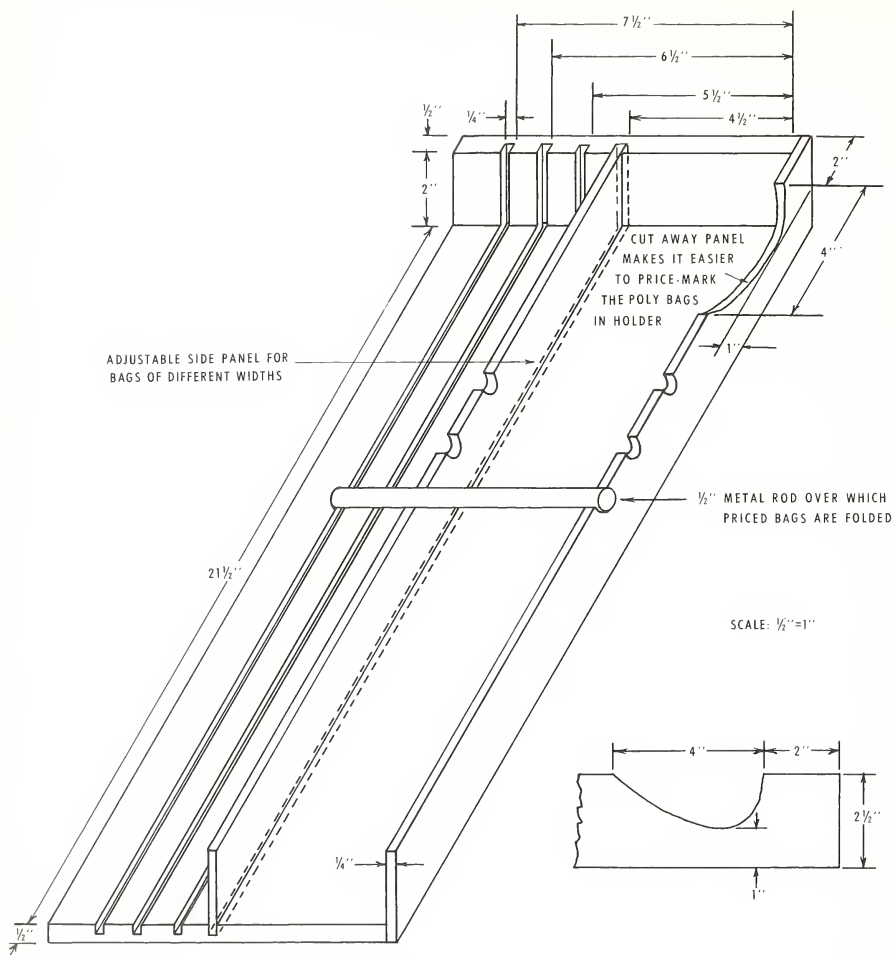


FIGURE 26.—Holder for pricing poly bags.

recommended that a fast-drying ink be used with the stamp to avoid smearing on the adjoining bags. A device was developed during the study to hold the bags while they were stamped (fig. 26). This had an adjustment for bags of different widths and a metal rod toward the center over which the priced bags were folded. The job of stamping the bags should be performed at a fixed work place with a chair that has both a back and a footrest. This job provides another opportunity to rotate jobs to lessen fatigue, and it is a good fill-in job when the line has downtime. A storage rack for priced bags should be located conveniently to the bagging heads. The weekly packaging schedule can readily determine when to stamp the price and how many bags of each variety are needed.

### The Take-Away Belt

Once bags have been filled, they are carried on an L-shaped take-away conveyor to an accumulation or packout station. The preferred location for the take-away belt is beneath the bagging heads and directly in front of the operator at knee height. The take-away belt is sometimes located behind the operator because the design of some bagging machines does not allow room in front of the operator for a belt.

The take-away belt can be either of two types, depending on whether open bags or closed bags are to be conveyed. When most of the bags are to be closed at a central closure, the take-away conveyor must hold the filled open bags in an upright position. A right-angle belt sloping 20° to 30°, with cleats on the upright belt to prevent open bags from tipping over, is most commonly used. Tipped-over bags slow down the bag-closing operation, which in turn lowers output at the bagging heads as the belt becomes full.

In one plant where the L-shaped conveyor was not cleated, the line output on 8-pound bags of potatoes was 24 bags per minute from 6 bagging heads. On the average, 16 percent of the bags tipped over on the way to the central closer. Production rose to 30 bags per minute when the belt was cleated. The bottom belt should be 6 inches wide and the top belt at least 12 inches wide. It is usually necessary to extend the height of the upright belt with a 2- to 3-inch-wide rail to prevent produce in tall bags from falling out. The cleats are approximately 7 inches apart, are 6 inches high, and are centered on the upright belt. Conveyor speed should be set to deliver open bags to the central closer as fast as the closer operator can work. The closer operator should have a foot-operated switch to control the flow of bags on the take-away belt.

It is difficult to vary the height of the L-belt so that the top of open bag is at the proper height

to feed into the closer. It is easier to change the height of the central closer than of the take-away belt.

When bags are closed at each bagging head, the job of a take-away belt is simplified. A flat conveyor belt carries closed bags from each bagging head to the area where they are packed into containers. A flat take-away belt is used with rotary baggers where the unclosed bags are removed directly from the machine and run through a central closer. In another method of operation the rotary bagging machine is allowed to release the bags into a right-angle take-away belt that conveys the open bags to a central closer. The first method is preferred because bags are not given an opportunity to tip over before being closed. An operator is required to guide the filled bags into the closer, and little is gained by automatically placing the filled bags on the L-conveyor.

### Bag Closing

The method of closing depends on labor requirements, material costs, coding requirements, and the integration of the closing function into the overall bagging line. On a produce bagging line the bags can be closed by each individual operator after filling is completed or they can be closed at a central station. It is essential that the closer be fast and economical and that the bag remain closed. Closers that relax or slip allow the bag to open, which creates extra work and the possibility of produce loss. Undersized bags or those with a short neck make closing more difficult and increase the chance of the closer coming off. The final criteria for evaluating a closer are the ease of opening the bag in the home and the possibilities of reusing the poly bag.

This study was only concerned with the closing of poly bags. Paper bags when packaged centrally are typically stitched, and mesh bags are either tied with strings or closed with a metal clip.

### *Material, Labor, and Equipment Cost for Poly Bag Closing*

Of several closing materials, wire and pressure sensitive tape are most typically used for central packaging operations (17). The use of wire is normally limited to a central closing station, whereas tape is used both at the bagging head closers and at a central station. Production rates of wire and tape closing machines differ little when used at a central station. The choice of material is therefore based on operating costs and the utility of the closing material. Wire costs less than tape and will save \$2,330 per year in a line handling 70,000 packages per week (table 21). But wire cannot be coded and the closure is difficult to open.

TABLE 21.—*Costs of equipment, material, and labor for closing poly bags, 1964*

Kind of closing material and method of closing	Equipment			Material	Labor <sup>2</sup>		Total	
	Total cost	Amortized cost per year <sup>1</sup>	Cost per closure	Cost per closure	Time per closure	Cost per closure	Cost per closure	Cost per year <sup>3</sup>
Wire: semiautomatic.....	<i>Dollars</i> 1, 200	<i>Dollars</i> 240	<i>Cent</i> 0. 007	<i>Cent</i> 4 0. 013	<i>Minute</i> 0. 030	<i>Cent</i> 0. 108	<i>Cent</i> 0. 128	<i>Dollars</i> 4, 659
Tape:								
Semiautomatic with 1-piece closure....	2, 600	520	. 014	<sup>5</sup> . 070	. 030	. 108	. 192	6, 989
Semiautomatic with 2-piece closure....	1, 900	380	. 010	<sup>6</sup> . 090	. 030	. 108	. 208	7, 571
Manual.....	<sup>7</sup> 300	60	. 002	. 070	. 067	. 241	. 313	11, 393

<sup>1</sup> 5-year depreciation.<sup>2</sup> At an average wage rate of \$2.16 per hour and a packaging line volume of 33 bags per minute.<sup>3</sup> 70,000 bags per week.<sup>4</sup> 13,000 closures in \$1.75 roll.<sup>5</sup> 50 cents for 60-yard roll; 3 inches used per closure. Predated  $\frac{3}{8}$ -inch tape costs 75 cents per roll and filament tape for heavy bag costs 95 cents per roll.<sup>6</sup> 50 cents for 60-yard roll; 4 inches used per closure.<sup>7</sup> 6 machines at \$50 each.

Several types of pressure-sensitive tape are used for poly bags. Most tapes are satisfactory for small bags holding up to 5 pounds. The one-piece tape is less likely to slip off than the two-piece tape. It is sometimes necessary to use a special tape to prevent slippage when the two-piece tape closer is used on 10-pound and heavier bags.

When the filled bags are closed at the bagging head, the tape dispenser is mounted on a bracket usually to the right front of the operator (fig. 27). After filling the bag, the operator shakes the contents to pack them down, and while suspending the bag by the top, she gives the bottom a spin to twist the neck. The twisted neck is then placed into the jaw of the dispenser, which seals the neck with tape. The operator then removes the bag and in

the same motion cuts the tape. The standard time to complete the bag filling (including closing) ranges from 0.185 to 0.250 minute and averages 0.198 minute per bag. The time just to close the bag at the bag-filling head ranges from 0.054 to 0.084 minute and averages 0.067 minute per bag (table 22).

When the bags are closed at a central station, they typically are conveyed to the semiautomatic closing mechanism by an L-type conveyor and sealed with wire or tape. The cycle time on these machines will range from 60 to 80 bags per minute, but in actual operation the maximum production ranges from 30 to 40 bags per minute, depending on the flow of bags to the closer and the skill of the operator.

The semiautomatic bag closer is located at the end of the L-type take-away conveyor. Its height is adjustable to accommodate a variety of bag sizes. The most convenient workspace arrangement has the operator standing behind the L-type conveyor, which puts him nearer to the jaw of the closer, and leaning on a support behind the conveyor to reduce fatigue. There is insufficient knee room on either side of the take-away conveyor for the operator to sit and work comfortably.

The most efficient working height for feeding the neck of the poly bag into the jaw of the closer is approximately 30 inches. To obtain this height, the packaging line will have to be elevated. It is not always possible to elevate the line or to lower the floor at the central closer. Management should accept the fact that this is a tiring job and should rotate it among the bag fillers at frequent intervals. The L-type take-away conveyor should end just before the neck of the poly bag enters the jaw of the closer. When the bag is closed, it will drop onto a flat-belt conveyor, which takes it to the packout area. The L-type and flat belts are separate, to allow closed bags to be conveyed away

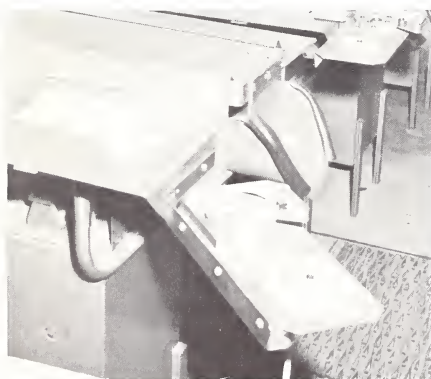


FIGURE 27.—Manual tape closer mounted on the semiautomatic bagging machine.



TABLE 22.—Labor requirements per bag for filling poly bags and closing with tape at the filling head

Work element	Potatoes		Grapefruit, 8's	Oranges, dozen	Apples, 3 lb.	Onions, 3 lb.
	10 lb.	5 lb.				
Obtain empty bag and adjust weight.....	<i>Minute</i> 0.069	<i>Minute</i> 0.065	<i>Minute</i> 0.077	<i>Minute</i> 0.070	<i>Minute</i> 0.065	<i>Minute</i> 0.065
Fill bag.....	.040	.030	.052	.031	.029	.026
Shake bag and twist.....	.047	.042	.065	.032	.046	.049
Close with tape.....	.017	.012	.008	.015	.009	.009
Place on conveyor.....	.014	.014	.015	.015	.016	.012
Total time.....	.187	.163	.217	.163	.165	.161
15-percent personal and fatigue allowance.....	.028	.024	.033	.024	.025	.024
Standard time <sup>1</sup> .....	.215	.187	.250	.187	.190	.185
Standard time for bag closing only <sup>2</sup> .....	.074	.062	.084	.054	.063	.067

<sup>1</sup> Average time (weighted by movement) to fill and close bag is 0.198 minute.

<sup>2</sup> Both "shake bag and twist" and "close with tape"; include a 15-percent personal and fatigue allowance. Average time to close with tape was 0.067 minute.

from the closer even if the t-belt is stopped because of a backup on this belt. This happens when bagging-head output temporarily exceeds the capacity of the closer and when filled bags tip over. Finally, this facilitates the handling of bags that are closed manually at the bagging heads.

### Coding

The packaging date should be coded and stamped on the package to help maintain quality.

The coding will not necessarily affect productivity, but it will help insure proper rotation of the produce at the retail store.

The poly bags can be date coded by using a different color tape to represent each day of the week. An alternative is predated tape, where a number or letter represents the date. These two methods are frequently used when the bags are manually closed. A semiautomatic bag-closing machine prints the code on the tape during the closing operation. Figure 28 illustrates the two-

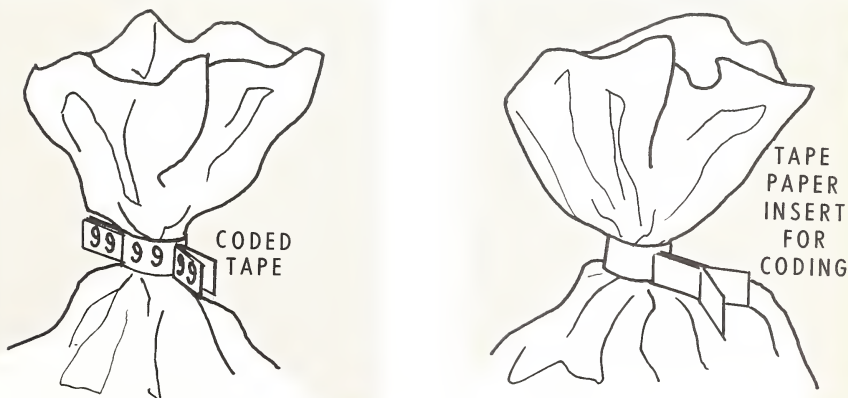


FIGURE 28.—Two techniques for closing and coding poly bags.

piece tape on which the code and sometimes other information is printed.

### ***Cost Comparison for Closing the Bag at the Filling Head vs. the Central Closing Station***

Where to close the bag depends on line output. The time to close the bag manually at the filling head is 0.067 minute. The time per bag for the central closer will vary with volume—from 0.10 minute per bag for an output of 10 bags per minute to 0.02 minute when line output is 50 bags per minute. The labor costs are the same for manual closing at the bagging head and at the central closer at a production of 15 bags per minute. Actually a line with a volume less than 20 bags per minute would probably not have a central packout station and, therefore, would not have a central closer. In effect, the bags should be closed at the head when line output is less than 20 bags per minute.

If the average volume is 33 bags per minute, central closing with a 1-piece tape closer would save \$4,404 per year and with the central wire closer would save \$6,734 per year when compared to manual closing at the bagging head (table 21).

If it is anticipated that the line output will exceed the normal capacity of the central closer (approximately 40 bags per minute), it is suggested that manual tape closers be installed at each bagging head. This will increase the capacity of the line, as fillers can be instructed to close every fourth or fifth bag on their manual tape closer. The closers at each head are also good insurance against a production stoppage during tape change-over and in case the tape jams.

The central closer will permit better utilization of packaging line equipment. When less time is required to fill and close the bag (0.198–0.131 equals 0.067 min.), more bags can be packaged in a given time with a given investment in plant and equipment. A reduction of 0.067 minute for the bag filling operation (which includes closing) will increase the capacity of the line by 51 percent.

### **Placing Bags in Master Containers**

The placing of closed consumer bags of produce into master containers is frequently referred to as the packout operation. The operation begins when the poly bags are closed, either at the bagging head or central closer, and ends when the bags in master containers are stacked on pallets, ready for transport to storage. The productivity of the packout is determined by the type of master container, handling equipment, layout, and, most importantly, the volume of the packaging line.

The heavier master containers, such as the fiberglass and the wood box, weigh more than 11 pounds and are difficult for a female employee to remove from a nested stack. Thus, where heavier

containers are used and where there is any empty pallet handling, a man should be used for the packout. A baler bag requires 128 percent more labor than a returnable container. The baler must either be manually held during filling or it is fed into a jig to hold the bag open. After it is filled, the baler bag must be closed with wire, strapping tie, or tape before it can be placed on a pallet. Containers that have lids or caps, such as banana boxes, wirebound containers, or two-piece telescoping fruit containers, require additional labor to open and close. Solid returnable containers that nest are the most economical to handle and require the least storage space.

The closed bags are typically conveyed on a flat belt from the point of closing to the packout area. An accumulation of bags is essential to balance the packout workload with the fluctuating output of the packaging line. The accumulation of bags allows the packout operator to remove empty containers and pallets and to do other necessary jobs. A turntable, approximately 5 feet in diameter, is the most typically used equipment for accumulating bags. The turntable should be approximately 34 inches high when all work is performed at a standing position. The height will vary with the height of the operator and can be adjusted by having the working height set for the tallest employee and providing a platform for shorter employees.

Various types of conveyors should be utilized to move pallets and containers. A floor conveyor should be used to feed pallet loads of empty and full containers to and from the packout area. Each pallet will hold between 80 and 100 empty stack-and-nest containers and either 16 or 20 filled containers, depending on whether they are stacked 4 or 5 tiers high. The conveyor for pallet loads of filled master containers will provide freedom for the forklift operator to service the line. Whenever the operator brings a load of unbagged produce to the line, he should take a load of packaged produce to storage. Conveyors are also used to feed empty containers to the turntable and full containers to the palletizing area when the two areas are separate functions (fig. 29).

There are two basic layouts used for packout. They differ in that the work areas for filling containers and placing them on pallets are separate in one method and are combined in the second. In the first layout an empty container is obtained and positioned on a conveyor that runs under the turntable (fig. 29). The top edge of the container is just below the top of the turntable so bags can be slid into the container with a minimum of effort. Good motion economy calls for the use of both hands working together simultaneously, with each hand directing one or more bags into the container. When filled, the container is given a gentle shove to start it down a gravity feed conveyor.

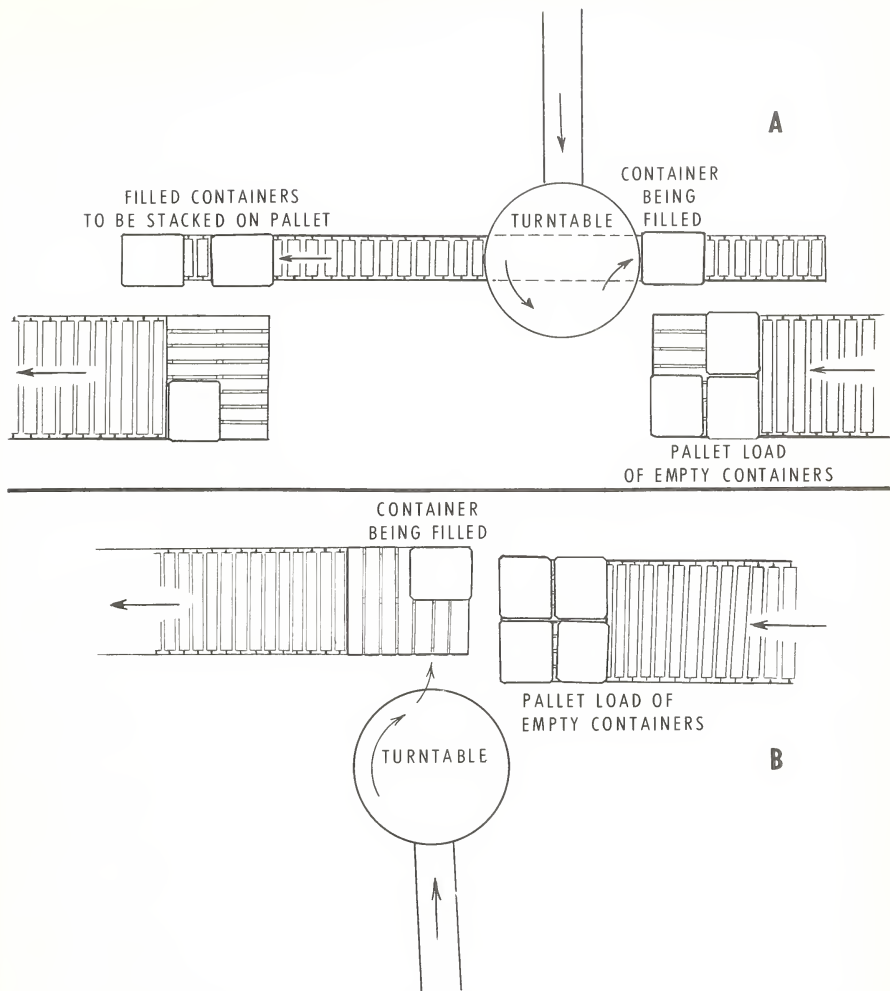


FIGURE 29.—Two methods of packing out packaged produce in a central warehouse: A, Turntable is separated from the palletization area by a conveyor; and B, operator fills the containers that are positioned on a pallet.



TABLE 23.—Labor cost per returnable master container for 3 methods of packing out 5-pound bags of potatoes for shipment to retail stores, 1964<sup>1</sup>

Work element	Fill master containers on a pallet at turntable (60 pounds)				Fill master containers at turntable and convey to area where they are palletized (60 pounds)				Fill 50-pound kraft bags at turntable			
	Time per container	Wages per minute	Labor cost per container	Minute	Cents	Wages per minute	Labor cost per container	Cents	Time per container	Wages per minute	Labor cost per container	Cost equivalent for 60-pound container
Obtain empty container-----	<i>Minute</i> 0.101	<i>Cents</i> 5.0	<i>Cents</i> 0.50	<i>Minute</i> 0.047	<i>Cents</i> 3.6	<i>Cents</i> 3.6	<i>Cents</i> 0.17	<i>Cents</i> 5.0	<i>Minute</i> 0.100	<i>Cents</i> 5.0	<i>Cents</i> 0.50	<i>Cents</i> 0.60
Position packages in container-----	.370	5.0	1.85	.304	3.6	3.6	1.09	3.6	.288	3.6	1.04	1.25
Stack containers on pallet-----	-----	-----	-----	2.121	5.0	5.0	.60	5.0	.062	5.0	.31	.37
Hold container during filling-----	-----	-----	-----	-----	-----	-----	-----	-----	.107	5.0	.54	.65
Delay for filling-----	-----	-----	-----	-----	-----	-----	-----	-----	.305	5.0	1.52	1.82
Miscellaneous handling elements-----	.047	5.0	.24	.039	5.0	5.0	.20	-----	-----	-----	-----	-----
Total-----	.518	-----	2.59	.511	-----	-----	2.06	-----	.862	-----	3.91	4.69
Cost for plant packaging 70,000 packages per week <sup>2</sup> -----	-----	-----	<i>Dollars</i> 181	-----	-----	-----	<i>Dollars</i> 144	-----	-----	-----	-----	<i>Dollars</i> 328

<sup>1</sup> Average rate for male employees is \$3.00 per hour, including fringe benefits; average rate for female employees is \$2.16 per hour, including fringe benefits.

<sup>2</sup> Only labor related to packout is included. Other activities, such as assisting other crew members, identifying commodities, and directing flow of product to and from the line, are excluded.

<sup>3</sup> An average of 10 packages per master container.

At the end of the conveyor a male employee stacks the containers onto a pallet.

In the second layout one or more (usually two) empty containers are placed on the pallet. The containers are filled and more are placed on the pallet. Usually the two rear tiers of containers are filled first. The employee must bend to fill the first layer of four containers and must reach up to fill the top row of containers. It also takes more time to fill the two rows of containers farthest from the turntable. It takes 36 percent more time to fill the containers on the top layer at the rear of the pallet than those that are more convenient to the turntable. The bending and twisting of the body plus the handling of the bags over a greater distance make this method more fatiguing.

The first packout method costs less than the second for a medium- to high-volume line. In a firm handling 70,000 produce packages per week, the separate packout and palletization operation costs \$144 per week as compared to \$181 for method two (table 23).

A one-station packout (method two) becomes more advantageous under one or more of the following conditions: (1) A lightweight container is used, which will permit the use of a female employee at a lower wage rate; (2) volume is such that one person can perform the entire function (ranges from less than 16 bags per minute for 10-

pound bags of potatoes to less than 33 bags per minute for 3-pound bags of onions); (3) the employee can place more than 2 bags in the container per trip; and (4) empty wood pallets (each weighing approximately 85 pounds) are fed to packout area by a conveyor.

The baler bag is the most costly master container; its cost is approximately equal to the entire material handling costs of recommended containers. Labor costs for packing out in baler bags is high because of the delay and nonproductive time. This is illustrated by figure 30, which shows 37-percent delay and nonproductive time for 10-pound bags of potatoes and a 36-percent delay for 5-pound bags of potatoes.

The cost of the baler bag in effect rules out the use of the baler as a master container except in emergencies, such as a container shortage during peak production periods. A better method of overcoming a container shortage during peak periods is to pack out sale items (especially 10-pound bags of potatoes) in pallet containers for those stores that have receiving docks and pallet packs.

### Layout for the Produce Bagging Line

The layout of the produce bagging line should be an orderly arrangement of equipment, work places, and material handling devices to provide for the movement of incoming produce, material

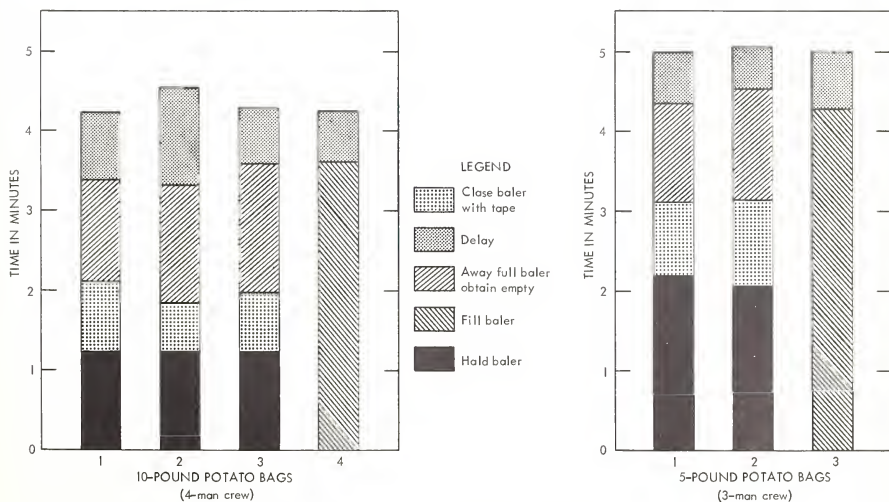


FIGURE 30.—Packout operation with 50-pound baler bags.

in process, bagged product, supplies, culls, waste, and containers through the packaging operation. The layout should prevent backtracking, crossflow, bottlenecks, extra handlings, unnecessary storages, undue physical handling, and superfluous equipment. A good layout for a produce packaging line can be achieved by following a series of principles of layout and by adapting the principles to produce packaging.

1. *Provide for an accumulation area between each major work area.*—The loaded pallet of shipping containers or the pallet box provides an accumulation of produce, but if there is room for

only a single pallet load, this system either ties the fork operator to the line or there is line downtime for the entire crew until a new load is delivered. A gravity or powered conveyor that holds three or four pallets will assure the product flowing continuously on the line without tying up the fork-truck operator. The provision for an accumulation area also applies to the temporary storage and removal of packaged produce from the line. The feed belt and hoppers serve as the accumulation area for the bag fillers, and the turntable serves as a temporary holding area for the packout operation (fig. 31).

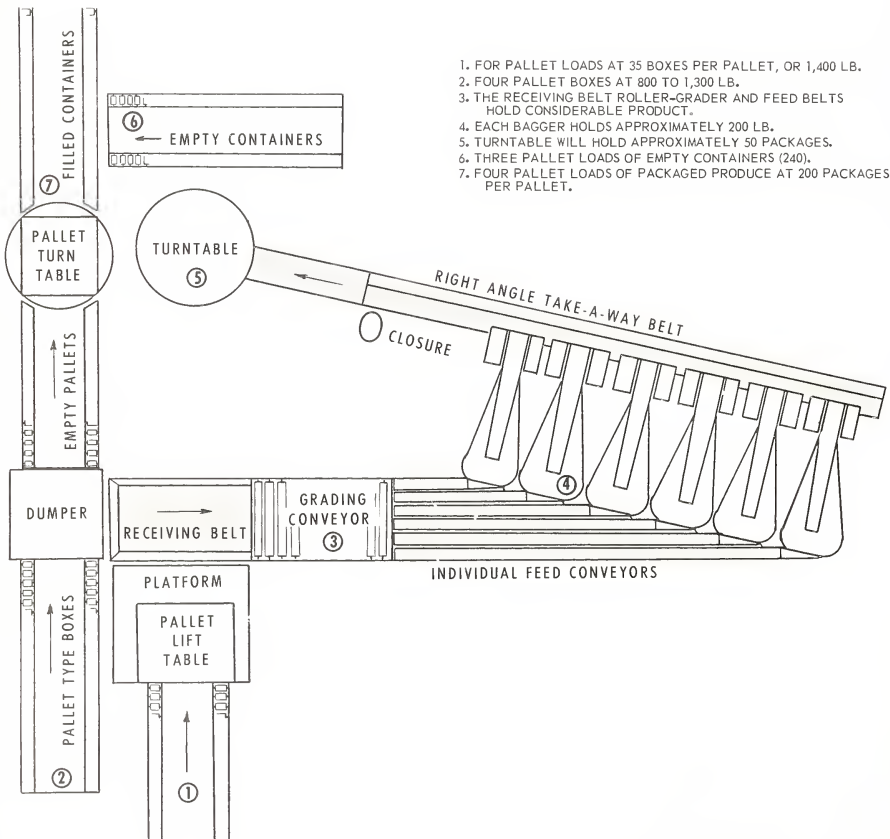


FIGURE 31.—Product accumulation areas in a produce packaging installation.

2. *Provide for expansion.*—The two pieces of equipment that could limit expansion are the feed belt and the l-type take-away belt. When planning a packaging facility the firm should estimate future volume and be sure the two belts are long enough to permit expansion. If present volume will justify only two double-head baggers or four single-head hopper-type baggers, the feed belt and the l-type take-away conveyors should be long enough to accommodate at least another double-head bagger or two single-head hopper-type baggers.

3. *Bring in and take away product in same area.*—This will reduce travel for the fork operator and give supervisors better control of the flow of product. Figure 32 shows how this was achieved in one plant.

4. *Use conveyor and material-handling devices to reduce physical handling.*—The floor-level dump chute or the pallet box tipper eliminates the manual handling of produce in shipping containers. A central bag closer eliminates the lifting and twisting of the filled bag.

5. *Keep work and storage areas out of major traffic areas.*—Work stations should be kept out of the aisles, especially where there is considerable fork-truck traffic. The work stations should have plenty of room to perform the function. A disadvantage of double-headed baggers is the crowding when one person operates each head.

6. *Integrate packaging lines so as to take advantage of specialized equipment.*—The design for one plant moved product from two packout stations to a central palletizer and automatically stacked the master containers on pallets (fig. 33). In another firm two packaging lines were supplied by a common dump area. This permits the packaging of two sizes of an item simultaneously. A

separate line feed allows the second and smaller line to package a different item (fig. 34).

7. *Locate coolers, supplies, and service facilities convenient to the packaging line.*—The packaging line should be located strategically between storage (both refrigerated and nonrefrigerated) and the loading docks.

8. *Provide for handling of waste material, off-quality product, and salvage containers.*—A barrel on wheels is an effective way to handle culls from the inspection belt. Salvage boxes (originally containing other merchandise when possible) should be collapsed and placed on a pallet. Sacks should be placed in a stack near the dump area and tied when a specified quantity is accumulated. If the empty shipping container is used in the packaging it should be conveyed to that area.

9. *Anticipate and provide for utilities, ease of maintenance, daily cleaning, and removal of wastes.*—Before the layout is installed, several questions should be asked to insure that it is complete. Will it (1) produce a superior product, (2) eliminate accidents, (3) reduce cost, (4) improve morale, (5) increase production, (6) reduce floor space, (7) improve housekeeping, (8) reduce waste, (9) improve sanitation, (10) improve working conditions, and (11) decrease maintenance?

The layout depends on volume in the sense that a low-volume packaging line would not have a receiving belt, feed belt, central closer, or a central packout area. But to a greater extent the layout depends on the items packaged and the flexibility of the equipment. A low-volume firm could use a relatively simple layout, as shown in figure 19. As volume expands, additional equipment can be added and the layout would resemble that illustrated by figures 31, 33, and 34.

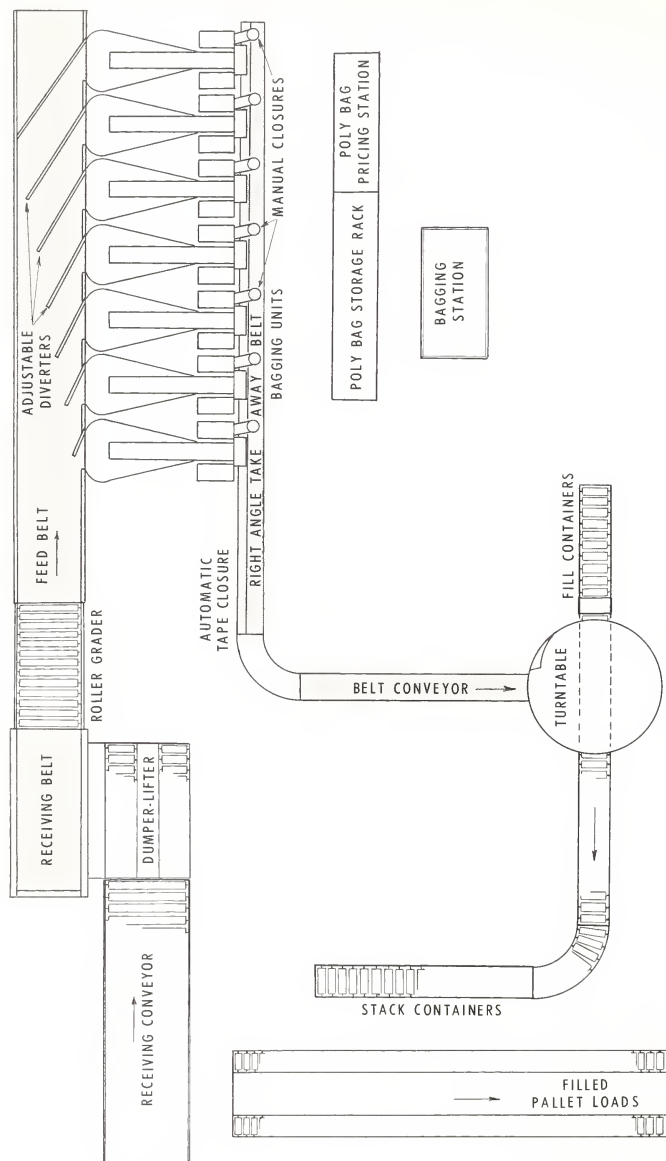


FIGURE 32.—Locating the bring-in and take-away areas in the same area reduces forklift travel.

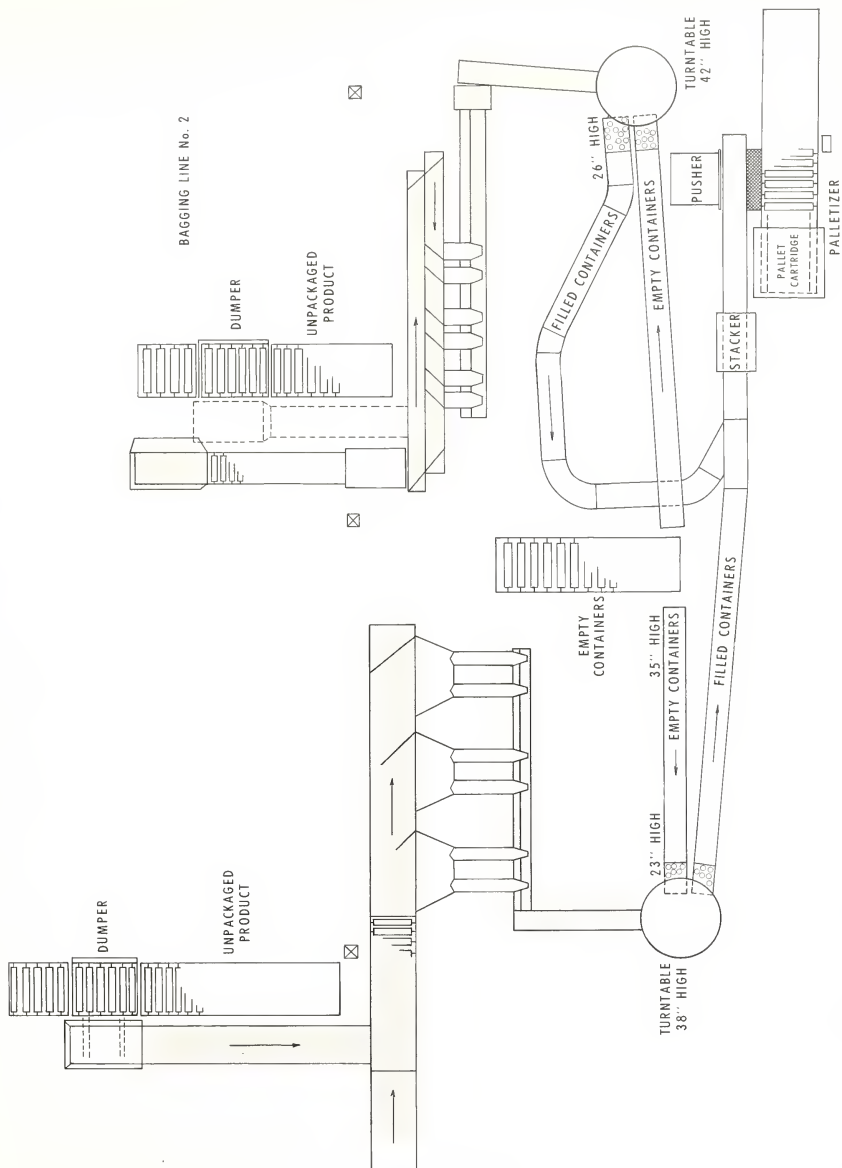


FIGURE 33.—The use of the container palletizer to palletize automatically the containers from two bagging lines.

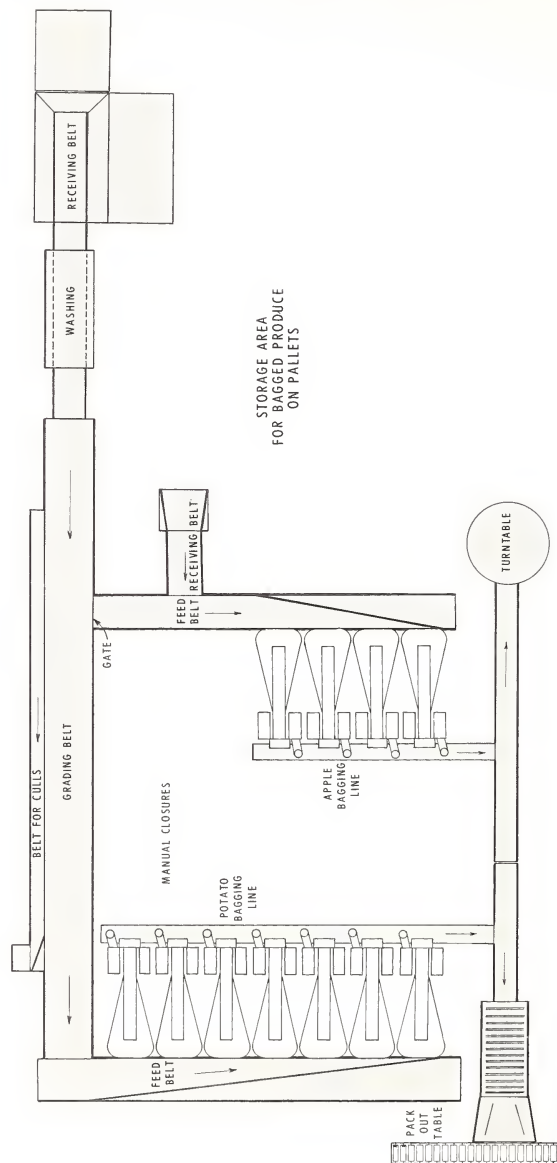


FIGURE 34.—A single dump area feeds two packaging lines.



## CONTAINERS FOR THE SHIPMENT OF PACKAGED PRODUCE TO THE RETAIL STORES

When the firm with a moderate volume (40,000 to 80,000 bags per week) packs a wide variety of items, the equipment should be flexible enough to handle all items. When volume exceeds the capacity of one line, then a second line should be added. The layout should integrate the receiving area and the packout area (through central, automatic palletization) and provide for integrated handling of pallets, warehouse-to-store containers, and salvage containers (fig. 31).

When produce is packaged at the central warehouse, a master container is essential for the delivery of bagged produce to the store. A warehouse-to-store container provides protection to the produce and simplifies handling for economical storage and movement to the retail store.

Warehouse-to-store containers are grouped into three categories: (1) One trip, or nonreturnable; (2) several trips, or semireturnable; and (3) fully returnable. The one-trip container is typically a kraft-paper baler.

The term "salvage container" designates all those containers in which merchandise, usually produce, was originally received and is reused for shipping bagged produce to the stores. If not reused they are either destroyed or sold for salvage value. Salvage containers typically are wooden celery, citrus, and chicken boxes or corrugated egg, tomato, banana, apple, and citrus boxes. Containers capable of being used a minimum of 50 trips are classified as fully returnable. They are constructed of various kinds of plastics, fiberglass, wood, metal, and other durable materials.

The various types of containers were evaluated in a simulated packaging operation that was a composite of seven packaging installations studied in detail. This simulated firm had an all-purpose line that produced 70,000 bags per week of potatoes, onions, apples, oranges, and grapefruit. Within this framework, six of the most typical warehouse-to-store containers were compared. The handling times were a composite of actual time studies gathered at the cooperating firms.

### Types of Containers for Packaged Produce

When the one-trip kraft baler bag is used (primarily for poly bag potatoes), most of the weight is supported by the product; consequently, the baler provides little protection. One or two more employees are needed to fill and close the baler bag than are needed for other containers. The cost of the baler bag (7.7 cents, 1964) is approximately equal to the total handling and material cost for returnable containers. This in effect rules out the

baler bag for any further consideration as an economical or bruise-free container for bagged produce.

Semireturnable or salvage containers are used extensively by the trade. A salvage container has fulfilled its original function before being used as a container for bagged produce. The reluctance to destroy the container causes it to be kept in use even after it has broken down. Bagged produce is subject to bruising when carried in these damaged containers. On the average, each salvage container is used three times before being destroyed. In the area where salvage containers were used extensively they had an average market or salvage value of 5 cents. The three salvage containers most typically used were: (1) A 24-dozen corrugated egg carton for 5- and 10-pound bags of potatoes; (2) a wooden celery box for 3-pound bags of onions; and (3) a corrugated bushel tomato box with wooden framing for 4-pound bags of apples, 5-pound bags of oranges, and 6-pack grapefruit.

The thermoplastic (ABS-type material) box is a fully returnable container with outside dimensions of 24½ by 20 by 13 inches, weighs 6 pounds, and costs \$8.50 (depending on quantity purchased).<sup>10</sup> The sides taper to dimensions of 21 by 14 inches at the base. It is designed to stack or nest by turning 180° (fig. 35). When two are stacked, the bottom of the top container is below the top of the bottom container. In a nested stack the containers occupy one-fourth of their original space. Inside lugs keep nested containers from binding or wedging together. The thermoplastic container will last an estimated 5 years.

A newly developed thermoplastic (polyethylene) container uses bails for stacking. This container has interior lines uninterrupted by stacking columns. It is lightweight (approximately 6 pounds) and is easier to stack than containers that require precise positioning. This container has outside dimensions of 19 by 24½ by 12¼ inches and occupies 5,702 cubic inches. Inside dimensions are 16½ by 22 inches at the top, 15 by 20½ inches at the base, and it is 11½ inches deep (fig. 36). The available storage space is 3,849 cubic inches, or a space utilization of 67.5 percent. This container will cost \$5 (in quantity lots).

The second fully returnable container is a fiberglass box similar to the thermoplastic in dimensions, design, and capacity. The fiberglass container weighs 11½ pounds, costs \$6.93 (depending on quantities purchased), and has an estimated life of 3 to 4 years (fig. 37).

<sup>10</sup> The cost of all containers is based on 1963 prices and on purchases of 1,000 or more.





FIGURE 35.—Reusable thermoplastic (ABS) container.

Another type of fully returnable container is a wooden "rexford" crate, which weighs  $11\frac{1}{2}$  pounds and has outside dimensions of  $18\frac{1}{2}$  by 24 by  $11\frac{1}{4}$  inches (fig. 38). This container is constructed of wooden slats. Empty rexford crates are stacked by placing one container on end inside another and capping these with a third container. The space of three is reduced to that of two. Original cost of the container is \$1.60. Repair of this box during its life adds another \$1.93 to the cost. The firm that used this crate in the study determined its life to be 200 trips or 5 years, whichever comes first.

Another fully returnable container is a wooden stack-and-nest box similar in design to a banana

box. The container weighs  $11\frac{1}{2}$  pounds, measures  $24\frac{1}{2}$  by  $16\frac{1}{2}$  by 13 inches outside, and costs \$4.50 when purchased in quantities. Bail wires are used for stacking. A reinforced version weighing  $13\frac{1}{2}$  pounds has a wider perimeter board that adds strength and prevents wedging when boxes are nested (fig. 39).

When bananas are received in two-piece corrugated boxes, many firms are left with idle wooden banana repack boxes. These are used by a few firms for produce bagging. The wooden stack-and-nest banana box, which measures  $34\frac{1}{2}$  by 16 by 13 inches, weighs  $14\frac{1}{2}$  pounds. Tapering sides permit the banana box to nest. Flop-over handles (bails) allow stacking of full containers.



FIGURE 36.—A thermoplastic (polyethylene) container with sliding bails for stacking. (A) Bails are moved to recessed position in molded lip on bottom container for nesting and (B) toward the center for stacking. (C) perspective drawing.



FIGURE 37.—Reusable fiberglass container: A, Stacked, and B, nested.

When the container is emptied, the handles are swung to the sides so the containers can nest. When filled to capacity, the box is too heavy for one man to handle. The container is awkward to handle because the worker's arms are spread 34 inches apart when he lifts it. The wooden banana box is more suitable for use if the overall weight

and length are reduced for easier handling. This can be accomplished by removing one end, cutting the box down to 24 inches, and replacing the end. The smaller box has a capacity of 50 pounds. The modification costs from \$1.00 to \$1.75, depending on local situations. The smaller version of the wooden banana box does not effectively utilize space. The regular wooden banana box is undesirable, since it is awkward and fatiguing to han-

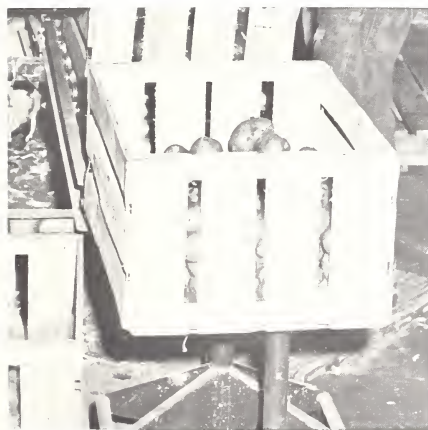


FIGURE 38.—The wooden rexford crate.



FIGURE 39.—A wooden stack-and-nest box for bagged produce.

dle. Gross weights can exceed 90 pounds when full. Space is not fully utilized on the standard warehouse pallet, which will accommodate only three banana boxes per layer.

A gridwork of heavy gage wire is used in the construction of a returnable container that has tapered sides for nesting and bail wires for stacking. This container, measuring 33 by 16½ by 13½ inches on the outside, weighs 20 pounds. The wire container is not recommended, because the wire surface tends to bruise produce items being carried. It is not prescribed for easy handling, since, like the banana repack box, it weighs approximately 95 pounds when filled to capacity. Another wire container nests and stacks with bails, measures 24 by 20 by 13 inches, has a solid bottom, and also weighs 20 pounds. This container when loaded weighs 80 pounds. It would not be suitable for items that are subject to bruising.

The average capacity of the various containers is as follows:

Container	Net weight per container, pounds
Thermoplastic .....	57.0
Fiberglass .....	56.0
Rexford .....	52.7
Wooden stack-and-nest .....	54.0
Salvage (averages of several types) .....	44.8

The thermoplastic containers will on the average hold more packages than the other containers, which means the firm will need fewer containers (table 24). The salvage container will carry the least product and consequently will require a greater inventory of containers.

Sometimes a pallet bin can be used as a container to ship bagged produce. It is especially advantageous for shipping high-volume items to large stores with receiving docks and pallet-handling equipment. A pallet bin, like a unitized load, eliminates numerous individual handlings and lowers the inventory of warehouse-to-store containers. A lightweight collapsible bin facilitates empty return handling. The base may be either a warehouse pallet or an integral part of the bin. The capacity will depend on the bin height and how well the usable cubage is utilized. Generally, weight is limited to 1,000 pounds. A pallet box is adaptable as a display fixture but requires added display space. Though it is easy to maintain pallet box displays, they must be rotated before they are shipped down to where a customer is forced to bend or stretch in making a selection.

TABLE 24.—Containers needed per week by a plant packaging 70,000 bags of specified produce, for 5 kinds of containers

Item	Unit	Potatoes		Onions, 3-pound bags	Apples, 4-pound bags	Oranges, dozen, size 138	Grapefruit, 8-pack	Total
		10-pound bags	5-pound bags					
Weekly packout .....	Bags .....	19,600	14,000	11,900	13,300	7,700	3,500	70,000
Proportion of total .....	Pounds .....	28	20	17	19	11	5	100
Thermoplastic containers								
(polyethylene and "ABS"):								
Capacity .....	Bags .....	6	13	22	12	16	8	<sup>1</sup> 10.1
Gross weight .....	Pounds .....	66.0	71.0	66.0	54.0	54.0	60.0	<sup>1</sup> 63.6
Weekly requirements .....	Containers .....	3,267	1,077	541	1,108	481	438	6,912
Fiberglass containers:								
Capacity .....	Bags .....	6	12	22	12	16	8	10.0
Gross weight .....	Pounds .....	71.5	71.5	71.5	59.5	59.0	52.0	67.5
Weekly requirements .....	Containers .....	3,267	1,167	541	1,108	481	438	7,002
Rexford containers:								
Capacity .....	Bags .....	6	12	16	11	15	6	9.4
Gross weight .....	Pounds .....	71.5	71.5	59.5	55.5	56.5	39.0	64.2
Weekly requirements .....	Containers .....	3,267	1,167	744	1,209	513	583	7,483
Wooden stack-and-nest containers:								
Capacity .....	Bags .....	6	12	20	11	15	7	9.7
Gross weight .....	Pounds .....	71.5	71.5	65.5	55.5	56.5	45.5	65.5
Weekly requirements .....	Containers .....	3,267	1,167	595	1,209	513	500	7,251
Salvage containers:								
Capacity .....	Bags .....	6	12	16	6	10	5	7.9
Gross weight .....	Pounds .....	65.0	65.0	53.0	29.0	35.0	32.0	49.8
Weekly requirements .....	Containers .....	3,267	1,167	744	2,216	770	700	8,864

<sup>1</sup> Average weighted, by weekly packout.

## Costs of Alternative Containers

### Labor Costs

Labor, the largest cost factor in handling, was studied in firms using the various containers. These handlings were then consolidated into a simulated operation. A filled container was handled an average of seven times in the course of each trip from warehouse to retail store. The return of an empty container under normal conditions requires four additional handlings. In the simulated operation containers of bagged produce were loaded on trailers, transported, and unloaded as pallet loads. This method, referred to as a "dock" operation, was most effective on short hauls to stores with docks or lift platforms.

Container handling at the packout, as shown in table 25, are similar for the four fully returnable containers, but salvage containers and balers cannot be handled in the same manner. A salvage container requires more time for workers to open lids or to remove caps and to close after filling. Baler bags require considerable time to handle at the filling workplace because they must be held open during filling. They are closed by stitching with string, tying with tape, or by closing with wire.

Filled thermoplastic and fiberglass containers are difficult to stack, and, during order selection, extra time is required to pre-position stacking lugs so that containers engage properly for positive stacking.

In the simulated operation, empty containers were returned to the warehouse on pallets. The nesting ability of some containers permits a greater number of containers to be handled on a pallet, which results in less handling time per unit.

The polyethylene container with bails has the lowest labor cost. The use of various salvage containers will add \$15,200 to labor costs (table 25).

The baler bag, typically used only for potatoes and onions, was not evaluated, since the high material cost made its use prohibitive.

In a nondock operation, produce containers are both pallet loaded and handstacked in the trailer. At the store they are manually unloaded by skids, two-wheeled trucks, stock carts, or conveyors. Handling costs of this method are one-third higher than the dock operation; however, more trailer space is utilized when produce is handstacked, and as distances increase the method becomes more economical.

The polyethylene container has the lowest annual cost for returnable containers, principally because of its long life and relatively low cost. The ABS and fiberglass containers had relatively high material costs because of their high initial cost.

### Material Cost

Much emphasis is placed on the initial investment when a container is to be selected. Though significant, initial cost is only part of the costs associated with moving bagged produce to the retail store. Each year \$7,000 to \$11,000 of capital is invested in containers (table 26). At the same time \$23,000 to \$40,000 is spent handling these containers.

Typical operating situations of the containers were applied to measure yearly costs for a firm handling a weekly volume of 70,000 bags. Returnable containers rotate one and one-half times each week; in addition, an analysis of container movement in several firms showed that 20 percent more containers were needed to take care of peak days.

A firm using the rexford crate determined its useful life to be 200 trips. The repair of crates adds \$4,514 to the cost. Semireturnable containers that averaged three trips required a yearly volume of 122,920 containers.

TABLE 25.—Labor requirements and cost for handling containers of packaged produce from warehouse to store, by type of container, 1964

Container	Labor per trip			Container trips per year <sup>3</sup>	Labor per year	Labor cost per year <sup>4</sup>
	Filled <sup>1</sup>	Empty <sup>2</sup>	Total			
	Minutes	Minute	Minutes	1,000 trips	1,000 minutes	Dollars
Thermoplastic:						
Polyethylene.....	1.00	0.26	1.26	359	452	22,600
ABS.....	1.06	.26	1.32	359	474	23,700
Fiberglass.....	1.08	.26	1.34	364	488	24,400
Rexford.....	1.00	.36	1.36	389	529	26,450
Wooden stack-and-nest.....	1.00	.27	1.27	377	479	23,950
Salvage.....	1.13	.51	1.64	461	756	37,800

<sup>1</sup> Table 63, p. 104.

<sup>2</sup> Table 64, p. 105.

<sup>3</sup> Containers per week times 52 (expressed in thousands).

<sup>4</sup> Based on a wage rate of \$3 per hour, including fringe benefits, for an average volume of 70,000 bags per week.

TABLE 26.—*Material costs for containers in warehouses handling 70,000 packages of produce a week, by type of container, 1964*

Item	Unit	Thermoplastic		Fiberglass	Rexford	Wooden stack-and-nest	Salvage
		Polyethylene	ABS				
Required to hold weekly volume of 70,000 packages. <sup>1</sup>	Containers----	6, 912	6, 912	7, 002	7, 483	7, 251	8, 864
Required if each container makes 1½ trips per week.	Containers----	4, 608	4, 608	4, 668	4, 989	4, 834	5, 910
Required with 20-percent allowance of peak days.	Containers----	5, 530	5, 530	5, 602	5, 987	5, 801	7, 092
Material cost per container-----	Dollars-----	5. 00	8. 50	6. 93	1. 60	4. 50	0. 05
Total investment in containers-----	Dollars-----	27, 650	47, 005	38, 822	9, 579	26, 105	2 6, 146
Estimated useful life of containers-----	Trips-----	200	200	200	200	200	3
Container investment per year-----	Years-----	5	5	4	2. 56	4	4
Interest on annual investment <sup>3</sup> -----	Dollars-----	5, 530	9, 401	9, 705	3, 742	6, 526	6, 146
Repair cost per year-----	Dollars-----	691	1, 000	971	239	653	-----
Total cost per year-----	Dollars-----	6, 221	10, 401	10, 676	8, 495	7, 179	6, 146

<sup>1</sup> For details see table 24, p. 54.

<sup>2</sup> 7,092 containers needed per week times 52 weeks in year divided by 3 trips per container times cents (cost of container) gives the yearly investment:

$$\frac{(7,092 \times 52)}{3} \times \$0.05 = \$6,146.$$

<sup>3</sup> Investment times interest rate of 5 percent for half the life of the container.

The yearly investment spent on containers depends largely on the useful life of a container. Time has not permitted thorough measures of the useful life of fully returnable containers that last several years. As a result, the estimated life of a container is based on wear and tear, performance tests, and on the amount of damage to containers currently in use. The polyethylene container has the lowest annual cost of the returnable containers, principally because of its long life and relatively low cost, and it is only slightly higher than the cost of the salvage container.

### Utilization of Storage Space for Container

An excellent measure of the effectiveness of warehouse-to-store containers is the space they occupy and the extent they utilize space. Figure 40 shows dimensions, capacity, space requirement, and the degree of space utilization for four containers. The packout is not the same for all firms; hence, the range is shown by the two figures (table 27). The stack-and-nest (wood) container has the best space utilization, but on the average it has a smaller capacity than the two other containers of comparable size.

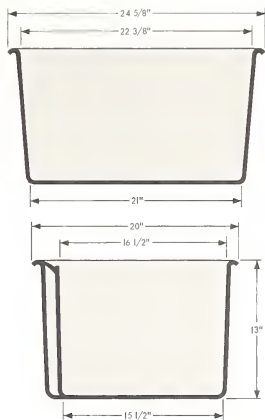
A 40- by 48-inch warehouse pallet will readily hold four thermoplastic or fiberglass containers

<sup>4</sup> Each year some containers must be replaced. If a container makes 200 trips, its useful life is 2.56 years. 5,987 containers divided by 2.56 equals 2,339 containers per year to replace. These containers during their life would have cost \$1.93 each for repairs: 2,339 times \$1.93 equals \$4,514.

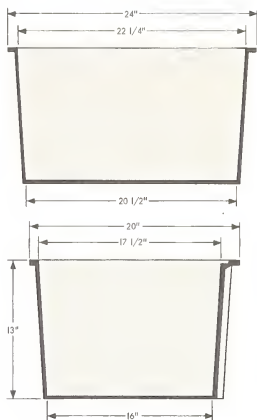
per layer. The wooden stack-and-nest container uses only 11.2 of the 13.3-square-foot-area of the pallet. If the pallet is the controlling factor, then more of some items in thermoplastic or fiberglass containers can be stored per layer on the pallet than with the wooden stack-and-nest. If the containers are not loaded on pallets in the trailer, then the one with the highest percentage of container-space utilization will have the advantage.

As warehouse volume increases, the need for space becomes critical. Every square foot of space in the warehouse carries the burden of building, depreciation, insurance, tax, and utilities. By liberating space more items can be stored or new manufacturing functions can be carried on without the need for expansion. The space used for storage by several firms averaged \$1.50 per square foot per year (1964). A reserve stock of warehouse-to-store containers is necessary for daily runs and peak periods. One-third of the returnable containers owned are normally stored at the warehouse. The inventory of salvage containers cannot be planned, due to the irregular source of supply; as a result, salvage containers are stockpiled. One firm using salvage containers had an average inventory of 6,500. The salvage containers that could not be nested occupied 1,500 square feet of floor space worth \$2,250 a year.

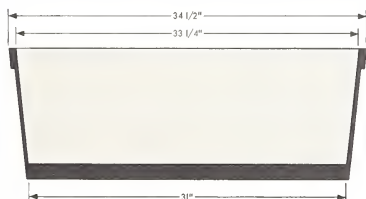




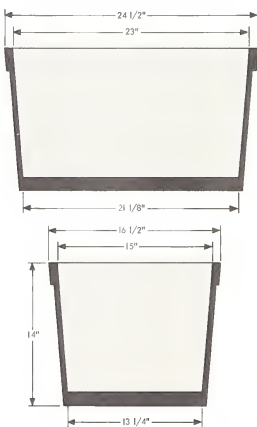
WEIGHT 6.0 LB.  
THERMOPLASTIC



WEIGHT 11.0 LB.  
FIBERGLASS



WEIGHT 14.5 LB.  
WOODEN BANANIA BOX



WEIGHT 11.5 TO 13.5 LB.  
WOODEN STACK-AND-NEST

	AREA		VOLUME		PER CENT
	OUTSIDE	INSIDE	OUTSIDE	UTILIZATION	
THERMOPLASTIC	493	4,167	6,409	65	
FIBERGLASS	480	4,304	6,240	69	
WOODEN BANANIA BOX	552	4,726	6,969	68	
WOODEN STACK-AND-NEST	404	3,560	5,660	65	

FIGURE 40.—A comparison of capacity and space utilization of four warehouse-to-store containers.

TABLE 27.—*Typical and maximum capacity and gross weight of containers shown in figure 40*

Item	Thermoplastic		Fiberglass		Banana box		Stack-and-nest	
	Typical	Maximum	Typical	Maximum	Typical	Maximum	Typical	Maximum
Capacity:								
Potatoes:	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
10-lb. bags.....	6	6	6	6	6	8	6	6
5-lb. bags.....	12	13	12	13	13	16	12	12
Onions, 3-lb. bags.....	20	22	20	22	20	24	18	20
Apples, 3-lb. bags.....	16	16	16	16	20	22	16	16
Oranges, dozen, size 113.....	12	13	12	12	12	15	10	12
Gross weight: <sup>1</sup>								
Potatoes:	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
10-lb. bags.....	66	66	71	71	74	94	72	72
5-lb. bags.....	66	71	71	76	79	94	72	72
Onions, 3-lb. bags.....	66	72	71	77	74	86	66	72
Apples, 3-lb. bags.....	54	54	59	59	74	80	60	60
Oranges, dozen, size 113.....	56	60	61	61	64	77	53	61

<sup>1</sup> At capacities listed above.TABLE 28.—*Cost of storage space for produce containers, by type of container, 1964*

Item	Unit	Thermoplastic		Fiber glass	Rexford	Wooden stack-and-nest	Salvage
		Polyethylene	ABS material				
Capacity per pallet.....	Containers.....	80	80	80	30	60	33
In storage, total.....	Containers <sup>1</sup> .....	1, 843	1, 843	1, 876	1, 995	1, 933	<sup>2</sup> 6, 500
	Pallet loads.....	23	23	23	66	32	197
Storage space required <sup>3</sup> .....	Square feet.....	230	230	230	660	320	1, 970
Cost of storage space at \$1.50 per square foot per year.....	Dollars.....	345	345	345	990	480	2, 955

<sup>1</sup> This is equal to one-third of the containers used per week. See table 26, p. 56.<sup>2</sup> This is the average inventory of salvage containers in one firm studied.<sup>3</sup> The analysis assumes the use of 40 by 48-inch pallets, which are stacked 2 high. The space occupied by each pallet is 10 square feet, which includes an allocated share of aisle space.TABLE 29.—*Utilization of space in thermoplastic (polyethylene), wooden stack-and-nest, and standard receiving containers*

Item	Potatoes		Onions, 3 lb.	Apples, 4 lb.	Oranges, dozen	Grapefruit, 8-pack	Weighted average <sup>1</sup>	Space utilized
	10 lb.	5 lb.						
Standard receiving containers:	<i>100-lb. bag</i>	<i>50-lb. bag</i>	<i>50-lb. bag</i>	<i>40-lb. bag</i>	<i>40-lb. bag</i>	<i>38-lb. bag</i>	<i>Pounds per cubic foot</i>	<i>Percent</i>
Space used.....cubic feet.....	4.04	4.04	2.17	1.85	1.25	1.25	-----	-----
Weight per cubic foot.....pounds.....	24.8	24.8	23.0	21.6	32.0	30.4	25.0	100.0
Received per week <sup>2</sup> .....containers.....	1,960	700	714	1,330	608	583	-----	-----
Thermoplastic (polyethylene) containers:								
Net weight of produce.....pounds.....	60.0	65.0	66.0	48.0	52.8	52.0	-----	-----
Weight per cubic foot <sup>3</sup> .....pounds.....	18.2	19.7	20.0	14.5	16.0	15.8	17.7	70.8
Packed per week <sup>4</sup> .....containers.....	3,267	1,077	541	1,108	481	438	-----	-----
Wooden stack-and-nest containers:								
Net weight of produce.....pounds.....	60.0	60.0	60.0	44.0	46.2	45.5	-----	-----
Weight per cubic foot <sup>3</sup> .....pounds.....	18.2	18.2	18.2	13.3	14.0	13.8	16.6	66.0
Packed per week <sup>4</sup> .....containers.....	3,267	1,167	595	1,209	513	500	-----	-----

<sup>1</sup> This figure is weighted by multiplying the weight per cubic foot by the proportion of total weekly packout bags used by a plant packaging 70,000 bags of specified produce weekly; see table 24.<sup>2</sup> Number of bags used per week (table 24) divided by number of bags per receiving container.<sup>3</sup> Based on 3.3 cubic feet per container.<sup>4</sup> See weekly requirements—table 24, p. 54.



Storage space for the three types of fully nestable containers would cost \$345 a year and for the rex-ford crate \$990 a year (table 28).

### Delivery Cost for Alternative Containers

Produce density (pounds per cubic foot) is decreased when consumer bags are packed in warehouse-to-store containers. The utilization is further decreased when stack-and-nest containers are used because of the tapering sides and stacking columns, both of which sacrifice space. If unfilled space is available in the trailer after loading is completed, the degree of space utilization will not affect the expense of transporting a given quantity of produce. The degree of utilization becomes important when the value of trailer load space is considered. When load space is critical, the decreased density of packaged containers can reduce the capacity and increase the expense of transportation. The objective, therefore, is to determine the cost difference of shipping produce in conventional containers as opposed to alternative warehouse-to-store containers and to determine whether the added space required for master containers will substantially add to delivery costs.

The utilization of a container may be measured in a number of ways. For example, it could be represented by the difference between inside and outside volume. (See fig. 4.) This report uses a comparison of receiving units per cubic foot to shipping units per cubic foot to determine utilization. Receiving units per cubic foot is the density of unbagged produce in conventional shipping (grower to warehouse) containers. Shipping units per cubic foot is the density of bagged produce in warehouse-to-store containers.

Two of the lower cost containers, thermoplastic (polyethylene) and wooden nest-and-stack, are compared with conventional shipping containers in table 29. The thermoplastic utilizes 71.7 percent of the space and the wooden stack-and-nest utilizes 66.0 percent of the cubic area occupied by the containers. The 71.7 percent utilization of the thermoplastic means that 2.4 cubic feet are occupied by product and 0.9 cubic foot of space is lost. The loss of space for the wooden stack-and-nest is 1.1 cubic feet.<sup>11</sup>

To obtain a value on trailer space, a study was conducted at a firm that packages produce centrally. During loading, 25 trailers were observed, 10 for city-store runs and 15 for country-store runs. All trailers for city-store deliveries had unused space available (after loading) that averaged 28 percent of available space; pallets occupied 6 percent of available trailer space. The 15 country runs averaged 9 percent unused space. Country-trailer runs were partly loaded with pallets and

TABLE 30.—Cost per run for trailer space for shipment of packaged produce to city stores and to country stores, 1964

Item	City stores (average round trip, 31 miles)		Country stores (average round trip, 292 miles)	
	Time	Cost	Time	Cost
Truck expenses at 19 cents per mile <sup>1</sup> .....		Dollars 5. 89		Dollars 55. 48
Loading at \$1.34 per hour <sup>2</sup> .....	1. 25	1. 68	1. 92	2. 57
Delays <sup>3</sup> .....	. 83	7. 78	. 83	5. 00
Driving costs <sup>4</sup> .....	1. 55	14. 52	7. 30	44. 02
Total cost per run.....		29. 87		107. 07
Average trailer: cubage.....		Cubic feet 1, 795		Cubic feet 1, 795
Cost per cubic foot.....		Cents 1. 7		Cents 5. 7

<sup>1</sup> Truck expenses are itemized as follows:

Cost item	Cents per mile
Road expense.....	0. 014
Gasoline.....	. 060
Oil and grease.....	. 001
Tires.....	. 005
Heat and refrigeration.....	. 011
License.....	. 019
Insurance.....	. 006
Repairs and maintenance.....	. 051
Supervision.....	. 011
Shortages and damages.....	. 005
Miscellaneous.....	. 003
	. 186

<sup>2</sup> Tie-up time was longer for country stores than for city stores, because the loads were largely handstacked.

<sup>3</sup> Delays averaged 50 minutes (30 minutes for engaging and weighing trailer, parking, and delays at stores, plus 10 minutes each for 2 additional stops) or 0.83 hour. Costs per hour for truck and trailer are estimated as follows:

	City stores	Country stores
Trailer.....	\$1. 34	\$1. 34
Tractor.....	1. 24	1. 24
Driver (\$3.00 an hour, plus 15 percent fringe benefits).....	3. 45	3. 45
Helper (\$2.90 an hour, plus 15 percent fringe benefits).....	3. 34	---
Total.....	9. 37	6. 03

<sup>4</sup> Driving cost was estimated as follows:

	City runs	Country runs
Average speed..... m.p.h.	20	40
Average trip..... miles	31	292
Time per trip..... hours	1. 55	7. 3
Cost per hour (see footnote 3).....	\$9. 37	\$6. 03
Cost per trip.....	\$14. 52	\$44. 02

<sup>11</sup> 2.9 cubic feet—(66.0×3.3)=1.1.

then topped off with handstacking. Pallets represented 3 percent of total trailer space.

The transportation cost for trailer load space averaged 1.7 cents per cubic foot on city-store deliveries and 5.7 cents per cubic foot on country-store runs (table 30). The extra cubage displaced by a thermoplastic container (0.9 cu. ft.) is valued at 1.5 cents for city runs and 5.1 cents for country runs. A wooden stack-and-nest container or rexford crate displaces 1.1 cubic foot additional space, amounting to 1.9 cents on city runs and 10.8 cents on country runs.

It is most difficult for the traffic department to schedule produce deliveries so that trailers are loaded to capacity. This is partly due to the seasonality of produce. Also, most produce is sold the last of the week and, being perishable, deliveries should approximate sales.

Potentially there is a loss of space when bagged produce is loaded in returnable containers. The extent of the loss depends on the proportion of containers delivered on country and city runs. It was assumed that 20 percent of the containers are delivered on country runs. The load space was critical in 7 of the 15 country runs; hence, 9.3 percent of the containers (7/15 × 20 percent) are taking up additional space and in turn decreasing the load. City runs typically had a surplus of space to accommodate the additional space required by the containers. In this study the thermoplastic (polyethylene) container would add 0.05 cent per bag and the wooden stack-and-nest would add 0.04 cent per bag to the cost of central produce packaging (table 31). If the country runs are handstacked in the trailer, the 3 percent gain in space from elimination of pallets would largely compensate for the loss of cubic space when stack-and-nest containers are used to ship packaged produce to the stores.

TABLE 31.—*Cost of trailer space lost by shipping produce to retail stores in returnable master containers, for 2 containers*

Item	Thermoplastic (polyethylene)	Wooden stack-and-nest
Shipped per year <sup>1</sup> .....containers	359,000	377,000
Occupy 9.3 percent of total space containers	33,387	35,061
Cost of space per container <sup>2</sup> .....cents	5.1	10.8
Annual cost of lost space.....dollars	1,903	3,786
Cost per bag <sup>3</sup> .....cents	.05	.10

<sup>1</sup> From table 24, p. 54.

<sup>2</sup> Cost of 5.7 cents per cubic foot for country runs (table 30). The extra cubage was 0.9 and 1.1 cubic feet, respectively, for the two containers.

<sup>3</sup> The cost per bag is derived by taking the annual cost of lost space and dividing it by a year's use of bags of a 70,000-bag-a-week plant:

$$\frac{\$1,903}{70,000 \times 52} = 0.05 \text{ cent.}$$

### Total Cost for Alternative Containers

The thermoplastic (polyethylene) container is the cheapest to use and, because of its lightness, capacity, and ease of stacking, the container has excellent acceptance with employees (table 32). The wooden stack-and-nest container costs only slightly more than the polyethylene, but its weight makes it difficult for women to handle at the pack-out station. The high cost of the salvage containers is due to labor and space costs. The baler bag is a limited-use container with extremely high material costs. Containers with a low capacity and inability to nest are the most expensive.

TABLE 32.—*Annual costs of labor, material, and storage space for specified warehouse-to-store containers for packaged produce in a 70,000-package-per-week warehouse, 1964*

Cost item	Thermoplastic		Fiberglass	Rexford	Wooden stack-and-nest	Salvage	Baler
	Polyethylene	ABS					
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Labor for handling.....	22,600	23,700	24,400	26,450	23,950	37,800	.....
Material cost.....	6,221	10,401	10,676	8,495	7,179	6,146	<sup>1</sup> 21,301
Storage space.....	345	345	345	990	480	2,955	.....
Total cost per year.....	29,166	34,446	35,421	35,935	31,609	46,901	.....

<sup>1</sup> Baler bag cost is \$77 per 1,000. The weekly requirement for 33,000 consumer units of potatoes is 5,320 bags. Cost per package is 1.22 cents and cost per year is \$21,301.

The selection of a container for shipment of package produce from the central warehouse to the retail store should be based on cost and the ability of the container to deliver produce to the store in good condition. It is the judgment of many produce executives that the baler bag, wire, salvage, and rexford containers have definite limitations in their ability to deliver bruise-free produce. Four of the containers, thermoplastic (both polyethylene and ABS), fiberglass, and wooden stack-and-nest, give good protection to the produce. The rexford crate is not recommended for bruise-susceptible items such as apples, despite its low cost. The wooden slats will bruise apples when they are jostled in the container. This crate does not have positive stacking; it will slide off the stack and fall in the lower container, damaging some of the product. Handling problems are complicated when more than one type of container is used; therefore a versatile container is desirable. Warehouses that bag only potatoes and onions can use a rexford crate and take advantage of the low investment.

## Design and Handling Principles for Containers

### *Dimensions*

1. The container should accommodate the largest number of packages for a given dimension.
2. For ease of handling, the container should not be too long or too wide. A container over 24 inches in length pulls the worker's arms apart in lifting and increases the strain. When the container is over 20 inches in width, the center of gravity moves further from the body and is harder to handle.
3. Females generally are not allowed to lift more than 40 pounds and males cannot readily lift over 70 pounds.
4. If the container is too deep the product will be bruised.
5. If the container is too small the cost of the extra handling and the inventory of containers will be prohibitive.
6. It is desirable that the container be able to handle different sized packages for a variety of items. This could include lettuce, salad items, and

cheese or meat items. If one container cannot handle all central packaging requirements, then perhaps two containers will give the desired flexibility.

### *Configuration*

1. The container should nest approximately 80 percent without wedging.
2. The container should stack without any danger of slipping or falling into the lower container.
3. Stacking should not cause delays.
4. To achieve maximum space utilization, the container should have uninterrupted interior lines.
5. The design of the container should incorporate features that will give secondary usage, such as a display container.
6. It should provide for coding (if necessary) and identification of contents.
7. The container should be compatible with other containers so that they can nest or stack together.

### *Material*

1. The container should be lightweight, to maximize the ratio of product to total weight.
2. The material should be washable in steam cleaners and should have high resistance to cleaning solutions.
3. The container should be able to withstand extreme cold.
4. There should not be any recesses to trap dirt.
5. The container should have a long life, withstand handling abuses, and have a uniform weight for tare purposes.
6. It should have Food Drug Administration approval for food handling.
7. It should be strong enough to support a six-high stack.

### *Material Handling System*

1. The container must be an integral part of the firm's delivery system.
2. It should fit on the warehouse pallet without any loss of space.
3. It should contribute to an overall savings from warehouse packaging to display in the store.

# PRODUCTION SCHEDULING AND CONTROL FOR THE PRODUCE PACKAGING OPERATION

The best way for a firm to insure that its produce packaging line will be efficient is to install a system of scheduling and cost control. Scheduling of product will permit the best utilization of plant and equipment, personnel, and shipping containers. It will prevent an excessive number of product changeovers and will insure that packaged produce will be in the stores at the right time and in the right amount. A cost control system will give management a continuous record of costs, which will assist in pricing and in the determination of what and when to package certain items. The price of produce often varies in the form of a bell-shaped curve during the season. It typically is high early and late in the season and relatively inexpensive during the peak of the season. Cost control will help management determine when packaging is profitable. There may be periods when packaging costs are too high in relation to the selling price, and at these times the firm should switch to an alternative packaging method or selling technique. Cost control will expose details that are otherwise buried in one overall cost figure.

Agricultural research specialists, working with cooperating firms who have central produce packaging facilities, have developed techniques for scheduling and complete step-by-step cost control systems. One system was designed for manual

cost control; another was programed for a computer use and could be extended to cover all central processing.

## Scheduling

Scheduling is the process of planning for production, which is continuously adjusting to changing conditions. It begins with long-range forecasts, based on supply and price conditions of the items to be packaged, and ends when the line is committed to a definite production run. It really doesn't end there, for scheduling errors often call for makeup runs late in the day. Effective scheduling will reduce costs through better utilization of labor, plant, and equipment and through the reduction of overtime.

## Long-Range Scheduling

It is desirable to level out production so as to utilize fully the factors of production labor, equipment, plant, and burden. In one firm, the volume of bagged produce during the year ranged from 17,000 to 60,000 packages a week. Of greater significance was the pronounced change in volume from week to week (fig. 41).

Such a variation in volume prevents the full utilization of resources. In an analysis of volume variance it was determined that there was a 66-percent chance that volume would be between 21,000

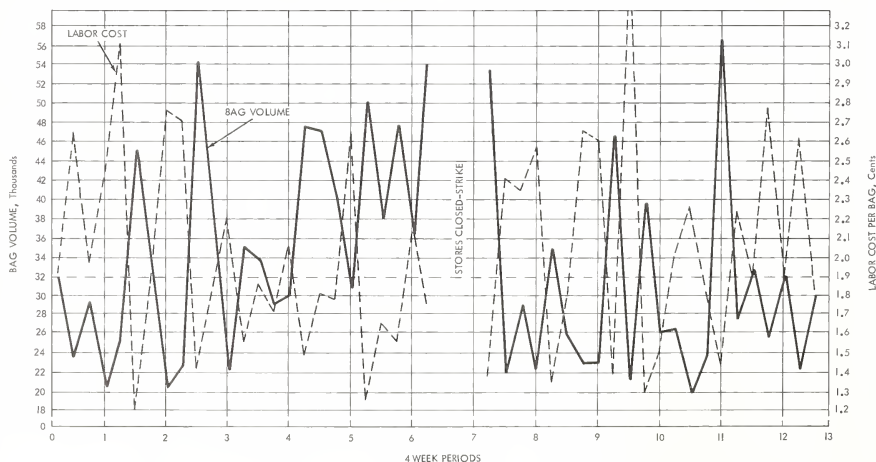


FIGURE 41.—Relationship between bag volume per week and labor cost, 1961.

and 43,000 bags per week. The fixed charges (equipment, supervision, rent, containers, and burden) were \$17,850 per year and ranged from 0.6 cent to 1.7 cents per bag, depending on volume.

<i>Weekly package volume</i>	<i>Fixed cost per package Cents</i>
20,000 -----	1.7
30,000 -----	1.2
40,000 -----	.9
50,000 -----	.7
60,000 -----	.6

Labor is normally treated as a variable cost; yet an examination of the relationship between labor cost per bag and weekly output reveals a rather high correlation (74 percent). Squaring this correlation ( $0.74 \times 0.74 = 0.54$ ) indicates that approximately half the change in labor costs is explained by a change in volume.<sup>12</sup> The impact of this relationship is evident in the straight line curve in figure 42. When volume increases from 30,000 to 50,000 packages per week, labor costs decrease from 2.1 cents to 1.4 cents per package. If half of this cost decrease is the result of increased volume, then labor costs would decrease by only 0.35 cent per package. The variation in labor costs when related to volume occurs because it is difficult to adjust the labor requirements from week to week, because the composition and balance of the packaging line crew is not efficient at all volume levels, and because the pressure exerted on the line by higher volume stimulates productivity while lower volume is conducive to relaxation.

### *The Weekly Schedule*

Operational scheduling for the central produce packaging line begins with the weekly planning schedule. This is where the plans of the buyers and merchandisers are first translated into a production plan. The packaging foreman should meet with them on Friday or Saturday to plan item by item production for the following week. They can be assisted in the scheduling by using the weekly scheduling form that is illustrated by figure 43. Each block for recording daily production and estimated time is divided with a diagonal line to permit adjustment in the forecast as the week progresses. The original estimate is entered in the lower left-hand corner and the revised estimate in the upper right-hand space. Production standards, which are developed from actual operating times, permit the translation of planned production into operating time. An example of a technique for converting output into labor requirements is illustrated in figure 44. When the standard line-running time for 5-pound bags of potatoes is 5 minutes per 100 bags and the planned output is 1,200 retail packages, the estimated runtime for

the planned production run is 60 minutes. The standard times are constantly reviewed and adjusted if necessary to reflect operating changes.

This schedule allows the operator to take a broader look at his production and make adjustments to bring equipment, labor, and output into balance. Changes in planned production on one item will lead to changes for other items, and planned time requirements are again balanced against the available time.

### *The Daily Schedule*

The weekly planning schedule is the basis for the daily planning and production report (fig. 45). Prior to each day's operation, estimates are taken from the weekly planning schedule and posted, item by item, to the daily report. At the completion of each run, the supervisor records actual production in retail units, elapsed time for the overtime run, and crew size. On certain runs he will record input and output in order to measure yield. This is the best time for the supervisor to check the performance of the line.

Figure 46 illustrates an easy way to measure performance. Points representing the actual run time and the standard time are lined up by a straight edge. The extension of this line to the right-hand side of the chart gives the performance level. For example, if the actual operating time is 100 minutes and the operating standard for that item run is 110 minutes, the performance level is 108 percent. This indicates that the line is at a level of efficiency 8 percent above the standard. Checking performance after each run immediately reveals "out of control" conditions and permits prompt immediate corrective action.

The daily planning of item runs should follow a logical sequence. Heavy items like 10-pound bags of potatoes should be scheduled for the beginning of the day while the bagging crew is fresh. Long changeovers can be avoided by running 5-pound and 10-pound packages of the same product next to each other. This achieves another purpose in giving baggers a break from the fatiguing 10-pound packages. A suggested sequence is 10 pounds of russets, 5 pounds of russets, 5 pounds of whites, and 10 pounds of whites. Lightweight items are easier to bag and should be saved for the end of day when the crew is tired. Onions are light and dirty and therefore should be the last production run. If there are more than one packaging line, the sequence of items is less critical.

### *Control of Short Runs*

Each production run requires a change of either product or packaging material, or of both. One objective of weekly scheduling is to reduce the number of changeovers by combining the short runs and packing slow movers on alternate days.

<sup>12</sup> The squaring of the correlation gives the coefficient determination. This value tells what part of the change in the dependent variable is explained by a change in the independent variable.



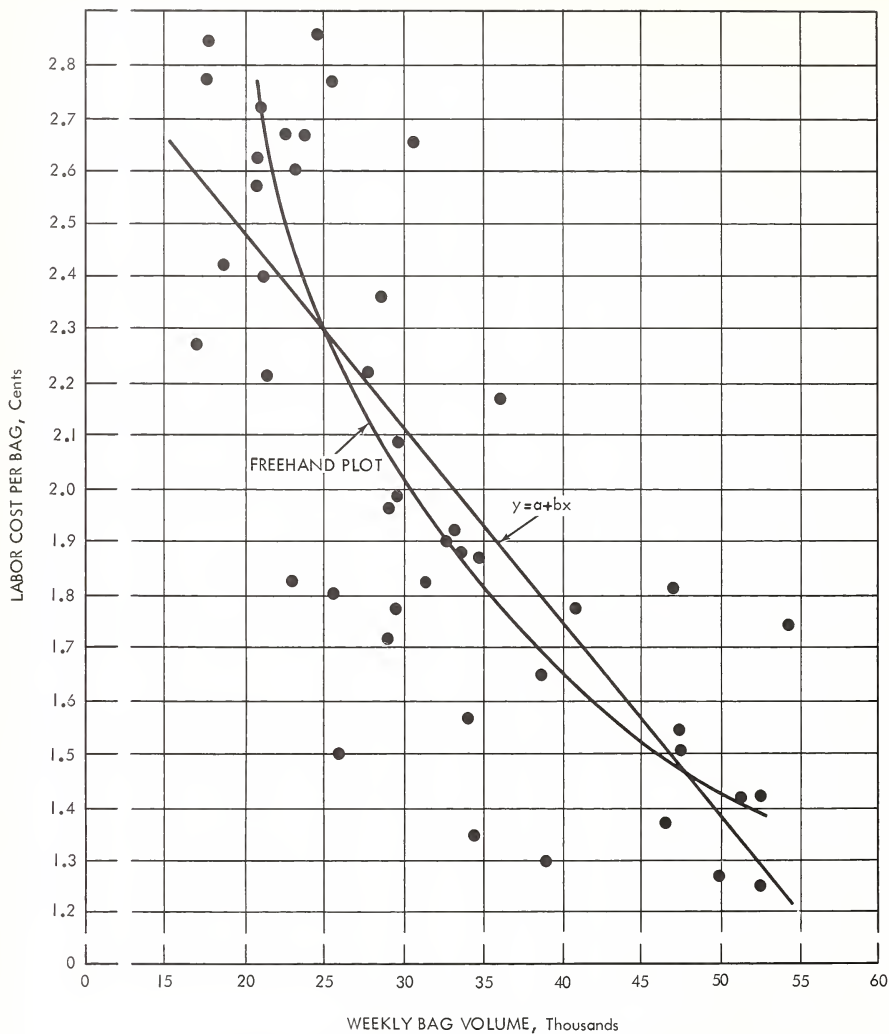


FIGURE 42.—Relationship between bag volume and labor cost.

## WEEKLY PLANNING SCHEDULE

For week of \_\_\_\_\_

Product Name and Size	MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY		SATURDAY		TOTALS	
	Retail Containers	Min.	Retail Containers	Min.	Retail Containers	Min.	Retail Containers	Min.	Retail Containers	Min.	Retail Containers	Min.	Retail Containers	Min.
Potatoes: Idaho 10 lb.	50	15	150	37	150	25	150	30	250	75	120	30	250	407
" 5 lb.	100	30	140	42	140	43	150	44	250	60	120	30	410	254
Red 10 lb.	100	20	100	20	150	30	150	30	250	60	120	30	410	254
" 5 lb.	120	30	120	30	150	30	150	30	250	60	120	30	410	254
New 10 lb.	100	20	120	20	150	30	150	30	250	60	120	30	410	254
" 5 lb.	100	20	120	20	150	30	150	30	250	60	120	30	410	254
White 10 lb.	100	20	120	20	150	30	150	30	250	60	120	30	410	254
" 5 lb.	100	20	120	20	150	30	150	30	250	60	120	30	410	254
Onions: Yellow 3 lb.														
" 1 1/2 lb.														
Apples: Red Del. 3 lb.														
" " 4 lb.														
Winesap 3 lb.														
" 4 lb.														
Jonathan 3 lb.														
" 4 lb.														
Greenings 3 lb.														
Rome 3 lb.														
Oranges: Florida														
Doz., 100's														
TOTALS														

✓ Returnable Shipping Containers Used.

FIGURE 43.—The weekly planning schedule for a central warehouse produce packaging line.



## Computation Chart

Bags (number)	Line running time in minutes per 100 bags <sup>1</sup>													
	2	3	4	5	6	7	8							
2,000	39	50	60	69	80	89	100	109	120	129	140	151	160	
1,800	36	45	54	63	72	81	90	99	108	117	126	135	144	
1,600	32	40	48	56	64	72	80	88	96	104	112	120	128	
1,400	28	35	42	49	56	63	70	77	85	91	98	105	112	
1,200	24	30	36	42	48	54	60	66	72	78	84	90	96	
1,000	20	25	30	35	40	45	50	55	60	65	70	75	80	
800	16	20	24	28	32	36	40	44	48	52	56	60	64	
600	12	15	18	21	24	27	30	33	36	39	42	45	48	
400	8	10	12	14	16	18	20	22	24	26	28	30	32	
200	4	5	6	7	8	9	10	11	12	13	14	15	16	

<sup>1</sup> Determine the number of bags per minute and convert to line running time per 100 bags. Read down from the appropriate line running time until reach horizontal line for number of bags produced. For example, if line production is at a rate of 20 bags per minute, running time is 5 minutes per 100 bags. If total run is 1,000 bags the time required will be 50 minutes.

FIGURE 44.—Example of a computation chart for estimating the time requirements for scheduled production runs.

## DAILY PRODUCE PACKAGING PRODUCTION REPORT

Date \_\_\_\_\_

Product Name and size	Packaging No.	Produced		Yield			Labor Requirement					Remarks
		Input S.C.	Output M.C.	Input Total, Wt. or No.	Output Total, Wt. or No.	Percent	Min.	Per- formance Percent	Other time Min.	Code	Crew Number	
Potatoes: Idaho 10 lb.	6	50	32	5000	5010	98.2	22	91	2	C/O		
" 5 lb.	13	20	30	2000	1998	99.7	11	109				
Red 10 lb.	6	100	160	10,300	9776	94.7	38	105				
" 5 lb.	13	50	75	5150	4995	97.0						
New 10 lb.	6											
" 5 lb.	13											
White 10 lb.	6	50	81									
" 5 lb.	13											
Onions: Yellow 3 lb.	20											
" 1 1/2 lb.	40											
Apples: Red Del. 3 lb.	15											
" " 4 lb.	12											
Winesap 3 lb.	15											
" 4 lb.	12											
Jonathan 3 lb.	15											
" 4 lb.	12											
Greenings 3 lb.	15											
Rome 3 lb.												
Oranges: Florida												
Doz., 100's	15											
Totals												

1/Shipping containers (receiving)

2/Warehouse-store master containers

FIGURE 45.—Suggested form for daily produce packaging production report.

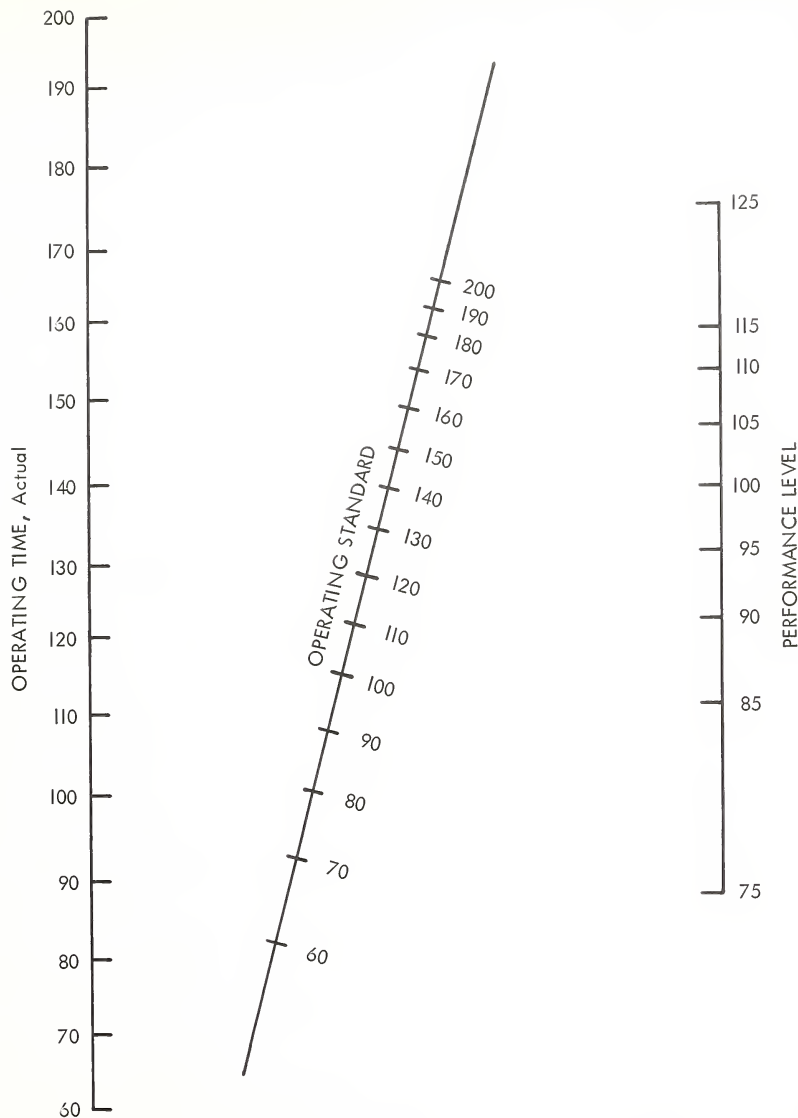


FIGURE 46.—Suggested method for determining performance level of a central produce packaging line.

If the item has a shelf life of several days, packing for inventory on alternate days will permit the leveling of production from day to day. If some short runs are necessary because of the perishability of the product, it is recommended that they be run on a single bagger where only one employee is used.

The advantage of scheduling short runs on a single bagger is illustrated by an actual run. This run of 100 packages on a line employing 10 people required 5 minutes. A 3-minute changeover increased labor requirements by 60 percent to 80 man-minutes. The same run on a single bagger with one employee required 40 minutes. Labor costs for the run were 100 percent higher on the line.

As runs become shorter, especially when quality is deteriorating at the end of the season for a particular item, the firm should consider the elimination of that item from the warehouse packaging inventory.

In one firm a record of the product runs, items, and packages was maintained for 5 weeks (fig. 47). The single line packaged a wide variety of items in different sizes. Of the total runs, 42 percent were for less than 200 packages (20 master containers) and 79 percent were for runs of less than 500 packages (50 master containers). On the average they packaged 21 items and had 15 product runs per day. A cost control system would warn management when the runs are too costly, a likely reason would be too many short runs.

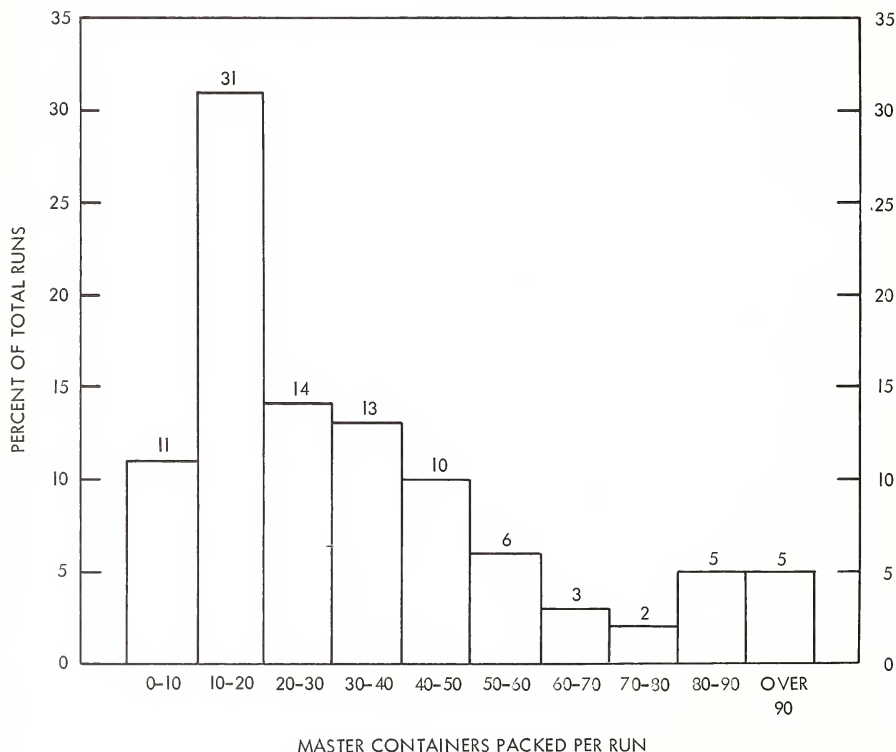


FIGURE 47.—Length of production runs and percentage of total runs during a 5-week period (25 days).

## Control of Changeovers

When package size is changed, bagging employees change weight adjustment of the bagging scales and obtain a new supply of poly bags. Many times, the height of the central bag closer is changed. Typically both package size and product are changed. If an average of 3 minutes per changeover and a crew of 10 is assumed, the line represented by figure 47 used 36 man-hours per week for changeovers, which is almost equivalent to one full-time employee. This indicates that line changeover is an area where improvements can be made. The best insurance that downtime is kept at a minimum is to assign specific duties for each employee. For example, one or more employees are assigned to complete the bagging of the last few packages. Others are assigned to change bag sizes, check the weights on the bagging machines, police the area, and organize and place empty containers in storage.

The common practice for measuring changeover time is to select two indicators that signify the end of one run and the beginning of another run: For example, from the time after the feed belt clears the product and ending when the first bag of a new run is placed in a master container, or from the time the last bag of a run passes through a central closer until the first bag of new run passes through the closer.

A more exact method of measuring actual production time lost during a changeover can be shown with the aid of a graph. Packages per minute are plotted against elapsed time in quarter-minute intervals. The number of packages leaving the take-away belt in a quarter minute is indicated by a vertical plot on the graph. Each package counted in the quarter minute in effect represents a production of four packages per minute on the vertical scale. A leveling line is drawn to approximate a trend of the plotted points.

During the hour of running time illustrated by figure 48, there was an elapsed time of 8 minutes, prior to a complete bagging line changeover from 2-dozen size 163 oranges to 1-dozen size 163 oranges, when production dropped considerably (an average of 8.4 bags per minute). In the next changeover (No. 2) to grapefruit, there was a loss of 1 minute plus a loss of labor due to declining productivity at the end of one run and at the beginning of the next run. The recommended break points are when production drops by half of the normal level and when production rises to half the normal level on the new run. The actual production loss in the second changeover is 3 minutes. The production profile (or graph) reveals other factors that affect output. The dip at No. 1 changeover shows the time required for a change in package size and the dip at No. 4 reflects a loss of production due to an inadequate supply of

empty containers. This chart is not a practical device for daily use but can be used to educate crew members when the changeovers are too long.

The recommended practical technique for measuring changeover time is to start the changeover period when the feed belt is clear of the product and to end the changeover period when the bagged product of the new run appears on the packout table.

## Cost Control

The objective of cost control is to keep management informed and to focus attention on unit costs. Generally those firms with good control over production have the best record of productivity. An effective cost-control system is one in which corrective action is almost automatic. The best opportunity to control production costs is through weekly and daily scheduling. The first evidence of actual costs is the performance level determination at the end of each run. This is also the right time to take corrective action if needed. The cost-control system should be tailored to the reporting and accounting facilities of the firm. During the study, cost-control systems were developed for use with an electronic data-processing computer and for a manually recorded operation.

### Manual Cost-Control Recording System

The data for the manual recording system originates with the Daily Produce Packaging Production Report (fig. 45). This report is a valuable control device as well as a source of data for cost analysis. It provides a measure of product control (yield) through item-by-item recording of input and output.<sup>15</sup> It also gives the supervisor an instant measure of the line's performance. The Daily Produce Packaging Production Report shows product identification, pack size, package output, line operating time, downtime, overtime, and crew size, and has a space to record any unusual event.

At the end of the week the output in master containers and the labor requirements for each item are posted from the Daily Produce Packaging Report (fig. 45) to the Weekly Produce Packaging Cost Analysis (fig. 49). Line output in packages is obtained by adding the production in master containers for each day and multiplying the week's total by the number of packages per master container for that item. A total of man-

<sup>15</sup>This is not a precise measure of yield, since it assumes the weight of items purchased by weight is as specified on the invoice. For example, a 100-pound bag of potatoes is assumed to weigh 100 pounds. It also assumes the weight in the package is the same as the unit of sale; that is, 10 pounds or 5 pounds. In practice, there is a minimum overpack to prevent shrinkage below the specified weight of both the receiving container and the customer unit. Yield is more accurately calculated in the computer cost-control system.

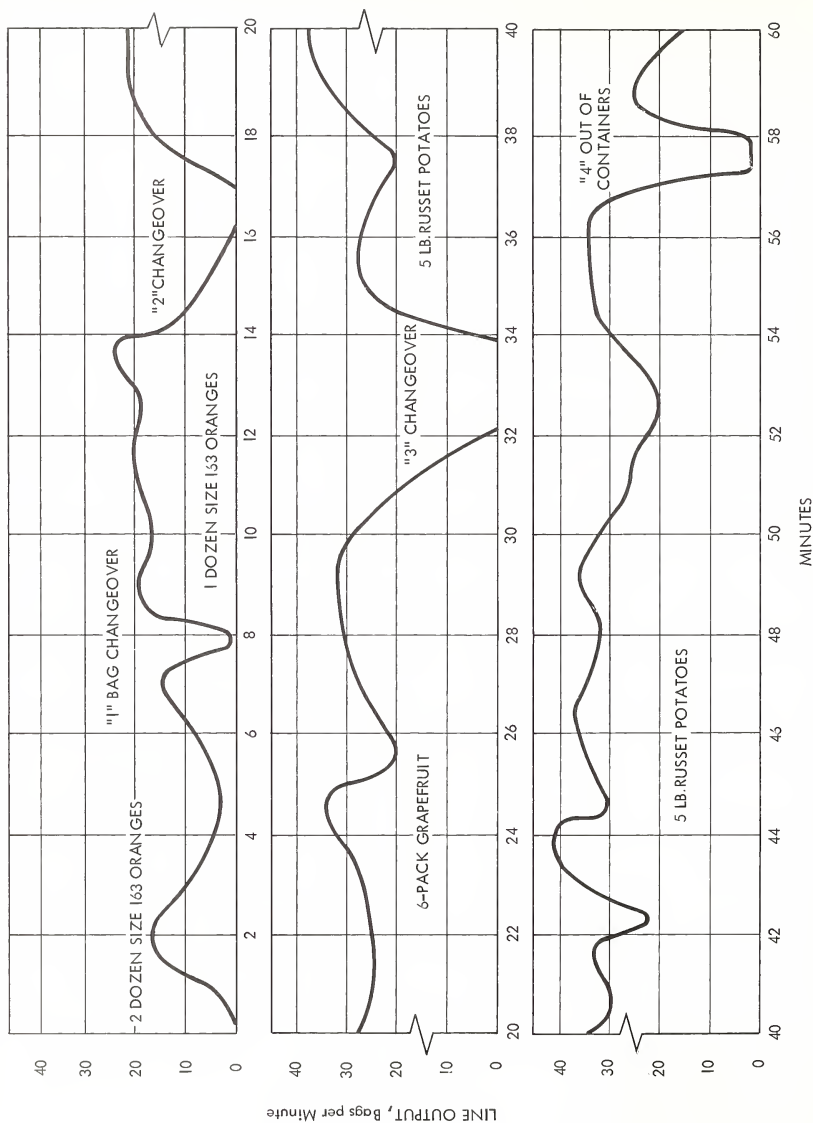


FIGURE 48.—A graphic technique to measure changeover time and highlight variations in rate of production.

## WEEKLY PRODUCE PACKAGING COST ANALYSIS

Week ending \_\_\_\_\_

Product Name and size	Pack	Mon.		Tues.		Wed.		Thurs.		Fri.		Sat.		Total pkg.	Total man- min.	Man- min. per pkg.	Labor cost per pkg.	Mat'l cost per pkg.	Indir. labor and burden per pkg.	Total cost per pkg. (cents)
		Pkg.	Man- min.	Pkg.	Man- min.	Pkg.	Man- min.	Pkg.	Man- min.	Pkg.	Man- min.	Pkg.	Man- min.							
Potatoes: Idaho 10 lb.	6			2370	1404	650	564	620	432	1550	1008	1040	528	6230	3936	63	.70	2.10	2.25	73
" 5 lb.	13			1050	492			1370	804	880	448	2540	1290	2390	51	.57	1.71	1.19	62	
Red 10 lb.	6			1750	1008	1510	1200	660	492	820	732			4740	3432	72	.80	2.40	2.25	
" 5 lb.	13			400	240	1310	720	760	420	590	348	1140	696	4200	2424	58	.64			
New 10 lb.	6																			
" 5 lb.	13																			
White 10 lb.	6			440	192	420	220	210	192	770	456	310	204							
" 5 lb.	13			1200	732	1220	564	1230	912	480	324									
Onions: Yellow 3 lb.	20			2540	910	1800	630	2040												
" 1 1/2 lb.	40																			
Apples: Red Del. 3 lb.	15																			
" " 4 lb.	12																			
Winesap 3 lb.	15																			
" 4 lb.	12																			
Jonathan 3 lb.	15																			
" 4 lb.	12																			
Greenings 3 lb.	15																			
Rome 3 lb.																				
Oranges: Florida																				
Doz. 100's	15																			
Totals																				
Downtime man-min.																				
Overtime man-min.																				
Non-productive man-min.																				
Weekly totals																				

Labor adjustment \_\_\_\_\_  
 Cents per man-min. \_\_\_\_\_  
 Performance level \_\_\_\_\_

FIGURE 49.—A suggested form for the Weekly Produce Packaging Cost Analysis.

minutes is obtained by multiplying the elapsed time for each item run times the crew size and then adding the daily totals by item, to obtain the weekly total of man-minutes. This total is merely the operating time (elapsed time multiplied by crew size) and must be adjusted to reflect overtime, downtime, and changeover time (providing it is recorded separately). It is not proper to charge overtime or downtime to a particular item run. The weekly total of man-minutes is the operating time (runtime), downtime, and one-half the overtime. This weekly total of man-minutes is divided by the total man-minutes of operating time to obtain the labor adjustment for the week. The labor adjustment can be incorporated in the average wage rate before it is multiplied by man-minutes per package to give the labor cost per package.

Material cost per package is the cost of the polyethylene bag and closure. This cost should

be periodically reviewed because of the competitive nature of the poly bag market. Indirect labor and burden includes supervision, forklift truck operator, equipment depreciation, occupancy, and other overhead charges.<sup>14</sup> The burden cost per package is obtained by dividing the weekly total charge by package volume. The sum of labor, material, and burden costs gives the total cost per package for the item. To obtain weekly totals, the individual item totals are weighted by package volume.

### *An Electronic Data Processing System for Cost Control*

The retail food industry is turning to electronic data processing (EDP) equipment as a manage-

<sup>14</sup>Typically the indirect labor and burden charges are on a yearly or operating period basis and are converted to a weekly basis.

ment tool for reducing costs. With EDP, most of the manual recording is eliminated and greater detail is available. The use of the computer for the packaging operation permits integration with programed systems for purchasing, inventory control, and store ordering. Inventory control is especially important with produce because of its perishability. There should be a common code for each item that would let the computer identify the item as to weight, size, retail package size, product characteristics, commodity, and origin. The detailed history of sales provided by EDP is an invaluable tool to both the buyer and the retail store.

It is not practical to assign code numbers that would meet the needs of the entire produce industry. Rather, a code class or code group was allocated to the various functions and product groupings. These are illustrated in table 33 where under item No. 3, columns 14 to 30 are reserved for the code number. This type of code permits subtotals, speeds up the computations, and results in precise information for management.

Columns 14 and 16 of the item code represent the type of operation, such as produce bagging, produce tray packing, banana packaging, luncheon

meat, ice cream, and cheese. The next three columns (18-22), when used for produce, identify the commodity (potatoes, apples, oranges, peppers, grapes). Two columns (24 and 26) identify the variety (Red Delicious, Navel, Russet), the origin (Florida, California, Texas), and the unit size (54, 88, 113, 120, 163; 6 oz., 8 oz.). The final columns (28 and 30) identify the package size (10 pounds, 3 pounds, dozen, 12 oz., 6 pack). This code should be modified to meet the operating practices of each firm.

This EDP system of cost control for produce bagging can utilize the portable hand punching card ("Port-a-punch") system. Special prescored punching cards with 40 columns (0 to 80 in even numbers) are placed in a punching board, covered with a clear plastic template with guide holes. The appropriate holes are made with a punching pencil (fig. 50). At the end of each item run the supervisor records the essential details in the card—date, code, input, output, run time, crew size, time information, and the average overpack. All other information is programed into the computer.

A typical produce bagging operation will use between 50 and 100 cards to record the week's pro-

TABLE 33.—*Cost control for centralized produce packaging*

PUNCH CARD DATA

Item No.	Port-a-punch entry	Punch card column No.	Source of data	Remarks
1	Card No.-----	2	-----	Instruction card, data card.
2	Date.-----	4-6	Calendar-----	Month.
		8-10	do.-----	Day.
		12	do.-----	Year.
3	Code.-----	14-16	Code table.-----	Class: produce bagging.
		18-22	do.-----	Commodity: potatoes, onions, apples, oranges.
		24-26	do.-----	Variety, origin, unit size.
		28-30	do.-----	Output package size; 5-pound, 1 dozen, 2 dozen.
4	Input.-----	32-36	-----	Hundred (pounds of count). <sup>1</sup>
5	Output (retail containers).-----	38-42	Daily record of packaging.-----	Number of retail containers.
6	Operating time.-----	44-48	Time clock.-----	Minutes.
		50	Code.-----	0=runtime, 1=overtime, 2=downtime. <sup>2</sup>
7	Changeover time.-----	52	Time clock.-----	When feed belt clears until start packing out.
8	Crew size.-----	54-60	Observation.-----	Number male and number female.
9	Average package over-weight.-----	62-66	Sample weighing.-----	In hundredths of a pound, applying only to items packaged by weight. <sup>3</sup>
10	Pack size.-----	68-70	Schedule.-----	Number of packages per retail container.

See footnotes at end of table.



TABLE 33.—*Cost control for centralized produce packaging—Continued*

COMPUTATION DATA			
Item No.	Data description	Computer computation	Computation by item No.
11	Packages-----	Summation (retail containers $\times$ pack size)-----	$(5 \times 10)$
12	Overtime (man-minutes)-----	Summation (overtime minutes $\times$ crew size)-----	$(6_1 \times 8)^4$
13	Downtime (man-minutes)-----	Summation (downtime minutes $\times$ crew size)-----	$(6_2 \times 8)^4$
14	Changeover (man-minutes)-----	Summation (changeover minutes $\times$ crew size)-----	$(7 \times 8)$
15	Total time to be allocated-----	Summation $[1\frac{1}{2}(\text{overtime man-minutes}) + (\text{downtime man-minutes}) + \text{changeover man-minutes}]$	$[\frac{1}{2}(12) + 13 + 14]$
16	Allocated man-minute per package-----	Total time to be allocated $\div$ packages-----	$15 \div 11$
17	Runtime (man-minutes)-----	Summation (runtime minutes $\times$ crew size)-----	$(160 \times 8)^4$
18	Man-minutes per package (runtime)-----	Man-minutes $\div$ packages-----	$17 \div 11$
19	Total man-minutes, per package-----	Man-minutes per package runtime $+$ allocated man-minutes per package-----	$16 + 18$
20	Direct labor cost per man-minutes-----	(Number male $\times$ male wage rate) $+$ (number female $\times$ female wage rate) $\div$ crew size (table 34).	$(8_M \times C_1) + (8_F \times C_2)^5$
21	Total direct labor cost per package-----	Total direct labor cost per man-minutes $\times$ total man-minutes per package-----	$19 \times 20$
22	Material cost per package-----	The item code will automatically select from a table in memory appropriate material cost for bags and closure (table 35).	8
23	Retail container cost-----	Container depreciation cost per week $\div$ total containers used per week-----	$C_3 \div 5^6$
24	Retail container cost per package-----	Retail container cost $\div$ pack size-----	$23 \div 10$
25	Burden and indirect labor cost per package-----	Weekly charge for burden and indirect labor $\div$ total weekly packages-----	$C_4 \div 11^7$
26	Total cost per package-----		$21 + 22 + 24 + 25$
27	Performance level-----	Man-minutes per package $\div$ standard time-----	$19 \div C_5^8$
28	Excess product in package per package-----	Overpack — tare allowance (see schedule of allowances).	$(9 - C_7)^{10}$
29	Line shrink per package-----	[Input — output] $\div$ packages-----	$[4 - (11 \times C_6)] \div 11^9$
30	Total shrink per package-----	Line shrink plus excess products in package-----	$28 + 29$

<sup>1</sup> If this pertains to items packaged by number such as oranges (or grapefruit) it will be manually calculated by taking (number of receiving orange boxes) times (number of oranges per box). If pertaining to items packaged by weight such as potatoes (or onions), it is then calculated by multiplying (number of bags received) and (pounds per bag).

<sup>2</sup> The various operating times will be recorded in columns 42 through 46. Column 48 will code the time as runtime, overtime, or downtime. A zero punched in column 48 indicates the operating time to be runtime, a one punch means overtime, and a two punch means downtime.

<sup>3</sup> (Total weight of packaged produce per pallet load) — [empty pallet  $+$  (no. containers  $\times$  average empty retail container weight)]  $\div$  total no. packages per pallet load = weight of package. Weight of package — package size = average package overweight.

<sup>4</sup>  $6_1$  means overtime minutes,  $6_2$  means downtime minutes,  $6_0$  means runtime minutes.

<sup>5</sup>  $C_1$  is constant in memory equaling male wage rate in

cents per minutes;  $C_2$  is a constant in memory of female wage rate in cents per minute (both include fringe benefits). See table 34.

<sup>6</sup>  $C_3$  is a constant in memory, which is the weekly container depreciation cost.

<sup>7</sup>  $C_4$  is a constant in memory equivalent to the total weekly charge for indirect labor, supervision (including fringe benefits), and burden charges for electricity, building, taxes, maintenance, etc.

<sup>8</sup>  $C_5$  is a predetermined standard time (man-minute per package) placed in memory for each item code. The weekly printout will be performance level for each day and for the total week.

<sup>9</sup> The computer will pick up package size from the item code (columns 26–28) and add average package overweight (columns 60–64) to yield  $C_6$ , which is the average package weight or count. Output is number of packages  $\times$  average weight or count.

<sup>10</sup>  $C_7$  is a table of tare allowances stored in memory for each item code.

CODE	DATE				CODE				INPUT IN HUNDRED POUNDS OR COUNT	OUTPUT IN RETAIL MASTER CONTAINERS	OPERATING TIME		CHG. OVER (MIN.)	CREW SIZE		AVERAGE PACKAGE OVERWEIGHT (HUNDREDS OF POUNDS)	PACK SIZE	
	NUMBER	MONTH	DAY	YEAR	CLASS	COMMODITY	VARIETY ORIGIN SIZE	CON- SUMER PACKAGE SIZE			MINUTES	CODE		MALE	FEMALE			
0 2 4 1	0 4 1	0 8 1	0 10 1	0 12	0 14 1	0 16 1	0 18 1	0 20 1	0 22 1	0 24 1	0 26 1	0 28 1	0 30 1	0 32 1	0 34 1	0 36 1	0 38 1	0 40 1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9 2	9 4	9 6	9 8	9 10	9 12	9 14	9 16	9 18	9 20	9 22	9 24	9 26	9 28	9 30	9 32	9 34	9 36	9 38

FIGURE 50.—Port-a-punch card on EDP cost control system.

duction. The system as described in this report is for produce bagging. With minor modification it can be extended to cover any central produce processing operation, or in fact to any central warehouse processing and packaging lines.

It is not possible to develop a computer program for packaged produce that can be used by all firms. It is possible to list the computations and the information that must be programmed into the computer, and to develop a printout form for recording the week's production results. A suggested

system is represented in table 33 which systematically lists the steps the computer will follow. The first 10 item numbers (columns 2-70) are for information that is hand-punched into the cards. This information should be readily available to the supervisor at the end of each run. The cards can be prepunched to identify the product class. The number of containers can be obtained by a conveyor case counter (a device to record number of units passing over a conveyor system). Time is more accurate and easier to record if the

TABLE 34.—*Suggested method of computing average direct labor costs (cents per man-minute) for programming into computer (see item No. 20, table 33)*<sup>1</sup>

Female <sup>2</sup>		Male <sup>2</sup>									
	0	1	2	3	4	5	6	7	8	9	10
0	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
1	5.00	4.17	3.89	3.75	3.67	3.61	3.57	3.54	3.52	3.50	3.48
2	5.00	4.44	4.17	4.00	3.89	3.81	3.75	3.70	3.67	3.64	3.61
3	5.00	4.58	4.33	4.17	4.05	3.96	3.89	3.83	3.79	3.75	3.72
4	5.00	4.67	4.44	4.29	4.17	4.07	4.00	3.94	3.89	3.85	3.81
5	5.00	4.72	4.52	4.38	4.26	4.17	4.09	4.03	3.97	3.93	3.89
6	5.00	4.76	4.58	4.44	4.33	4.24	4.17	4.10	4.05	4.00	3.96
7	5.00	4.79	4.63	4.50	4.39	4.31	4.23	4.17	4.11	4.06	4.02
8	5.00	4.81	4.67	4.55	4.44	4.36	4.29	4.22	4.17	4.12	4.07
9	5.00	4.83	4.70	4.58	4.49	4.40	4.33	4.27	4.22	4.17	4.12
10	5.00	4.85	4.72	4.61	4.52	4.44	4.38	4.31	4.26	4.21	4.17

<sup>†</sup> For example, a crew of 8 females and 4 males would have a labor cost of 3.89 cents per man-minute.

<sup>2</sup> Female at \$2.00 per hour, including fringe benefits.

<sup>3</sup> Male at \$3.00 per hour, including fringe benefits.

TABLE 35.—*Suggested method of identifying material costs per package for programing into computer (see table 33)*<sup>1</sup>

Bag No.	Cost	Bag size	Consumer packages
	<i>Cents</i>	<i>Inches</i>	
1	0. 75	2 x 4 x 12....	6 lemons, 1½ lb. onions.
2	1. 00	5 x 3½ x 13....	3 lb. onions, 3 lb. red potatoes, dozen 163 oranges.
3	1. 25	6 x 3½ x 15....	6-pack grapefruit, 4 lb. apples, dozen 113 oranges.
4	1. 50	6 x 4 x 17....	5 lb. potatoes, 8-pack grapefruit.
5	2. 00	7 x 4 x 21....	10 lb. potatoes, 10-pack grapefruit.

<sup>1</sup> The cost, bag sizes, and suggested packages are listed merely to illustrate the schedule and do not represent the author's recommendations.

time clock reading is placed on the card. The most difficult information to obtain is the average package overweight; but this can be on a sample basis, say one pallet load of the containers to represent the entire run. Item Nos. 20, 22, 23, 24, and 25 are costs that are programed into the computer. Examples are illustrated by the labor cost schedule (table 34) and the material cost schedule (table 35).

Each week, production cost, output, and shrinkage are printed out by item, by item group, and by grand total on the summary sheet (fig. 51). This can also be printed out for any operating period such as a quarter or year. Other information that can appear on the printout are daily performance level, number of runs per week, overtime, downtime. The buying office can obtain movement by item or from a particular source of supply, as well as relative yield from alternative sources of supply.

The "port-a-punch" system is ideally suited to an operation that has a limited number of long product runs.

It is recommended that the supervisor also maintain a log of daily production to permit immediate action if costs are out of control and to have a daily record of labor and output.

### **Control of Individual Employees**

The performance of an entire bagging operation is largely determined by the pace set at the bagging heads. No matter how efficiently produce is supplied to the bagging heads and packaged produce is removed, productivity will not increase appreciably unless the performance at the heads is improved. Recording individual performances at the bagging heads will point out individuals not maintaining their share of work. Employees who realize there is a check on their performance typically are more productive.

Several firms use mechanical counters to record individual bagging head production. These can be read on a central control panel in the office or at the head. Another firm randomly attaches a counter to a bagging machine to spot check production. Another approach is to count poly bags used. Each person is given a specified number of bags and the remaining bags at the completion of the run are weighed to determine the number. To illustrate, an operator was given 100 "P-7" bags for 5-pound packages of potatoes. At the conclusion of the run the remaining bags weighed 7½ ounces. An examination of figure 52 discloses that this is equal to 20 bags; output at that bagging head was 80 packages. This information is then recorded on a "Record of Individual Production" (fig. 53), which can be used as a spot check or as a continuing record, perhaps in conjunction with an incentive wage program.

Another problem in controlling the employee is the determination of the number of employees required for a packaging line and the proper balance between work stations. Often a change in method, equipment, or layout will reduce labor requirements. Figure 54 illustrates how several crew members' time was utilized during an actual production run. Shipping containers were lifted manually onto the receiving belt, so two men were required. The packout station was separated from the pallet loading area, so an employee was required at each station. During the run for 5-pound bags of potatoes two girls were stationed at the packout because the empty reusable containers were inconveniently located.

Over 45 percent of the time for each man dumping potatoes on the 5-pound run is nonproductive. The 49 percent nonproductive time for 5-pound bags of potatoes adds 0.4 cent to the cost of each bag. The crew members shown on this chart were, on the average, working only 60 percent of the time. If all down time and miscellaneous time were included, the productive time would be further reduced.

When an operator sees that an employee is idle or is holding something such as a 100-pound sack of potatoes while a second employee cuts the strings, he should recognize that this nonproductive labor increases labor costs and adds nothing to the value of the product. The situation can usually be corrected by modifying the work place, using better methods, substituting equipment for manpower, changing the sequence of the operation, or revising the crew arrangement. In this particular firm a pallet-lift table was installed so that the product to be bagged was placed slightly higher than the receiving belt. Since it was no longer necessary to lift the 100-pound sack, the second crew member was eliminated.

WEEKLY SUMMARY OF PRODUCE PACKAGING COSTS AND PERFORMANCE  
(Figures in columns refer to sources of data or method of computation)

PRODUCE CODE (3)	ITEM DESCRIPTION		TOTAL PACKAGES (11) (NUMBER)	MAN- MINUTE PER PACKAGE (19) (MINUTES)	TOTAL DIRECT LABOR COST PER PACKAGE (21) (CENTS)	MATERIAL COST PER PACKAGE (22) (CENTS)	RETURNABLE CONTAINER COST PER PACKAGE (23) (CENTS)	BURDEN AND INDIRECT LABOR COST PER PACKAGE (24) (CENTS)	TOTAL COST PER PACKAGE (26) (CENTS)	PERCENT OF PACK- AGES TO CONSUME TOTAL 1/ (PERCENT)	EXCESS PRODUCT IN PACKAGE (PER PACKAGE) (28)	LINE SHRINK (PER PACKAGE) (29)	TOTAL SHRINK (PER PACKAGE)
	NAME (3)	SIZE (3) (10)											
0110	POTATO, RED	10 lb.											
0210	POTATO, WHITE	10 lb.	6										
0310	POTATO, CALIF.	10 lb.	6										
0410	POTATO, RUSSET	10 lb.	6										
0510	POTATO, IDAHO	10 lb.	6										
	TOTAL	10 lb.											
1005	POTATO, RED	5 lb.	13										
1105	POTATO, WHITE	5 lb.	13										
1205	POTATO, CALIF.	5 lb.	13										
1305	POTATO, RUSSET	5 lb.	13										
1405	POTATO, IDAHO	5 lb.	13										
	TOTAL	5 lb.											
	POTATO, OTHER												

DAILY PERFORMANCE LEVEL \_\_\_\_\_  
 NUMBER OF WEEKLY RUNS \_\_\_\_\_  
 WEEKLY MAN-MINUTES \_\_\_\_\_  
 DOWNTIME \_\_\_\_\_  
 CHANGE OVER TIME \_\_\_\_\_  
 OVERTIME \_\_\_\_\_

MON. | TUES. | WED. | THUR. | FRI. | SAT. |

1/ PACKAGES OF ITEM OR ITEM GROUP DIVIDED BY TOTAL WEEKLY PACKAGES.  
 2/ SUM OF ALL CARD WITH RUNTIME RECORDED.

Figure 51.—Suggested printout form for Weekly Summary of Produce Packaging Costs and Performance.

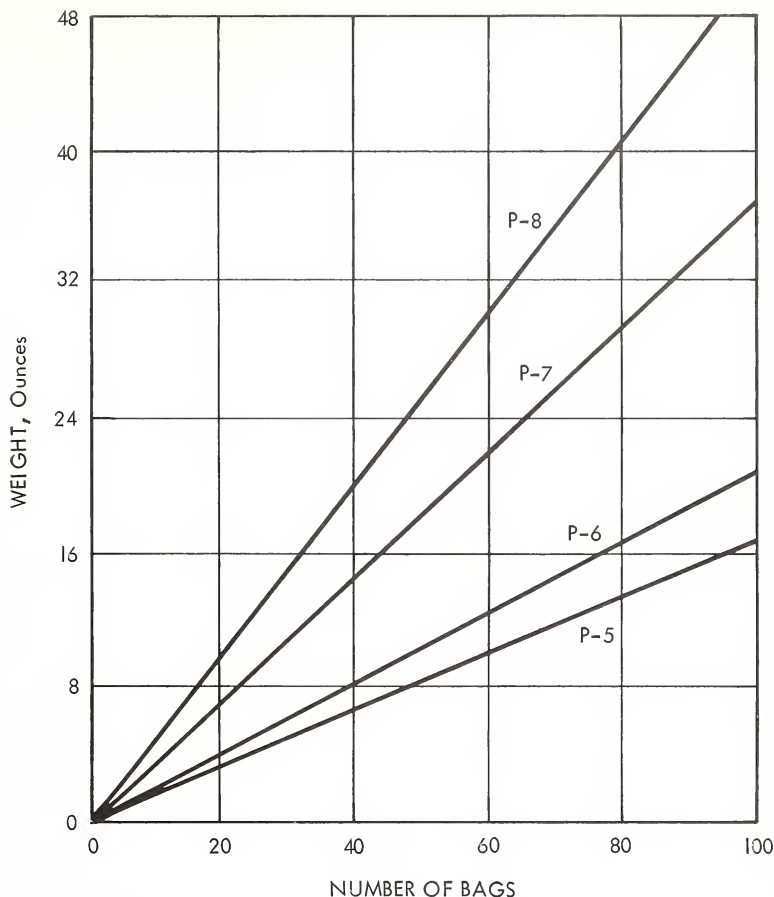


FIGURE 52.—Chart for computing number of unused bags at end of a product run.

### ***Control Through Maintenance***

One must never underestimate the value of good maintenance. Equipment that has been properly maintained through inspection, lubrication, and replacement of worn parts performs most effectively with less likelihood of breakdown during operation. Firms following a preventive maintenance program invariably had a good record of productivity.

Periodic checks of scale accuracy should be included in the maintenance program. Scales consistently producing excess overweight packages give away a valuable product. In a firm where scale readings were compared against actual package weight, the packages from one off-balance scale weighed 8 ounces more than the scale indicated. In this firm, scales were set to overweight packages 3 ounces on the particular item to compensate for

Employee Name \_\_\_\_\_

Date \_\_\_\_\_

Record of Individual Production  
(Bags used)

Item	Start	End	Time	Bags used	Bags per minute	Remarks
10# Russet						
10# White						
10# Red						
5# Russet						
5# White						
5# Red						
3# Potatoes						
3# Apples						
4# Apples						
Doz. Oranges						
24 Oranges						
6 Grapefruit						
10 Grapefruit						
3# Onions						
23 Lines						
Totals						

FIGURE 53.—A chart for recording production of individual employees.

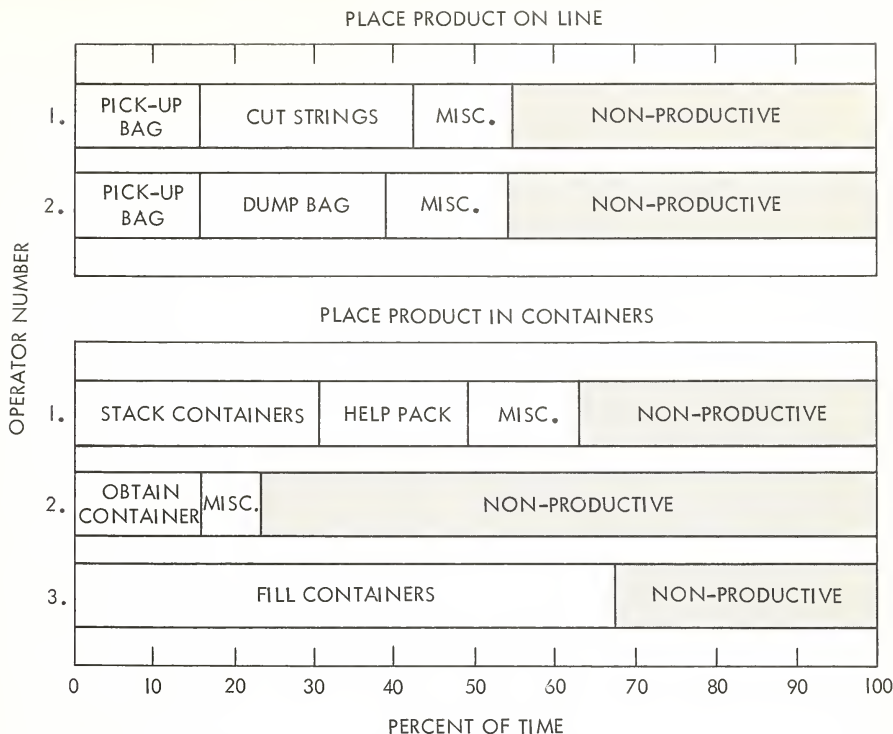


FIGURE 54.—Crew utilization of selected produce packaging functions.

weight loss or dehydration prior to sale. On another scale the package weights for the same item were  $\frac{1}{2}$  ounce less than the scale reading or  $3\frac{1}{2}$  ounces less than that required. The weight inaccuracies were eliminated when the scales were regularly checked between each product run.

The dump-chute bag fillers have two adjustments that when properly set will increase productivity. The scales are set for a given package weight, including the amount over or under this weight that goes into the weighing section. If the weight is set too high, the operator is continu-

ally removing produce. It is easier to estimate and add the correct amount than to remove the additional weight.

The second adjustment is on a microswitch that starts the flow of product into the weighing section as soon as the contents of the dump chute are emptied into the bag and the dump chute returns to the filling position. If this control is not in adjustment, there is a delay until the operator engages the switch. A regular system of preventive maintenance will increase productivity and lower costs.



## COMPARATIVE COSTS OF PACKAGING PRODUCE AT THREE LOCATIONS

### Cost of Pre-Store Packaging

Several produce items, other than those bagged items discussed in this report, are packaged at the source of production to avoid shipping inedible produce, because the items have a long package life or because they require highly specialized equipment.

Charges for packaging are not likely to be uniform because many growers and shippers produce each item and the majority independently arrive at a pricing decision.

When there are not precise USDA grades to recognize differences in sizes and quality, there is a wide variation in the upcharge of the packers in an area. This especially applies to potatoes where U.S. No. 1 may vary considerably in size, providing the pack averages out to a certain size. Some firms package selected size potatoes (8 to 12 oz.) for bakers and bag the rest as U.S. No. 1. They qualify as No. 1 because there would be enough large potatoes (over 12 oz.) to offset the smaller potatoes. In this situation it is entirely possible to price the consumer packs (with a variety of sizes but still U.S. No. 1) the same as the 50- or 100-pound sacks, which are normally shipped for retail stores and which have a sizable proportion of 8- to 12-ounce potatoes. The difference in quality eliminates the need for an upcharge to cover packaging costs.

Where there are good grade standards and where there are strong cooperatives or grower associations, the upcharge tends to be uniform for the item and the area. This is true for citrus and apples.

#### Potatoes

The premium charged for bagged potatoes varies considerably. In four of the major growing areas the upcharge for 10-pound bags ranged from 6.5 to 14.5 cents (6). The charge for 5-pound bags in all areas was approximately 6 cents. For purposes of comparing the upcharge for source-packed potatoes with packaging at the store and central warehouse, the average upcharge for Red River Valley potatoes (9.1 cents per 10-pound bag) was considered typical.

#### Citrus

The upcharge for citrus can be determined from charts prepared by both the Florida Citrus Mutual and the Texas Citrus Commission. For a given f.o.b. price and with the 1½-bushel box as the standard container, the chart suggests the price to be charged for other types of containers and

packages. Assuming the produce follows these charts, one can determine the difference in price for a 4-pound bag of Florida oranges (approximately a dozen size 113 oranges) for any f.o.b. prices by the horizontal distance between the straight line curves in the chart in figure 55. At an f.o.b. price of \$3 per 1½-bushel box, the upcharge is 5 cents, whereas at a \$4 f.o.b. price, the upcharge is 5.7 cents. The difference in price for alternative methods of shipping Florida grapefruit is likewise represented in figure 55. The upcharge ranges from 7.9 cents per 6.5-pound bag at the \$2.50 f.o.b. price to 8.6 cents at an f.o.b. price of \$3.50.

In a separate study of citrus packinghouse costs in Florida, it was determined that the total packinghouse cost per 5-pound equivalent was 6.0 cents when packed in the 1½-bushel box and 9.2 cents when packaged by the shipper in poly bags (13). The difference in cost (3.2 cents per 5-pound bag) is substantially less than the computed upcharge. The total packinghouse cost for grapefruit in 5-pound poly bags is 4.0 cents higher than the 1½-bushel box equivalent. The upcharge at the \$3.05 f.o.b. price is 7.6 cents, which is 3.6 cents higher per poly bag than the packaging costs.

The upcharge is similar for Texas citrus. When oranges in 1½-bushel containers have an f.o.b. price of \$4.00, units of 5-pounds in the 1½-bushel container cost 23.5 cents, whereas the 5-pound poly bag costs 28.8 cents. The 5-pound grapefruit unit costs 25.6 cents in the 1½-bushel container and 32.5 cents for the 5-pound poly bag.

#### Apples

The principal source of apples for poly bagging is the Washington State area (including Oregon, Idaho, and Canada). This area accounted for 48 percent of apple shipments during 1963 (1). It is quite common for the shippers to charge the same price for apples packaged in poly bags and in two-piece telescoping container with molded dividers for each layer. Most firms that package apples at the central warehouse receive them in the 40-pound loose-pack carton. Typically, Winesap apples in poly bags and in tray packs are priced at 5.5 cents higher per 4-pound unit than in loose-pack cartons. Delicious apples in poly bags or tray-pack cartons are 5 cents higher than the loose pack. Since the majority of source-packed apples from the Northwest are of the Winesap variety, the 5.5 cents upcharge is used for the comparison with retail food store and central warehouse packaging.

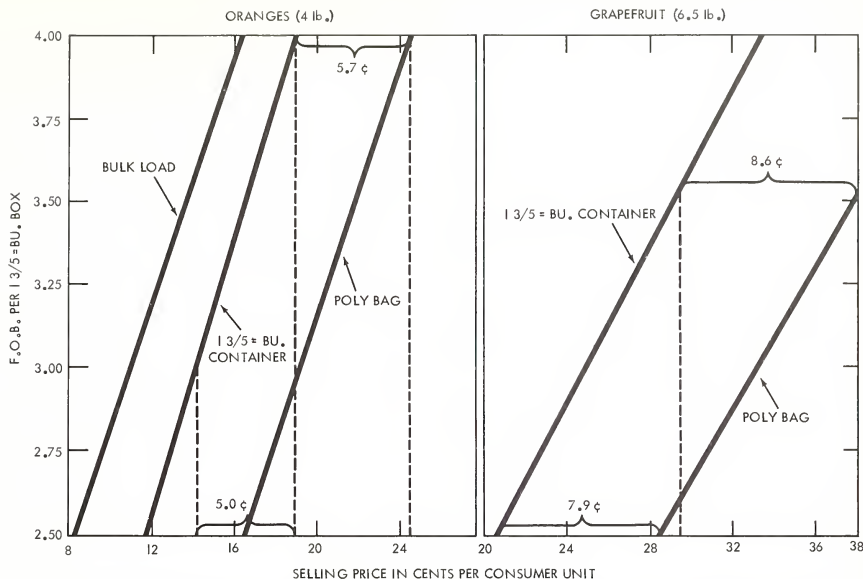


FIGURE 55.—Suggested selling price for Florida citrus in alternative containers and at different f.o.b. prices.

## Onions

Onions are not usually packaged by the grower-shipper because of the need for ventilation. Most onions are therefore packaged by a terminal repacker, the central warehouse, or the retail store. In one metropolitan area the principal terminal onion packager charged 52 cents for packaging a container of twelve 3-pound bags, an average of 4.3 cents per unit.

The following charges are used in this report and represent the accepted practice for each commodity by a large segment of the industry in 1964:

Item	Upcharge <sup>1</sup> Cents
Potatoes, 10 lb.-----	9.1
Potatoes, 5 lb.-----	6.0
Onions, 3 lb.-----	4.3
Apples, 4 lb.-----	5.5
Oranges, dozen-----	7.1
Grapefruit, 8 pack-----	8.6
Average-----	7.6

<sup>1</sup> Average weighted by volume.

Each retailer firm, when comparing source packaging with retail food store and central warehouse packaging, should insert the upcharge normally paid for each item for the firms from which they purchase produce. They should be sure the quality is comparable in each instance.

## Packaging Produce in the Retail Store

When the retailer installs a table and scale in the produce backroom he has no assurance that the employees will use the best methods, for typically the least skilled or newest clerk will be assigned to produce bagging. With this limited equipment the bagging is manual and quite fatiguing (10). A semiautomatic bagging machine, which is illustrated in figure 56, will to some extent guarantee that the employees use good work methods and will eliminate some of the fatigue, but the job is still paced by the employee and depends on close supervision to achieve an efficient operation.

Both machine and hand bagging were studied in the retail store. Labor costs for hand bagging were based both on production standards and on

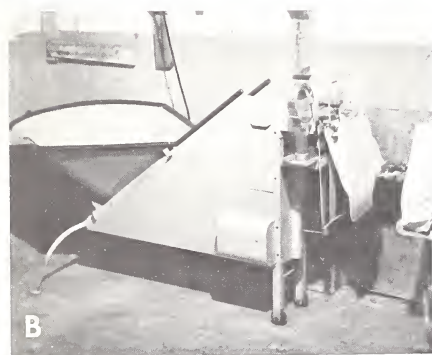
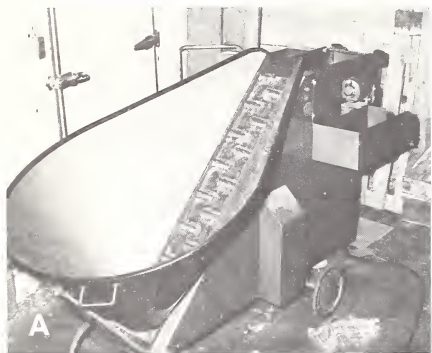


FIGURE 56.—Two types of semiautomatic equipment for retail store produce bagging.

detailed records of labor costs in four stores.<sup>15</sup> The average cost per item for packaging by hand was 5.8 cents per package. Production standards for all items indicated that if proper work methods and layout were used, the cost of hand bagging would be 5.3 cents per package. Production standards for produce bagging with the semiautomatic machine showed a weighted average cost of 4.2 cents per package (table 36). Burden charges for the three methods were allocated to each item

<sup>15</sup> For a period of 1 week in each store all produce employees were observed, and the time spent for each function (by item) was recorded to the nearest minute. The total time per function was then divided by the number of packages or consumer units. Each store had a table and scale for produce bagging.

TABLE 36.—Cost per package for bagging specified produce items in the retail food store by hand and by machine<sup>1</sup>

Item	Proportion of package volume	Bagging by hand		Machine bagging
		Production standards	Store records	
	<i>Percent</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Potatoes, 10 lb.----	28	7.2	7.8	5.2
Potatoes, 5 lb.----	20	5.0	4.7	3.8
Onions, 3 lb.-----	17	4.1	3.9	3.3
Apples, 4 lb.-----	19	4.5	5.8	3.9
Oranges, dozen-----	11	3.8	5.6	3.7
Grapefruit, 8-pack--	5	5.8	6.1	5.0
Weighted average---	100	5.3	5.8	4.2

<sup>1</sup> For additional details, see tables 66 and 67.

according to the standard time per package; i.e., the items requiring the most packaging time were assigned a proportionally higher share of the burden (appendix table 65).

## Cost of Produce Packaging at the Central Warehouse

Costs are not standardized for warehouse produce packaging nor for any of the components. Wage rates vary by firm even in areas that have the same wage contracts because of the differences in fringe benefits. Costs of packaging materials vary considerably among firms. Depreciation varies with equipment used, and burden charges and supervision show considerable variation in the industry. The components of packaging costs are averaged for several firms to obtain a cost that is reasonably representative of the industry. Each firm can substitute its costs to determine what its costs would be with central packaging.

### Labor

Detailed records of packaging-line labor were obtained in four firms for periods of 3 months to a year. They represent the actual man-hours spent on produce packaging by nonsupervisory employees. Supervision and forklift truck operator are included in burden charges. An analysis of wage rates in seven firms showed the average rate for male and female combined (including fringe benefits) to be \$2.51 per hour. The wage rates ranged from \$2.01 to \$3.00, depending on the area and whether the crew operated under a union contract (table 37).

TABLE 37.—*Hourly wage rates paid to labor for packaging produce in 7 central warehouses*

Firm	Male		Female		Fringe benefits	Weighted average
	Number	Hourly rate	Number	Hourly rate		
1-----	3	Dollars 2.89	9	Dollars 2.00	15	2.56
2-----	3	2.94	8	2.08	20	2.78
3-----	2	2.89	8	2.00	23	2.68
4-----	4	2.09	8	2.09	20	2.51
5-----	3	1.98	7	1.65	15	2.01
6-----	5	2.90	5	2.13	19	3.00
7-----	2	2.58	8	1.62	15	2.08
Average-----	2.61		1.93			2.52

The labor required to package each of the bagged items in four firms is shown in table 38. Time required for bagging ranged from 0.36 man-minute for 3-pound bags of onions to 0.54 man-minute for 10-pound bags of potatoes. There was surprisingly little variation from firm to firm in the time required to package each item.

TABLE 38.—*Average labor costs per package in 4 firms for packaging specified in the central warehouse*

Items	Potatoes, 10 pounds	Potatoes, 5 pounds	Onions, 3 pounds	Apples, 4 pounds	Oranges, dozen	Grapefruit, 8-pack	Average
	<i>Man-min.</i>	<i>Man-min.</i>	<i>Man-min.</i>	<i>Man-min.</i>	<i>Man-min.</i>	<i>Man-min.</i>	<i>Man-min.</i>
Firm 1-----	0.60	0.42	0.34	0.48	0.47	0.52	0.48
Firm 2-----	.50	.38	.35	.39			.41
Firm 3-----	.57	.46	.41	.48	.50	.52	.49
Firm 4-----	.48	.41	.36	.45	.47	.54	.44
Average per package-----	.54	.42	.36	.45	.48	.53	.46
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Cost per package at \$2.52 per hour <sup>1</sup> ..	2.27	1.76	1.51	1.89	2.02	2.23	1.93

<sup>1</sup> The average wage rate was based on an analysis of wage rates in seven firms and includes fringe benefits which varied from 15 to 23 percent. The ratio of female to male typically was 8 to 3.

TABLE 39.—*Average material cost per package for packaging produce in 6 firms<sup>1</sup>*

Produce item	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6	Average
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Potatoes, 10-lb-----	2.29	1.84	1.76	2.04	2.44	2.06	2.07
Potatoes, 5-lb-----	1.24	1.20	.94	1.54	1.50	1.23	1.28
Onions, 3-lb-----	.97	.97	.86	1.04	1.26	.81	.98
Apples, 4-lb-----	1.11	1.03	.92	1.29	1.58	1.56	1.26
Oranges, dozen-----	1.11	1.13	.92	1.04	1.50	1.36	1.18
Grapefruit, 8-pack-----	1.73	1.84	1.76	2.04	2.32	2.06	1.96

<sup>1</sup> The size of the bag, its thickness, type of construction, and amount of color printing varied from firm to firm. The one-piece closure costs 0.04 cent per bag and is included in the cost of the poly bag.

## Material Costs

There was considerable variation in the price paid for poly bags in the six firms where costs were analyzed. The difference was due to the size of the bag, the thickness, the number of colors, the extent of printing, whether the bag was flat or gusseted, and the skill of the buyer in obtaining discounts. Some firms used a slightly larger bag than was necessary so as to have a longer neck, which made bag closing easier. When filled too full, the poly bags were difficult to pack in the containers and to display. Average material costs for the major items are shown in table 39.

## Burden

The burden charge is largely dependent on the volume of the packaging installation. The equipment depreciation and interest charges will be constant for any volume; hence, the charge per package will vary with volume. Maintenance, repairs, rent, utilities, and other variable costs will change slightly with volume. Supervision depends on whether the foreman is in charge of one or more lines or whether he had additional duties not related to produce packaging. The charge for the forklift truck and operator should depend on volume, but in practice they are assigned to one

TABLE 40.—Average burden charges for 4 firms that averaged 70,000 packages per week<sup>1</sup>

Item	Firm 1		Firm 2		Firm 3		Firm 4		4 firms, average per package <sup>2</sup>
	Produce- tivity index	Cost per package <sup>2</sup>	Produce- tivity index	Cost per package <sup>2</sup>	Produce- tivity index	Cost per package <sup>2</sup>	Produce- tivity index	Cost per package	
Equipment, depreciation, maintenance, repair, and interest.....	Percent	Cent	Percent	Cent	Percent	Cent	Percent	Cent	Cent
Rent, utilities, supervision.....	-----	0.09	-----	0.10	-----	0.10	-----	0.17	0.12
	-----	.38	-----	.52	-----	.28	-----	.36	.36
Total burden.....	-----	.47	-----	.38	-----	.38	-----	.69	.48
Burden allocation by kind of produce:									
Potatoes, 10 lb.....	125	.59	124	.47	116	.57	109	.75	.60
Potatoes, 5 lb.....	88	.41	94	.35	94	.46	93	.64	.47
Onions, 3 lb.....	71	.33	87	.32	84	.41	82	.57	.41
Apples, 4-lb.....	100	.47	98	.36	98	.48	102	.70	.50
Oranges, doz.....	98	.46			102	.50	107	.74	.57
Grapefruit, 8-pack.....	108	.51			106	.52	123	.85	.63

<sup>1</sup> The allocation of the burden to each kind of produce is proportional to the time required for packaging that item and is represented by the productivity index.

<sup>2</sup> The burden cost per package is a weighted average based on burden cost per item times proportion of volume.



or more packaging lines for a fixed period each day. The same forklift truck will be used during one or more night shifts, so only part of its use is charged to produce packaging. More time is required to package certain items; therefore, it is necessary to allocate the burden proportional to the time that each item uses the packaging facilities. For example, in firm 1 the productivity index for 10-pound bags of potatoes is 125 and for 3-pound bags of onions is 71. Thus the 10-pound unit uses the facilities 76 percent more time than the 3-pound unit. For the four firms, the average burden charge ranges from 0.41 cent on 3-pound bags of onions to 0.63 cent for eight grapefruit (table 40).

### Warehouse-to-Store Shipping Containers

The cost per package for reusable master containers depends on original cost, depreciation, trips per week, number of packages per container, and the labor costs to return empties to the central warehouse. Assumptions used in developing container costs for a warehouse produce packaging operation of 70,000 packages per week were: (1) That each container would make  $1\frac{1}{2}$  trips per week; (2) that they would last an average of 5 years; (3) that a 20-percent allowance over average requirements would handle peak daily requirements; and (4) that the containers would nest and stack, be made of polyethylene plastic material, and cost \$5. Since the material and labor cost for the container are the same for each trip, the cost per item will vary with the number of

packages per container. The cost per package ranges from 0.14 cent for 3-pound bags of onions to 0.50 cent for 10-pound bags of potatoes (table 41).

### Total Packaging Cost at Warehouse

The average cost per item for packaging bagged produce items in a simulated central warehouse operation is 4.23 cents per package. The cost ranges from 3.04 cents for 3-pound bags of onions to 5.44 cents for 10-pound bags of potatoes (table 42). This cost of labor, materials, and burden does not represent one firm or one type of equipment but an average of several firms. The returnable container with the lowest total cost (table 41) was used to determine the packaging cost that a firm can expect for central produce packaging. If a firm with an average volume of 70,000 packages per week were to adopt the improved methods, equipment, materials, layout, and operating practices that have been discussed in this report, it would be possible to have an average cost of 3.58 cents per package. This simulated cost is that which was experienced by the firm which had the lowest cost in any of the three categories: Labor, materials, and burden. The costs are as follows:

Cost	Cents
Labor .....	1.72
Materials .....	1.18
Burden .....	.38
Containers .....	.30
Total .....	3.58

TABLE 41.—Cost per consumer package for warehouse-to-store returnable containers

Consumer package	Proportion of volume	Packages per week	Bags per container	Container trips per week	Containers required <sup>1</sup>	Cost per package <sup>2</sup>
	Percent	Number	Number	Number	Number	Cent
Potatoes, 10-lb.....	28	19,600	6	3,267	2,614	0.50
Potatoes, 5-lb.....	20	14,000	13	1,077	862	.23
Onions, 3-lb.....	17	11,900	22	541	433	.14
Apples, 4-lb.....	19	13,300	12	1,108	886	.25
Oranges, doz.....	11	7,700	16	481	385	.19
Grapefruit, 8-pack.....	5	3,500	8	438	350	.38
Total.....		70,000		6,912	5,530	

<sup>1</sup> Each container will make on the average  $1\frac{1}{2}$  trips per week. An allowance of 20 percent has been added to handle peak daily requirements.

<sup>2</sup> Cost per container (3.03 cents) divided by number of bags per container. Cost per container was computed as follows:

$$\begin{aligned} &\text{Depreciation allowance: } 5,530 \\ &\quad \text{containers at } \$5.00 \text{ with 5-year} \\ &\quad \text{depreciation} \\ &\quad \frac{5,530 \times 5}{5} = \$5,530 \end{aligned}$$

Interest: Five percent on half the life of the container:

$$\frac{(5,530 \times 5) \times 0.05}{2} = \$691$$

$$\begin{aligned} &\text{Labor: Return of containers from} \\ &\quad \text{store to packaging line at 0.26} \\ &\quad \text{minutes per container:} \\ &\quad \frac{6,912 \times 52 \times 0.26 = 93,450}{93,450 \text{ at } 5 \text{ cents/min.}} = 4,672 \end{aligned}$$

$$\begin{aligned} &\text{Total} \quad \quad \quad \$10,893 \\ &\text{Cost per package: } \frac{\$10,893}{70,000 \div 52} = 0.30 \text{ cent} \end{aligned}$$

$$\text{Cost per container: } (70,000 \div 6,912) \times 0.30 \text{ cent} = 3.03 \text{ cents}$$



TABLE 42.—*Total cost per consumer unit for packaging specified produce items in the central warehouse, by cost items<sup>1</sup>*

Cost item	Potatoes, 10 pounds	Potatoes, 5 pounds	Onions, 3 pounds	Apples, 4 pounds	Oranges, dozen	Grape- fruit, 8-pack	Average cost per package
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Labor.....	2.27	1.76	1.51	1.89	2.02	2.23	1.94
Materials.....	2.07	1.28	.98	1.26	1.18	1.96	1.47
Burden.....	.60	.47	.41	.50	.57	.63	.52
Warehouse to store containers.....	.50	.23	.14	.25	.19	.38	.30
Total packaging cost per bag..	5.44	3.74	3.04	3.90	3.96	5.20	4.23

<sup>1</sup> For details, see tables 38, 39, 40, and 41.

### Cost Comparison

This study has developed the savings that can be anticipated through the receiving of produce in pallet containers as compared to standard shipping containers. It has also determined the costs of packaging at alternative locations. Any determination of where to package must consider the overall system and include those costs factors affected by the location of the packaging facility. The cost comparison was therefore expanded to include freight and costs related to receiving produce in different types of containers.

The cost of packaging produce with the semi-automatic machine at the store, using improved methods, equipment, and layout, is the same as the costs that four firms experienced when packaging at the central warehouse using average methods, equipment, and layouts. This cost (4.2 cents per package) is 1.6 cents less than the upcharge for source-packaged produce, which was used in this study (table 43).

When the cost of freight, receiving containers, and labor is added to the packaging costs, the low-

est cost location for packaging is at the central warehouse. As indicated in table 44, the cost at the central warehouse is 11.4 cents per package. The most costly location is the retail store using conventional equipment and work methods or purchased prepackaged. There is a potential annual savings of \$101,920 for a firm that packages at the central warehouse and has an average output of 70,000 packages per week.

It should be emphasized that this savings applies only to certain *bagged* items (potatoes, onions, citrus, and apples), which typically account for 25 to 35 percent of the produce department's volume. Preliminary research on bananas, lettuce, and tray-packed items (large-sized apples, oranges, peaches, and pears and beans, corn, grapes, tomatoes, and similar produce) shows similar savings when the packaging is moved from the retail store to the central warehouse.

There is an opportunity for the retail food firm to realize considerable savings in a program of central produce packaging. These savings are accomplished through more efficient use of labor, equipment, materials, facilities, and shipping con-

TABLE 43.—*Cost per consumer unit for packaging produce at the retail store and at the central warehouse, and the upcharge for source-packaged produce*

Packaging location	Potatoes		Onions, 3 pounds	Apples, 4 pounds	Oranges, dozen	Grape- fruit, 8-pack	Average cost per package
	10 pounds	5 pounds					
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Retail store:							
Hand packaged.....	7.8	4.7	3.9	5.8	5.6	6.1	5.7
Machine packaged.....	5.2	3.8	3.3	3.9	3.7	5.0	4.2
Central warehouse.....	5.4	3.7	3.0	3.9	3.3	5.2	4.2
Cost to firm when source packaged..	9.1	6.0	4.3	5.5	7.1	8.6	6.8

TABLE 44.—*Total cost for packaging produce at alternative locations, 1964*<sup>1</sup>

Packaging location	Total cost per consumer unit	Total cost per year
Store:	<i>Cents</i>	<i>Dollars</i>
Machine packaged.....	12.5	455, 000
Manual.....	14.2	516, 880
Warehouse, lowest cost method..	11.4	414, 960
Source.....	14.2	516, 880

<sup>1</sup> For additional details see table 68.

## STEPS IN CONVERTING FROM IN-STORE TO CENTRAL WAREHOUSE PACKAGING

The conversion from in-store to central produce packaging involves a substantial investment and a change in the working conditions of many employees. Before making the decision the retail food firm should carefully evaluate the relative merchandising advantages of packaging at the alternative locations. The store can readily adjust to its clientele, whereas the warehouse can quickly react to competition and to changes in quality and can change price or package size for all stores. The retail firm should consider the availability of the desired quality from alternative sources. Can they obtain packaged produce in the sizes and quantity desired? What is the relative advantage of source-packaged produce with many different brands as compared to store-packaged produce with a company brand? Will central packaging allow the firm to offer its customers something in the way of price, quality, or convenience that its competitors cannot?

It is easier to obtain answers to the economic aspects of central packaging. Before the retail firm is committed to a change, it should estimate the costs of central packaging (labor, materials, depreciation, containers, transportation, utilities, and burden). These costs should be compared with in-store packaging costs. Too often the operator's estimate of total packaging costs consists only of labor and materials. Produce packaging in the store must bear its proportionate share of space and burden costs. It also should reflect the possibility of an expensive shipping container (from the grower).

The retailer should then carefully evaluate the cost, availability, and quality of grower-packaged produce. If there is an established terminal packer, his charges should be compared with packaging costs at store and warehouse.

Estimated volume will play a key role in the warehouse cost calculations. An equally impor-

tant step during the planning stage is to consider all those who have an interest in produce packaging and either make them a part of the team or keep them informed. The following steps are not listed in the order of importance but rather in a suggested planning sequence.

*Decide on equipment requirements.*—The anticipated volume will to a large extent determine whether the line will use specialized equipment or have the flexibility to handle a variety of items. A high-volume operation (in excess of 80,000 bags per week) can use a high-capacity machine-paced bagger for potatoes and onions and a more versatile and relatively bruise-free line for other items. The feed belt and the L-type take-away belt should be long enough to add additional bagging heads.

*Plan the layout.*—The packaging facility should allow for the orderly movement of product from storage, through packaging, and during shipment to the stores. Handling equipment for produce and packaging should be used to eliminate manual handling. Provision for normal expansion should be considered as well as addition of such new items as trayed packages, salads, lettuce, and bananas.

*Determine number and design of containers.*—The number of warehouse-to-store containers will be determined by anticipated volume and the number of trips per week. The design will in part be determined by the pallet size and material-handling equipment but should stack and nest, hold about 60 pounds, and be easy to handle. Pallet-size containers should be used to receive produce, and the necessary equipment should be incorporated in the layout.

*Develop a system for production scheduling and cost control.*—If necessary, the store order forms and the daily requisition should be modified. A form to schedule product and labor should be prepared. A system of cost control should be devel-

oped and incorporated in the present cost-accounting system. Periodic reports for the week, month, period, or quarter should be planned, and standards should be developed in order to evaluate performance.

*Plan for improved quality control.*—There is an opportunity for rigid control of quality at the central warehouse if everyone is conscious of the problem. Someone with considerable retail produce experience will have an understanding of the merchandising problems. All packaged produce should be coded to protect warehouse and store.

*Arrange for the work force.*—If it is thought that the line will not operate on a full schedule, be sure the people are willing to work on a flexible schedule. The worker who dumps the produce should be reasonably strong and be able to keep the

feed belt full so as to encourage higher output. The bag fillers and the tape closer should have good manual dexterity. Each member of the crew should be re-evaluated after 6 weeks.

*Adjust margins to reflect new cost conditions in store.*—The gross margin of a produce department that does in-store packaging includes labor, material, depreciation, and burden. When this function is transferred from the store, the gross margin should be adjusted correspondingly (12). When the items discussed in this report are packaged at the central warehouse, the gross margin of the entire produce department can be reduced by 4.3 percent (table 45). Store packaging costs range from 3.9 cents on 3 pounds of onions to 7.8 cents on 10 pounds of potatoes.

TABLE 45.—*Adjustment of produce department gross margin when selected items are packaged prior to receipt at store*<sup>1</sup>

Reference code	Item	Potatoes		Onions, 3 lb.	Apples, 4 lb.	Oranges, dozen	Grapefruit, 8-pack
		10 lb.	5 lb.				
A	Size of receiving unit.....pounds..	100	100	50	40	40	<sup>2</sup> 1½
B	Packages per receiving unit.....number..	10	20	16	10	11½	12
C	Cost of merchandise <sup>3</sup> .....dollars..	3.40	3.40	3.00	4.50	3.24	4.05
D	Typical gross margin.....percent..	24.6	24.6	27.9	32.5	25.9	25.9
E	Retail price per container (E) = C ÷ (100-D) × 100.....dollars..	4.51	4.51	4.16	6.67	4.37	5.47
F	Average selling price (F) = E + B.....cents..	45	23	26	51	38	46
G	Sales per week (G) = H × F <sup>4</sup> .....dollars..	302	110	106	233	100	55
H	Packages sold per week <sup>5</sup> .....number..	672	480	408	456	264	110
I	Percentage of packaged volume <sup>6</sup> .....percent..	10.1	7.2	6.1	6.8	4.0	1.8
J	Gross margin per package (J) = F × D.....percent..	11.1	5.7	7.3	16.6	9.8	11.9
K	Total gross margin per week (K) = G × D.....dollars..	75	27	30	75	26	14
L	Packaging cost per consumer unit <sup>7</sup> .....cents..	7.8	4.7	3.9	5.8	5.6	6.1
M	Packaging cost per receiving unit (M) = B × L.....cents..	78	94	62	58	64	73
N	Adjusted gross margin per unit with prestore packaging (N) = E - (C + M) ÷ E.....percent..	7.3	3.8	13.0	23.8	11.2	12.6
O	Adjusted gross margin per item per week with prestore packaging (O) = N × G.....dollars..	22	4	14	55	11	7
P	Gross margin on all other commodities <sup>8</sup> .....dollars..	825	873	870	825	874	886
Q	Adjusted overall produce department gross margin when gross on items is reduced through prestore packaging (Q) = O + P ÷ \$3,000.....percent..	28.2	29.2	29.4	29.3	29.5	29.8
R	Adjustment to produce department gross margin with shift to prestore packaging (R) = 0.30 - Q.....percent..	1.8	.8	.6	.7	.5	.2

<sup>1</sup> The technique for adjusting produce department gross margin and much of the basic data was adopted from a Delaware report (12).

<sup>2</sup> In bushels.

<sup>3</sup> Average prices on Chicago market 1962.

<sup>4</sup> These items represent 30 percent of produce sales.

<sup>5</sup> This is based on the ratio of 800 bagged items per \$1,000 produce sales and for each item the weighting factors as shown on p. 2 are used. In this analysis the above bagged items represent 36 percent of produce packages.

<sup>6</sup> For each item the percentage to total packaged volume is calculated by multiplying the percentage of the item to total bagged volume times 36 percent. For example,  $28 \times 0.36 = 10.1$  percent.

<sup>7</sup> For details, see table 67, p. 105.

<sup>8</sup> This analysis assumes an average gross margin in produce departments of 30 percent. Therefore to find Q we use the formula  $H + X \div \$3,000 = 0.30$  and solve for X.

In a \$3,000-per-week produce department that sells 2,400 consumer units of bagged potatoes, onions, apples, oranges, and grapefruit per week, the transfer of the packaging function out of the store will reduce costs \$127 per week. If margins are not adjusted to reflect the elimination of certain packaging costs at the store, then the firm in effect is charging twice for packaging. This will put a brake on sales and undermine the store's competitive position.

*Methods of stimulating production.*—The following list represents practices that have been used by cooperating firms:

1. Keep feed belt full.

2. Constantly check on production. Give bag fillers a measured number of bags or install counters on machine.

3. Keep crew advised of output and productivity. Use charts and post on bulletin board.

4. Keep close tab on product changeovers. Combine short runs on alternate days or use separate bagger. Have assigned jobs during changeover.

5. Create conditions conducive to productivity, such as music with frequent change in tempo, job rotation, good lighting, and air-conditioning. Get ideas from the crew on how to simplify the work.

## CASE STUDIES

The equipment, layout, work methods, and operating practices of five firms in which studies were conducted are explained in detail to illustrate how produce is typically packaged at the central warehouse. The total packaging costs and the component costs are not comparable because of differences between firms in packaging-material costs, wage rates, and overhead.<sup>16</sup> In addition, productivity is affected by supervision, morale, equipment, length of production runs, and volume. The cost of the warehouse-to-store container is included because it is a significant cost factor and because of the variation from firm to firm.

### Firm A

The produce packaging line at firm A can receive produce in either conventional shipping containers or pallet box containers (see fig. 32). A forklift truck places pallet loads on a floor-level roller conveyor that holds four pallet loads of merchandise. This will supply the line for approximately 20 minutes for packaging 10-pound bags of potatoes or 30 minutes for 5-pound bags.

A pallet-box tipper is used to deposit produce from bins into a receiving belt (fig. 57). The empty bins are collapsed and stacked on pallets. Conventional containers are handled on the same dual-purpose tipper that converts to a lift table. Less manual effort is necessary when the product to be dumped is at the right height.

Bins can increase labor productivity. When bins were used to feed the line, 10-pound bags of potatoes required 0.45 man-minute per bag. When 100-pound burlap bags were used to feed the line, 10-pound bags of potatoes required 0.58 man-minute per bag. Packaging 5-pound bags of potatoes required 0.38 man-minute with bins and 0.40 man-

minute with 100-pound burlap bags. Productivity was increased with bins, because less labor was needed to feed the line and because bins were more effective in keeping the hoppers supplied with potatoes.

Produce is conveyed over a roller grader to a one-way feed belt. Adjustable positive plows divert product into each of seven hoppers in accordance with the speed of the individual bag fillers. The plows can be adjusted to bypass one hopper and maintain a flow into the other hoppers (fig. 32). After being filled, open poly bags are conveyed on a cleated L-type take-away belt to a semiautomatic tape closer. Each bag filler has a manual-type tape closer to use during tape changeover, breakdown, or when the output of the line exceeds the capacity of the central closer.

At the packout area an empty container is transferred from a nested stack to a stationary section of roller conveyor. Bags that accumulate on the turntable are then packed in a container. A gentle shove starts the filled container down the gravity feed conveyor to the place where they are stacked on pallets. Another floor-level conveyor provides accumulation for pallet loads of packaged merchandise, which is transported to storage racks by forklift truck.

Three men and nine women are employed on the line. One man feeds the line with product, a second man stacks filled containers on pallets, and a third man helps feed the line and performs house-keeping duties. Seven women work at filling units, one woman guides bags through a semiautomatic tape closer, and one woman packs out containers at the turntable. When quality is below normal, one or more crew members grade the produce.

Changeovers were a problem at firm A, because of the great number of different produce items and sizes run on the line each day. Much of the non-productive time is converted to useful work at a bagging table situated near the filling units where,

<sup>16</sup> In all case studies "burden" represents rent, utilities, insurance, interest, depreciation, maintenance, and other miscellaneous occupancy charges.





FIGURE 57.—Equipment for packaging produce at firm A: A, Pallet-box tipper; B, tipping produce on belt; C, hopper-type bagging machines; D, filling poly bags; E, closing poly bags; and F, the packout areas.

during the changeover, the crew bagged items such as 6-pack lemons, which are not easily packaged on the line. The low ratio of run time to change-over time make short production runs undesirable on the complete bagging line. Firm A uses a separate hopper-type bagging unit for production runs of 200 bags or less. Overtime increased the direct labor cost on all bagging by 8 percent. Packaging costs ranged from 3.8 cents for 3-pound onions to 6.2 cents on 10-pound potatoes (table 46).

TABLE 46.—*Produce packaging costs at firm A*

Produce item	Labor	Materials	Burden <sup>1</sup>	Containers	Total
Potatoes:	<i>Cents</i>	<i>Cents</i>	<i>Cent</i>	<i>Cent</i>	<i>Cents</i>
10 lb.-----	2.52	2.29	0.59	0.75	6.15
5 lb.-----	1.76	1.24	.41	.45	3.86
Onions, 3 lb.-----	1.43	.97	.33	.22	2.95
Apples, 4 lb.-----	2.02	1.11	.47	.30	3.90
Oranges, doz-----	1.97	1.11	.46	.30	3.84
Grapefruit, 8-pack---	2.18	1.73	.51	.50	4.92

<sup>1</sup> See footnote 16, p. 89.

## Firm B

The produce bagging line at firm B is used almost entirely for bagging potatoes and onions (fig. 58). Poly-bagged units consist of 4, 5, and 10 pounds of potatoes and 3 pounds of onions. Potatoes are received in either 100-pound burlap bags or 50-pound paper bags; onions are received in 50-pound sacks. The items are placed on pallets as received and transported to warehouse floor storage near the line.

A forklift truck is used to position pallet loads on both sides of the dumping area. The items are deposited on a receiving belt and moved over a roller conveyor that takes the produce through a brush and vacuum cleaner and onto a two-way feeder belt system (fig. 59). Iron rods divert the product into the four double-head level-feed baggers.

Consumer-size bags are placed on a right-angle take-away belt that conveys them to a central wire closer. After they are closed, bags are conveyed to an accumulation turntable where they are packed into salvage containers or cribs. The typical salvage containers are two-piece corrugated banana boxes, corrugated egg cartons, and reusable chicken crates. Before they are filled, these containers are placed on a stationary section of conveyor where lids are opened or removed. When filled, the containers are closed and pushed onto a belt conveyor, where they accumulate for stacking on pallets. A forklift truck transports pallet

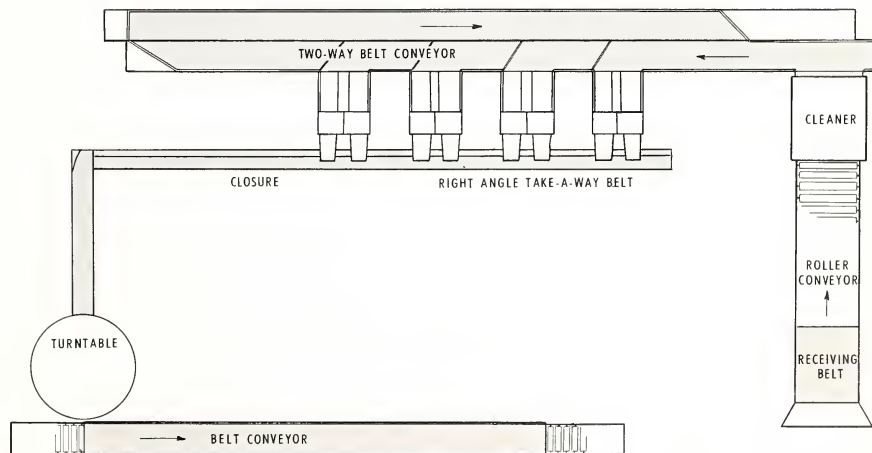


FIGURE 58.—Layout of produce packaging line at firm B.





FIGURE 59.—Produce packaging equipment in firm B: A, Line feeding; B, bag filling; C, bag closing; and D, packout.

loads of consumer bags to storage racks. A crib is a pallet container that accommodates 75 10-pound bags or 100 5-pound bags.

A labor force of 10 to 12 employees produce about 55,000 bags per week. Six to eight women fill bags while one woman operates the closer, one person fills containers at the turntable, and two men supply the line with the product, stack containers on pallets, provide empty containers at the turntable, and carry bagged merchandise to

storage racks. The work of these men is flexible; they rapidly change to jobs urgently needing assistance. Occasional production peaks require the help of a second closer and assistance at the turntable. When poor quality produce is run, one or more fillers perform as full-time graders; otherwise, grading is done at the individual bag-filling stations.

Salvage containers create handling and storage problems. A study revealed that the unnecessary

handling associated with these containers amounted to almost \$10,000 yearly. Salvage containers were stored at the warehouse in large numbers. When the supply is abundant, salvage containers are collected and stored for periods of short supply. There were occasions when the flow of salvage containers from stores and warehouse was insufficient and the firm bought salvage containers locally. Many times the base and lids are used as separate containers and consequently have limited stacking strength. The study did not attempt

to measure the bruising when the containers were stacked five and six high without lids.

This firm operates with favorable labor, material, and overhead costs. Relatively low wage rates, coupled with few changeovers and a steady work pace, result in a moderate labor cost per bag. Packaging costs ranged from 3.2 cents for 3-pound bags of onions to 5.6 cents for 10-pound bags of potatoes (table 47).

### Firm C

Firm C packages a wide variety of produce items in different sized consumer packages. Produce is received in either conventional or pallet box containers. The line is equipped with a hydraulic pallet-bin tipper to discharge the produce received in pallet boxes. Conventional shipping containers on a pallet are placed on a platform level with the receiving belt (fig. 60). Other basic equipment includes a roller-conveyor, two-way feed belt, three double-head baggers, cleated l-type take-away belt, semiautomatic tape closer, and turntable (fig. 60).

The normal crew consists of a line feeder (male) who either dumps produce from conventional containers onto the feed belt or operates the bin tipper, five to six girls filling bags at dump chutes, one

TABLE 47.—Produce packaging costs at firm B

Produce item	Labor	Materials	Burden <sup>1</sup>	Containers	Total
Potatoes:	<i>Cents</i>	<i>Cents</i>	<i>Cent</i>	<i>Cent</i>	<i>Cents</i>
10 lb.-----	2.30	1.84	0.47	0.94	5.55
5 lb.-----	1.75	1.20	.35	.43	3.73
4 lb.-----	1.79	1.03	.36	.38	3.56
Onions, 3 lb.-----	1.61	.97	.32	.28	3.18

<sup>1</sup> See footnote 16, p. 89.

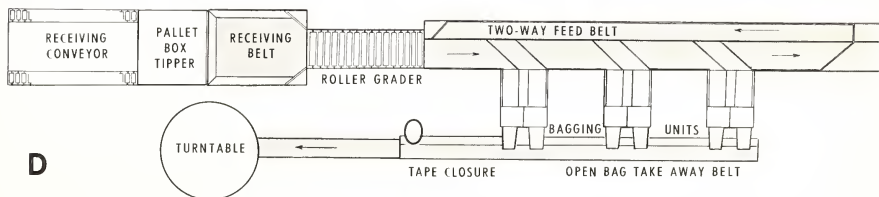
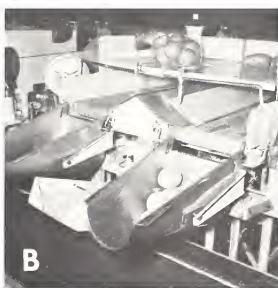
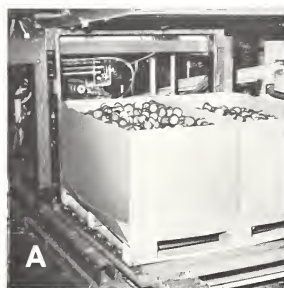


FIGURE 60.—Firm C: Produce packaging equipment—A, Line feeding with pallet box tippers; B, double-head level-belt baggers; C, filling poly bags, and D, layout of the produce packaging line.

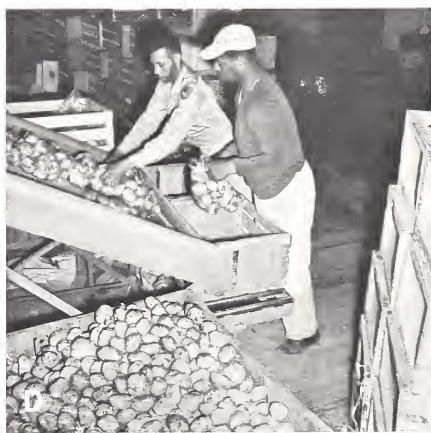


FIGURE 61.—The potato packaging line at firm D; A, Line feeding; B, hopper-type baggers; C, filling and closing; D, packout.

TABLE 48.—*Produce packaging costs at firm C*

Produce item	Labor	Materials	Burden <sup>1</sup>	Containers	Total
Potatoes:	<i>Cents</i>	<i>Cents</i>	<i>Cent</i>	<i>Cent</i>	<i>Cents</i>
10 lb.-----	2.39	2.44	0.57	0.60	6.00
5 lb.-----	1.93	1.50	.46	.30	4.19
Onions, 3 lb.-----	1.72	1.26	.41	.18	3.57
Apples, 4 lb.-----	2.02	1.58	.48	.36	4.44
Oranges, doz-----	2.10	1.50	.50	.30	4.40
Grapefruit, 8-pack----	2.18	2.32	.52	.45	5.47

<sup>1</sup> See footnote 16, p. 89.

girl operating a central closer, and one man placing filled bags in returnable containers. Sometimes a girl will grade the produce or, during production peaks, assist in placing filled bags in master containers. The line is supplied by a forklift operator, whose time is used almost entirely by the line. Average production is 46,000 bags per week. The packaged produce is shipped to the stores in returnable nest-and-stack fiberglass containers.

All packages except onions are in polyethylene bags. A plastic mesh bag is used for onions because it permits better airflow. Its disadvantages are higher cost, greater bruising, and filling and closing problems as compared to polyethylene bags. Packaging costs ranged from 3.6 cents for 3-pound bags of onions to 6.0 cents for 10-pound bags of potatoes (table 48).

## Firm D

Firm D is a rather large-volume packaging facility that has four separate lines for bagged produce and additional lines for other types of produce items (see fig. 34). Each line is designed to handle a particular type or group of products, which permits the use of the specialized equipment for certain items. For example, the onion line has a brusher and vacuum to remove loose peels, the potato line has a washer, and the apple line has padding to reduce bruising.

Potatoes are received in either 50-pound paper bags or 100-pound burlap bags. A forklift truck elevates a pallet load of bags to a dumping platform. One man working on the platform feeds the packaging line except when the combined lines are packaging 10-pound bags of potatoes and then a second man is added to the crew. Potatoes are

conveyed through a washer and onto a grading conveyor where they are constantly inspected. The potatoes move to a one-way feed belt which has a stationary plow, extending the length of the bagging machine hoppers, to push potatoes equally into the hoppers. Both 5- and 10-pound bags are filled with potatoes at seven bagging machines (fig. 61). A woman at each machine fills and closes each bag before placing it on a flat take-away belt. An accumulating table catches bags as they leave the take-away belt. The table is sloped so that bags slide to one end where they are packed six 10-pound or twelve 5-pound bags into a wooden container of 60-pound capacity. Packout of containers requires two men to obtain box, fill box, and place box on pallet.

Fifty-pound onion bags are emptied onto a receiving belt that conveys the onions to a cleaner. Brushes and airflow remove loose onion skins. A two-way belt system with iron-rod diverters feeds the produce to two double-head baggers. Four women fill and manually close 3-pound bags at the heads. At the packout table a man places eighteen 3-pound onion bags into a wooden salvage container.

An apple and orange bagging line uses four bagging machines. The line runs parallel to the potato bagging line and may be tied in with the potato line when there is a need for increasing potato package output. Local apples are received in wooden field crates belonging to the grower. Most of the oranges and other apples are received in two-piece corrugated containers. Incoming boxes of apples and oranges are tipped onto a receiving belt and are distributed to the bag machine hoppers on a one-way feed belt. The bags are filled and closed before being placed on a conveyor leading to a packout turntable. Salvage containers (usually tomato boxes) are used for shipment to the store; they hold six 4-pound apple bags. Six workers on the line include one man to supply produce to the line, four women to fill and close bags, and one man to fill containers.

Containers are a major cost item in this firm because of the limited number of round trips, the number of handlings, the space needed to maintain a reasonable inventory of empty containers, and the need to make two intermediate stops between the prepack warehouse and the store (at the distribution center and salvage warehouse). The types and number of container handlings are illustrated by figure 62. Packaging costs range from 3.6 cents for 3-pound bags of onions to 6.5 cents for 10-pound bags of potatoes (table 49).



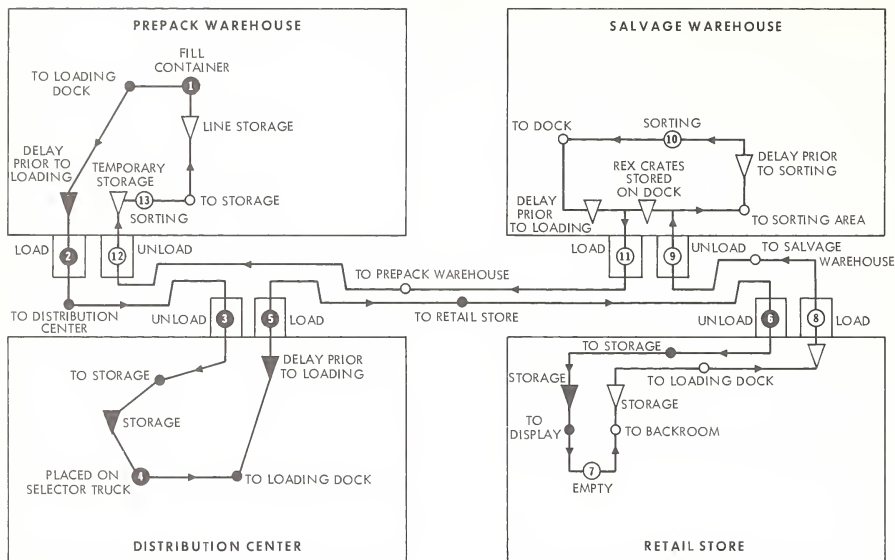


FIGURE 62.—Flow diagram of containers for packaged produce when packaged centrally.

TABLE 49.—Produce packaging costs at firm D

Produce item	Labor	Materials	Burden <sup>1</sup>	Containers	Total
Potatoes:	<i>Cents</i>	<i>Cents</i>	<i>Cent</i>	<i>Cents</i>	<i>Cents</i>
10 lb.-----	2.13	2.06	0.75	1.54	6.48
5 lb.-----	1.82	1.23	.64	.77	4.46
Onions, 3 lb.-----	1.59	.81	.57	.58	3.55
Apples, 4 lb.-----	1.99	1.56	.70	1.54	5.79
Oranges, doz.-----	2.08	1.36	.75	1.16	5.35
Grapefruit, 8-pack.---	2.39	2.06	.85	.93	6.23

<sup>1</sup> See footnote 16, p. 89.

### Firm E

The produce line at firm E is used almost exclusively for packaging 10 and 5 pounds of potatoes. Because of the limited number of items, this firm was not included in the evaluation of packaging costs in four firms. This firm used a rotary-type bagger that automatically fed produce into

the bag. Potatoes in conventional 50- and 100-pound shipping containers were dumped into the hopper. One and sometimes two girls hung the poly bags on the machines, two girls checked the weights in the filled bags, one girl closed the bags on a semi-automatic wire closer, and three or four men placed the five 10-pound or ten 5-pound potato bags in kraft baler bags (fig. 63). The estimate for burden charges (see p. 84) was based on data in similar firms. The container cost is high because of the one-trip baler bag (table 50).

TABLE 50.—Produce packaging costs at firm E

Produce item	Labor	Materials	Burden <sup>1</sup>	Containers	Total
Potatoes:	<i>Cents</i>	<i>Cents</i>	<i>Cent</i>	<i>Cents</i>	<i>Cents</i>
10 lb.-----	2.17	1.92	0.70	1.94	6.73
5 lb.-----	1.52	1.03	.55	.97	4.07

<sup>1</sup> Estimated; see footnote 16, p. 89.

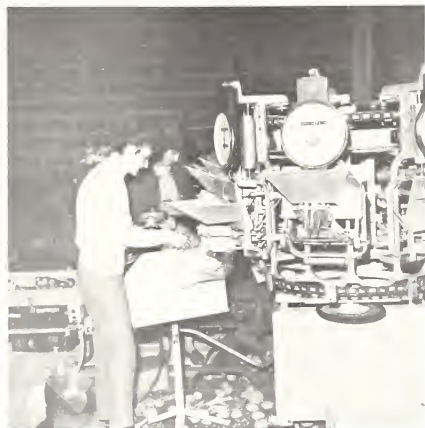


FIGURE 63.—Equipment for produce packaging at firm E; A, Hanging empty bags; B, checking for weight; C, bag closing; D, packout in baler bags.



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## APPENDIX

TABLE 51.—Pallet box capacity and weight of product for alternative depths and different common carrier loads

Pallet depth (inches)	Pallet-box capacity	Apples or grapefruit, 32 lb. per cu. ft.	Oranges, 34 lb. per cu. ft.	Potatoes and onions, 40 lb. per cu. ft.	Empty pallet container and base <sup>1</sup>	Tare per load <sup>2</sup>
Capacity and Weight of Product and Containers						
Triple stacking:	<i>Cu. ft.</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
20.....	21.60	691	734	864	44	2,376
21.....	22.68	726	771	907	44	2,376
22.....	23.76	760	808	950	45	2,430
23.....	24.84	795	845	994	45	2,430
Double stacking:						
30.....	32.40	1,037	1,102	1,296	44.5	1,602
32.....	34.56	1,106	1,175	1,382	45.5	1,638
34.....	36.72	1,175	1,248	1,469	46.5	1,674
36.....	38.88	1,244	1,322	1,555	47.5	1,710
Common Carrier Load Capacity <sup>3</sup>						
Triple stacking:						
20.....	39,700	42,000	49,000			
21.....	41,600	44,000	51,400			
22.....	43,500	46,100	53,700			
23.....	45,400	48,100	56,100			
Double stacking:						
30.....	38,900	41,300	48,300			
32.....	41,500	44,000	51,400			
34.....	44,000	46,600	55,300			
36.....	46,500	49,300	57,690			

<sup>1</sup> All pallet capacities are for a 42- by 47-inch two-piece corrugated pallet container. For details on tare weights see Tables 52, 54, 55, and 56.

<sup>2</sup> This is based on 54 containers for triple-stacked loads and 36 containers

for double-stacked loads. This applies to 37- to 40-foot over-the-road trailers and 33-foot refrigerated rail cars.

<sup>3</sup> This is equal to the weight of product and empty containers for the load

TABLE 52.—Development of production standard for receiving oranges in trailers at the central warehouse in standard receiving containers

Worker and job element	Total elemental time	Frequency element occurs	Weighted elemental time
Receiver:	<i>Minutes</i>	<i>Percent</i>	<i>Minutes</i>
Open door and position dock plate.....	0.691	3.7	0.026
Enter car with transporter and engage load.....	.194	100.0	.194
Move load to temporary storage.....	.120	100.0	.120
Move away dock plate and close door.....	.264	100.0	.264
Obtain transporter.....	.551	3.7	.020
Total.....			.624
Unloader:			
Help open door and position dock plate.....	.598	3.7	.022
Obtain empty pallet.....	.390	100.0	.390
Load 35 containers on pallet.....	4.060	100.0	4.060
Wait for receiver.....	.323	81.5	.263
Help close door and remove plate.....	.406	3.7	.017
Total.....			4.752
Total minutes per pallet load.....			5.376
Fatigue and personal allowance (15 percent).....			.806
Standard time per pallet.....			6.182
Standard time per container (35 per pallet).....			.177
Standard time per load (945 containers).....			167.26

TABLE 53.—*Development of production standard for receiving oranges in trailers at the central warehouse in pallet containers*

Job element	Elements	Total time	Frequency of occurrence	Weighted time
	Number	Minutes	Percent	Minutes
Open door and position dock plate.....		1.181	1.8	0.021
Enter car with transporter.....	3	.263	33.3	.088
Engage pallet.....	3	.186	33.3	.062
Move load to temporary storage.....	3	.323	33.3	.108
Move plate and close door.....		1.381	1.8	.023
Obtain transporter.....		.338	1.8	.006
Return to car.....	3	.204	33.3	.068
Remove dunnage.....		.594	1.8	.010
Install light.....		.166	5.6	.009
Close warehouse doors.....		.725	1.8	.013
Total time per pallet box.....				.410
Fatigue and personal allowance (10 percent).....				.041
Standard time per pallet box.....				.451
Standard time per load.....				24.4

TABLE 54.—*Production standard for feeding the packaging line when shipping containers are emptied by hand*

Job element	Potatoes			Oranges		
	Time	Frequency of occurrence	Weighted time	Time	Frequency of occurrence	Weighted time
	Minutes	Percent	Minute	Minute	Percent	Minute
Position container.....	0.084	100.0	0.084			
Cut strings.....	.073	100.0	.073			
Empty contents on feed belt.....	.110	100.0	.110	0.080	100.0	0.080
Police area.....	.082	14.5	.012	.082	14.5	.012
Obtain box and open.....			.044	.044	100.0	.044
Organize empty sacks.....	1.200	2.0	.024			
Travel in area.....	.070	10.0	.007	.070	10.0	.007
Place aside empty container.....				.100	100.0	.100
Place aside empty top.....				.060	100.0	.060
Total per container.....	.310					.303
Fatigue and personal allowance (15 percent).....	.046					.045
Standard time per container.....	.356					.348
Standard time per hundredweight.....	.356					.870

TABLE 55.—*Production standard for feeding the packaging line when produce is received in pallet containers*

Job element	Potatoes			Oranges		
	Time	Frequency of occurrence	Weighted time	Time	Frequency of occurrence	Weighted time
	Minutes	Percent	Minutes	Minutes	Percent	Minutes
Cut tape and place aside.....				0.323	100.0	0.323
Position pallet box in tipper.....	0.139	100.0	0.139	.079	100.0	.079
Raise pallet box.....	.428	100.0	.428	.330	100.0	.330
Rake out remaining produce.....	.390	100.0	.390	.286	100.0	.286
Lower pallet box.....	.120	100.0	.120	.160	100.0	.166
Remove from tipper.....	.111	100.0	.111			
Collapse pallet box and stack on pallet.....	.217	100.0	.217	.615	100.0	.615
Delay.....	.168	14.3	.024	.168	14.3	.168
Check on tipper.....	.121	8.0	.011			
Police area.....	1.020	10.0	.102	.315	20.0	.063
Remove pallet box cover and place aside.....				.279	100.0	.279
Pull pallet box forward.....				.088	25.0	.022
Total time per pallet box.....			1.542			2.187
Fatigue and personal allowance (10 percent).....			.154			.219
Standard time per pallet box.....			1.696			2.406
Standard time per hundredweight.....			.130			.285

TABLE 56.—Cost of receiving potatoes shipped by rail car from Idaho to Minneapolis, Minn., by type of container

Cost component	Standard		Two-cell corrugated <sup>1</sup>			Wooden pallet <sup>2</sup>
	100-pound burlap	50-pound buler bag	1 trip	3 trips	5 trips	
Per container:						
Material:						
Container.....	Dollars 0.13	Dollars 0.08	Dollars 3.60	Dollars 1.00	Dollars 0.60	Dollars 0.34
Base <sup>3</sup> .....			1.20	.12	.12	
Strapping <sup>4</sup> .....			.26	.26	.26	
Freight:						
Product <sup>5</sup> .....	1.08	.54	14.04	14.04	14.04	14.04
Container, incoming.....	.01	.02	.58	.58	.58	1.30
Container, returned.....				.66	.66	1.48
Labor: <sup>6</sup>						
Receiving.....	.02	.01	.03	.03	.03	.03
Line feeding.....	.02	.02	.08	.08	.08	.08
Total cost.....	1.26	.67	19.19	16.77	16.37	17.27
Per carload (46,800 lb.).....	590	627	691	604	589	622
Per 10-pound bag.....	Cents 12.6	Cents 13.4	Cents 14.8	Cents 12.9	Cents 12.6	Cents 13.3

<sup>1</sup> As illustrated in figure 10, two-cell double-wall corrugated box base with pad and identical top and bottom caps. The box costs \$3, holds 1,300 pounds, weighs 20 pounds. Dimensions are 42 by 47 by 30 inches deep.

<sup>2</sup> This 2-piece wooden collapsible container, as illustrated in figure 9, will make an estimated 50 trips, weighs 120 pounds, and costs \$16.80.

<sup>3</sup> At \$182 per 1,000, these bags cost 18 cents each; average salvage value is 5 cents.

<sup>4</sup> This 2-color printed, wet strength, satchel bottom bag costs \$80.80 per 1,000 and weighs 1 pound.

<sup>5</sup> The modified 4-way-entry wooden pallet as illustrated in figure 6, costs \$1.20, weighs 25 pounds, and will make an estimated 10 trips.

<sup>6</sup> Laminated rayon strapping at \$17.25 per 1,000 yards; the 40 feet used per box costs 23 cents. The metal clips cost \$10.30 per 1,000, or 3 cents per box.

<sup>7</sup> Freight from Idaho to Minneapolis, Minn., is \$1.08 per cwt. for minimum car weight of 45,000 pounds.

<sup>8</sup> Under Western Trunk Line proposal No. 113-332 shippers can return knocked-down pallet containers at a rate of \$1.23 per cwt.

<sup>9</sup> At a wage rate of \$3.00 per hour.

TABLE 57.—Computations for determining the lowest cost container for receiving produce at alternative freight rates, by commodity

Commodity and container	Material	Labor	Interest	Total	Weight of product	Cost per hundred-weight	Tare weight	Return weight <sup>1</sup>	Total weight <sup>2</sup>	Freight factor for total product <sup>3</sup>	Equation for straight line curve
Potatoes (Idaho): <sup>4</sup>	Dol.	Dol.	Dol.	Dol.	Lb.	Dol.	Lb.	Lb.	Lb.		
100-lb. burlap.....	0.13	0.04	-----	0.17	100	0.170	1	-----	101	1.01	$y=0.17+1.01x$
2-cell corrugated pallet container.....	.98	.11	-----	1.09	1,300	.084	54	62	1,416	1.09	$y=0.084+1.09x$
Wooden pallet box.....	.34	.11	-----	.45	1,300	.035	120	138	1,558	1.20	$y=0.035+1.20x$
Potatoes (regional): <sup>5</sup>											
100-lb. burlap.....	.13	.04	-----	.17	100	.170	1	-----	101	1.01	$y=0.17+1.01x$
2-cell corrugated pallet container.....	.98	.11	-----	1.09	1,300	.084	54	364	1,718	1.32	$y=0.084+1.32x$
Wooden pallet box.....	.34	.11	-----	.45	1,300	.035	120	810	2,230	1.72	$y=0.035+1.72x$
Wooden pallet box, received net weight, free return.....	.34	.11	-----	.45	1,300	.035	-----	-----	1,300	1.00	$y=0.035+1.00x$
Apples (Washington): <sup>6</sup>											
40-lb. tray-pack carton.....	.53	.03	-----	.56	40	.140	5	-----	45	1.12	$y=0.140+1.12x$
40-lb. loose-pack carton.....	.31	.03	-----	.34	40	.850	4	-----	44	1.10	$y=0.85+1.10x$
Expandable pallet container.....	5.86	.14	-----	6.00	730	.821	52	-----	782	1.07	$y=0.82+1.07x$
5-trip, one-cell corrugated pallet container.....	1.26	.14	.05	1.45	795	.182	45	144	984	1.24	$y=0.18+1.24x$
Wooden pallet box.....	.51	.14	.10	.75	730	.103	97	311	1,138	1.56	$y=0.10+1.56x$
Oranges (Florida): <sup>7</sup>											
13-bu. wirebound.....	.38	.04	-----	.42	85	.494	6	-----	91	1.07	$y=0.49+1.07x$
3-bu. corrugated carton.....	.25	.03	-----	.28	40	.700	2.5	-----	42.5	1.06	$y=0.70+1.06x$
Expandable pallet box.....	5.86	.14	-----	6.00	771	.778	52	-----	823	1.07	$y=0.78+1.07x$
Corrugated pallet box, 5-trips.....	1.27	.14	.05	1.46	845	.175	45	105	965	1.18	$y=0.17+1.18x$
Wooden pallet box, 5-trips.....	.51	.14	.10	.75	771	.097	97	227	1,065	1.42	$y=0.10+1.42x$
Bulk load.....	20.93	22.30	-----	43.23	45,630	.095	-----	-----	45,630	1.00	$y=0.10+1.00x$
Grapefruit (Florida): <sup>8</sup>											
13-bu. wirebound.....	.38	.04	-----	.42	78	.538	6	-----	84	1.08	$y=0.54+1.08x$
3-bu. corrugated carton.....	.25	.03	-----	.28	38	.737	2.5	-----	40.5	1.07	$y=0.58+1.07x$
Expandable pallet box.....	5.86	.14	-----	6.00	730	.822	52	-----	782	1.07	$y=0.82+1.07x$
Corrugated pallet box, 5-trips.....	1.27	.14	.08	1.49	795	.187	45	105	945	1.07	$y=0.19+1.07x$
Wooden pallet box.....	.51	.14	.10	.75	730	.103	97	227	1,054	1.44	$y=0.10+1.44x$

<sup>1</sup> The ratio of return freight to incoming freight times the weight of the empty container.

<sup>2</sup> Weight of product plus weight of container plus adjusted weight of empty container.

<sup>3</sup> Ratio of total weight (footnote 2) to weight of product.

<sup>4</sup> Incoming freight \$1.08 cwt.; return of empty, \$1.23 cwt.

<sup>5</sup> Incoming freight \$0.40 cwt.; return of empty, \$2.70 cwt.

<sup>6</sup> Incoming freight is \$1.64 cwt.; incentive freight is \$1.51 cwt. and return of empty rate is \$4.84 cwt.

<sup>7</sup> Incoming freight \$1.78 cwt.; return of empty is \$4.16 cwt.

TABLE 5S.—Cost of receiving apples shipped from Washington State to Minneapolis, Minn., by type of container

Cost component	Standard shipping cartons <sup>1</sup>		One cell corrugated pallet box <sup>2</sup>			Wooden pallet box <sup>3</sup>
	Tray-pack	Loose-pack	1 trip	3 trips	5 trips	
Per container:						
Material:						
Container	Dollars 0.53	Dollars 0.31	Dollars 4.40	Dollars 1.47	Dollars 0.88	Dollars 0.30
Base			<sup>4</sup> 1.20	<sup>5</sup> .13	<sup>5</sup> .13	
Strapping <sup>6</sup>			.26	.26	.26	
Liner						<sup>7</sup> .21
Labor: <sup>8</sup>						
Receiving <sup>9</sup>	.01	.01	.02	.02	.02	.02
Line feeding <sup>10</sup>	.02	.02	.12	.12	.12	.12
Interest:				<sup>11</sup> .19	<sup>12</sup> .13	<sup>12</sup> .09
Freight:						
Incoming product <sup>14</sup>	.66	.66	11.02	12.00	12.00	11.02
Incoming container <sup>15</sup>	.08	.07	.79	.66	.66	1.84
Return of container <sup>16</sup>				2.13	2.13	5.90
Total cost per container	1.30	1.07	17.81	16.98	16.33	19.50
Per pallet box equivalent:						
Per carload (net wt. 42,930 lb.)	23.84	21.27	19.40	16.98	16.33	19.50
	1,395	1,148	1,048	917	882	1,148
Per 4-lb consumer bag	Cents 13.0	Cents 10.6	Cents 9.8	Cents 8.5	Cents 8.2	Cents 10.7

<sup>1</sup> The cartons have a net weight of 40 pounds. The tray-pack carton has 5 molded dividers and weighs 5 pounds. The loose-pack carton weighs 4 pounds.

<sup>2</sup> The one-cell pallet boxes are 42 by 47 inches. The 1-trip box is 21 inches deep, weighs 27 pounds, and holds 750 pounds. The multitrip corrugated box is 23 inches deep, weighs 28 pounds, and has a capacity of 795 pounds.

<sup>3</sup> The collapsible wooden box has same dimensions and capacity as the 1-trip box, weighs 97 pounds, and will make an estimated 50 trips.

<sup>4</sup> Modified 4-way entry wooden pallet base, 42 by 47 inches, weighs 25 pounds.

<sup>5</sup> A stack of 3-pallet containers has six channels that weigh 3.75 pounds each to support the upper 2 pallet boxes and a modified wooden pallet (see footnote 4 above) for the bottom pallet box.

$$\frac{(6 \times 3.75)}{3} + 25 = 16 \text{ lb. per pallet}$$

<sup>6</sup> The 3/4-inch-wide laminated rayon cord costs \$17.25 per 1,000 yards or 0.58 cent per foot. Three straps require 40 feet for a total of 23 cents per box. Metal buckles to secure the straps are \$10.30 per 1,000, or 3 cents per pallet box.

<sup>7</sup> Apples in a wooden container will bruise unless the base and walls are lined with corrugated material. The pad and liner weigh 5.9 pounds, at 12 cents per pound they cost \$1.06. Boxes will make an estimated 5 trips.

<sup>8</sup> A average wage rate is \$3.00 per hour, including fringe benefits.

<sup>9</sup> Receiving time is 18 minutes for the cartons and 0.34 minute per container for pallet boxes.

<sup>10</sup> The time to feed the line is 0.43 minute for tray-pack containers, 0.34 minute for loose-pack cartons, and 2.41 minutes for pallet boxes.

<sup>11</sup> Modified 4-way entry bases make 10 trips and are used only for bottom of stack, or one for every 3 pallet boxes.

$$\frac{3.2 \times 54 \times 52 \times 0.33 \times \$1.20}{10} = \$356$$

The channel dividers make an estimated 20 trips, are used for top 2 pallet boxes, cost \$3.00 each, and use 3 per pallet box. Thus, 6 are required per stack of 3 containers, which is equivalent to 2 per container.

$$\frac{3.2 \times 54 \times 52 \times \$6.00}{20} = \$2,698$$

Tops make 3 trips,

$$\frac{1.6 \times 54 \times 52 \times \$4.59}{3} = \$13,747$$

Total \$16,801

$$\$16,801 \text{ at } 5 \text{ percent} = \$840$$

No. pallet box trips per year:  $1.6 \times 54 \times 52 = 4,493$   
 $\$840 \div 4,493 = 18.17$  cents interest per pallet trip.

<sup>12</sup> 4-way modified boxes: (see footnote 11 above) \$356 channel dividers (see footnote 11 above) \$2,696

$$\text{Tops: } \frac{3.2 \times 54 \times 52 \times \$1.59}{5} = \$8,258$$

Total \$11,310

$$\$11,310 \text{ at } 5 \text{ percent interest} = \$565$$

No. pallet box trips per year:  $1.6 \times 54 \times 52 = 4,493$

$\$565 \div 4,493 = 12.6$  cents interest per pallet trip

<sup>13</sup> Must have enough pallet containers for peak periods to assume an inventory of 10 loads of 34 boxes.

$$10 \times 54 \times \$14.90 = \$8,046$$

$$\frac{\$8,046 \times .05}{4,493} = 9.0 \text{ cents interest per pallet trip}$$

<sup>14</sup> At \$1.64 per hundredweight for 40-pound cartons, because load is not large enough for incentive rate. Freight is \$1.51 for pallet boxes.

<sup>15</sup> Same rate as for product.

<sup>16</sup> The return rate is \$4.54 per hundredweight applied to tare weights of the various pallet containers:

	3 and 5 trips	Wood
Base 25 lb.	16	25
Top 27 lb.	28	97
Total	44 lb.	122 lb.

TABLE 59.—Cost of receiving oranges shipped from Florida to Minneapolis, Minn., by type of container

Cost component	Standard shipping containers <sup>1</sup>		One-cell corrugated pallet box <sup>2</sup>			Wooden pallet box <sup>3</sup>	Bulk trailer loads <sup>4</sup>
	1½-bu. wire-bound	½-bu. 2-piece carton	Expendable wooden base	3 trips	5 trips	50 trips	
Per container:							
Material:	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Container	0.38	0.25	4.40	1.47	0.88	0.30	\$12.17
Base			\$1.20	7.13	7.13		
Strapping			.26	.26	.26		
Liner						7.21	8.76
Labor: <sup>5</sup>							
Receiving	11.01	12.01	13.02	13.02	13.02	11.02	14.00
Line feeding	16.03	16.02	17.12	17.12	17.12	17.12	14.30
Interest:				19.08	20.05	21.10	
Freight: <sup>6</sup>							
Incoming product	1.51	.71	13.72	15.04	15.04	13.72	812.21
Incoming container	.11	.04	.93	1.79	1.79	4.04	
Return container							
Total cost per container trip	2.04	1.03	20.65	19.71	19.09	20.24	855.44
Per 845-lb. pallet box equivalent	20.28	21.76	22.63	19.71	19.09	22.26	15.85
Per 45,630-lb. load	1,095	1,175	1,222	1,064	1,031	1,198	856
Per consumer unit dozen (3.5 lb.) <sup>7</sup>	Cents 8.4	Cents 9.0	Cents 9.4	Cents 8.2	Cents 7.9	Cents 9.2	Cents 6.6

<sup>1</sup> The 1½-bu. wire-bound holds 45 lb., weighs 6 lb., costs 48 cents, and has an average salvage value of 10 cents. The ½-bu. carton is a 2-piece telescoping corrugated container that holds 40 lb., has a tare weight of 2½ lb., costs 25 cents, and normally does not have a salvage value.

<sup>2</sup> This triple-wall corrugated container has area dimensions of 42 by 47 inches and costs \$4.40. The 1-trip box is 21 inches deep, weighs 27 lb., and holds 771 lb. The multitrip box is 23 inches deep, weighs 29 lb., and holds 845 lb. of oranges.

<sup>3</sup> Dimensions are 42 by 47 by 21 inches deep. The box holds 771 lb., costs \$14.90, weighs 97 lb., and will make an estimated 50 trips.

<sup>4</sup> Oranges are loaded in trailers to a depth of approximately 36 inches. Single-gang corrugated rolls are used for floor and sides (73 lb. at 12 cents per roll).

<sup>5</sup> In the central warehouse the bulk load will likely unload into pallet containers. This will require 36 boxes at \$16.90, which can be used an estimated 50 times. At 33.8 cents per use, the cost per load is \$12.17.

<sup>6</sup> Wooden 4-way entry pallet base, which has an estimated life of 10 trips but will be used with expendable box is thrown away after one trip because of cost of return (\$1.04), is almost equal to replacement; weighs 25 lb., and costs \$1.20.

<sup>7</sup> Modified wood 4-way entry pallet base to support bottom pallet box of stack costs \$1.20, weighs 25 lb., and makes 10 trips. The upper 2 containers are each supported by three 16-gage aluminum channels which weigh 3.75

pounds each and cost \$3.33. Will make estimated 50 trips. Average base weight per pallet box is 16 pounds.

<sup>8</sup> Corrugated pallet containers require strapping to lessen bulging. The 3½-inch laminated rayon cord costs \$17.25 per 1,000 yards or 0.58 cent per foot. Three straps require 40 feet, or 23 cents per pallet box. Metal clips to secure the straps are \$10.30 per 1,000, or 3 cents per box.

<sup>9</sup> Corrugated liner for sides and base pad weighs 8.8 lb., costs 12 cents per lb., and can be used for 5 trips. (8.8×0.12)÷5=21 cents.

<sup>10</sup> \$3.60 per hour, including fringe benefits.

<sup>11</sup> 0.26 minute per container.

<sup>12</sup> 18 minute per container.

<sup>13</sup> 0.45 minute per pallet box.

<sup>14</sup> Crew of 3 unloads trailer into pallet container in 2 hours, or 6 man-hours at \$3 per hour.

<sup>15</sup> 0.60 minute per container.

<sup>16</sup> 0.35 minute per container.

<sup>17</sup> Feeding line from pallet boxes using tipper is 2.42 minutes, or 12 cents at \$3 per hour.

<sup>18</sup> 36 pallet containers at 2.40 minutes is 86 minutes, or \$4.30 at \$3 per hour.

<sup>19</sup> Incoming freight on product and container in this area was \$1.78 per cwt.

<sup>20</sup> Return freight on empty containers was \$4.16 per cwt.

<sup>21</sup> The average weight of size 188 oranges is 3.5 lb. per dozen.

TABLE 60.—Cost of receiving grapefruit from Florida to Minneapolis, Minn., by type of container<sup>1</sup>

Cost component	Standard shipping containers		Corrugated pallet containers			Wooden pallet containers
	1½-bu. wire-bound <sup>2</sup>	½-bu. 2-pc. carton <sup>3</sup>	Expendable <sup>4</sup>	3 trips <sup>5</sup>	5 trips <sup>6</sup>	
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Per container:						
Material:						
Container	0.38	0.25	4.40	1.47	0.88	0.30
Base			1.20	.13	.13	
Strapping			.26	.26	.26	
Liner						.21
Labor:						
Receiving	.01	.01	.02	.02	.02	.02
Line feeding	.03	.02	.12	.12	.12	.12
Interest:				.08	.08	.10
Freight:						
Product	1.39	.68	12.99	14.15	14.15	12.99
Incoming container	.11	.04	.93	.80	.80	1.73
Return of container				1.87	1.87	4.04
Total cost	1.92	1.00	19.92	18.90	18.31	19.51
Per 795-lb. pallet box equivalent	19.56	20.92	21.71	18.90	18.31	21.25
Per 42,930-lb. load	1,056	1,130	1,171	1,021	989	1,148
	Cents	Cents	Cents	Cents	Cents	Cents
Per consumer unit (6.5 lb.) <sup>7</sup>	16.0	17.1	17.7	15.5	15.0	17.4

<sup>1</sup> Container construction and size, material costs, labor and freight are the same as for oranges (table 59) unless otherwise specified.

<sup>2</sup> Capacity is 78 lb. and container weight is 6 lb.

<sup>3</sup> Weights 2½ lb. and holds 38 lb.

<sup>4</sup> 21-inch-deep pallet box holds 730 lb.; top weighs 27 lb. and base 25 lb.

<sup>5</sup> 23-inch-deep pallet box holds 795 lb.; top weighs 29 lb. and base 25 lb.

<sup>6</sup> Average package holds 8 grapefruit. There is an equivalent of 6,600 bags per carload (42,930÷65).



TABLE 61.—Annual savings when produce to be packaged at central warehouse is received in pallet containers instead of conventional shipping containers, by type of produce and annual volume packaged

Produce item	Savings per bag	Annual volume, all produce <sup>1</sup>											
		800,000 packages (\$1 million)		1,600,000 packages (\$2 million)		2,400,000 packages (\$3 million)		3,200,000 packages (\$4 million)		4,000,000 packages (\$5 million)		4,800,000 packages (\$6 million)	
		Volume	Savings	Volume	Savings	Volume	Savings	Volume	Savings	Volume	Savings	Volume	Savings
Potatoes:	<i>Cents</i>	<i>1,000 pkg.</i>	<i>Dollars</i>	<i>1,000 pkg.</i>	<i>Dollars</i>	<i>1,000 pkg.</i>	<i>Dollars</i>	<i>1,000 pkg.</i>	<i>Dollars</i>	<i>1,000 pkg.</i>	<i>Dollars</i>	<i>1,000 pkg.</i>	<i>Dollars</i>
10-lb. bag.....	0.8	224	1,732	448	3,584	672	5,376	896	7,186	1,120	8,960	1,344	10,752
5-lb. bag.....	.4	160	640	320	1,280	480	1,920	640	2,560	800	3,200	960	3,840
Apples, 4-lb. bag.....	4.8	152	7,296	304	14,592	456	21,888	608	29,184	760	36,480	912	43,776
Oranges, doz.....	1.1	88	968	176	1,936	264	2,904	352	3,872	440	4,840	528	5,808
Grapefruit, 8-pack.....	2.1	40	840	80	1,680	120	2,520	160	3,360	200	4,200	240	5,040
Total.....		664	11,536	1,328	23,072	1,992	34,608	2,656	46,102	3,320	57,080	3,984	69,216

<sup>1</sup> Percentages of annual sales of all produce for the respective kinds of produce are:

Potatoes, 10-lb. bag.....	28
Potatoes, 5-lb. bag.....	20
Apples, 4-lb. bag.....	19
Oranges, doz.....	11
Grapefruit, 8-pack.....	5

TABLE 62.—Standard time to fill bags of selected produce items for 3 types of bagging equipment

Equipment and produce item	Obtain empty bag and adjust weight in chute	Fill bag and move to conveyor	Delay and miscellaneous elements	Standard time per bag
<i>Level belt, double-head baggers</i>	<i>Minute</i>	<i>Minute</i>	<i>Minute</i>	<i>Minute</i>
Single-head operation:				
Potatoes, 10 lb.....	0.163	0.076	0.025	0.264
Potatoes, 5 lb.....	.101	.031	.009	.141
Oranges, doz.....	.117	.047	.005	.169
Onions, 3 lb.....	.097	.029	.007	.133
Double-head operation:				
Potatoes, 10 lb.....	.107	.046	.012	.165
Potatoes, 5 lb.....	.089	.052	.005	.146
Oranges, doz.....	.123	.046	.005	.174
Onions, 3 lb.....	.090	.052	.003	.145
<i>Hopper-type, double-head baggers</i>				
Single-head operation:				
Potatoes, 10 lb.....	.085	.102	.064	.251
Potatoes, 5 lb.....	.093	.064	.009	.166
Oranges, doz.....	.099	.061	.005	.165
Onions, 3 lb.....	.080	.047	.003	.130
Double-head operation:				
Potatoes, 10 lb.....	.108	.047	.012	.167
Potatoes, 5 lb.....	.087	.056	.005	.148
Oranges, doz.....	.092	.063	.005	.160
Onions, 3 lb.....	.084	.049	.003	.136
<i>Hopper-type, single-head baggers</i>				
Single-head operation:				
Potatoes, 10 lb.....	.079	.056	.012	.147
Potatoes, 5 lb.....	.075	.051	.005	.131
Oranges, doz.....	.081	.046	.005	.132
Onions, 3 lb.....	.075	.043	.003	.121

TABLE 63.—Labor requirements per container trip for handling filled returnable containers from warehouse to retail store in a simulated operation, by type of container

Job element	Pallet	Thermoplastic		Fiberglass	Rexford	Wooden stack-and-nest	Salvage
		Polyethylene	ABS				
	<i>Minutes</i>	<i>Minute</i>	<i>Minutes</i>	<i>Minutes</i>	<i>Minute</i>	<i>Minute</i>	<i>Minutes</i>
Container handling at packout.....	0.77	0.09	0.09	0.09	0.09	0.09	0.26
Transport to selection area.....	.17	.04	.04	.04	.04	.04	.03
Order selection.....	.23	.23	.23	.23	.17	.17	.17
Load in trailer.....	2.28	.11	.11	.11	.11	.11	.10
Unload at store.....	2.78	.14	.14	.14	.14	.14	.12
Transport to storage.....	.17	.17	.17	.17	.17	.17	.17
To display and return.....	.28	.28	.28	.28	.28	.28	.28
Total time.....		1.00	1.06	1.08	1.00	1.00	1.13

TABLE 64.—*Labor requirements per container trip for handling empty returnable containers from warehouse to retail store in a simulated operation, by type of container*

Job element	Pallet load	Thermoplastic	Fiberglass	Rexford	Wooden stack-and-nest	Salvage
	<i>Minutes</i>	<i>Number</i>	<i>Minute</i>	<i>Number</i>	<i>Minute</i>	<i>Number</i>
Load at retail store.....	1.41	20	0.07	20	0.07	12
Unload at warehouse.....	3.61	20	.18	20	.18	12
Transport to line.....	1.02	80	.01	80	.03	33
Sorting.....						
Total time.....			.26	.26	.36	.27

TABLE 65.—*Allocation of burden to each bagged produce item based on production time*

Produce and package size	Packaged by production standards			Hand store records			Machine packaging		
	Standard time per package	Index	Burden allocation <sup>1</sup>	Standard time per package	Index	Burden allocation <sup>1</sup>	Standard time per package	Index	Burden allocation <sup>2</sup>
	<i>Minute</i>	<i>Percent</i>	<i>Cent</i>	<i>Minute</i>	<i>Percent</i>	<i>Cent</i>	<i>Minute</i>	<i>Percent</i>	<i>Cent</i>
Potatoes, 10 lb.....	0.828	136	0.74	0.964	133	0.73	0.446	110	0.73
Potatoes, 5 lb.....	.647	106	.58	.603	83	.45	.380	94	.63
Onions, 3 lb.....	.531	87	.48	.513	71	.39	.344	85	.57
Apples, 4 lb.....	.581	96	.53	.824	114	.62	.450	111	.74
Oranges, doz.....	.461	76	.42	.778	108	.59	.397	98	.65
Grapefruit, 8 or 10.....	.601	99	.54	.657	91	.50	.404	100	.67
	.608	100		.723	100		.404	100	

<sup>1</sup> Based on 0.547 cent per package.<sup>2</sup> Based on 0.608 cent per package.TABLE 66.—*Space and equipment charges per year for retail store packaging of bagged produce items*[For \$3,000-per-week produce department; 117,000 annual package volume] <sup>1</sup>

Item	Hand bagging	Machine bagging	Item	Hand bagging	Machine bagging
	<i>Dollars</i>	<i>Dollars</i>		<i>Dollars</i>	<i>Dollars</i>
Space (rent, utilities, insurance, etc.) 80 sq. ft. at \$7.....	560	560	Depreciation—Continued		
Depreciation:			Equipment (10-year life):		
Scale, \$250.....	25		Containers (5-year life): 40 at \$5 each.....	40	40
Table, \$150.....	15		Maintenance.....		48
Bagger, \$1,225.....		122	Total.....	640	779
Tape closer, \$50.....		5	Per package <sup>1</sup> .....	.547	.666
Apple board, \$38.....		4			

<sup>1</sup> In 3 firms there was an average of 750 consumer packages of bagged produce per \$1,000 of produce sales.TABLE 67.—*Cost per package for bagging selected produce items in the retail store by typical hand methods and equipment, by improved hand methods and equipment, and by improved methods with a semiautomatic bagging machine*

Produce and bagging method	Fill and weigh	Close bag	Other elements	Total time per package	Standard time per package <sup>1</sup>	Labor cost per package <sup>2</sup>	Material cost per package <sup>3</sup>	Burden charges per package	Total cost per package <sup>4</sup>
	<i>Minute</i>	<i>Minute</i>	<i>Minute</i>	<i>Minute</i>	<i>Minute</i>	<i>Cents</i>	<i>Cents</i>	<i>Cent</i>	<i>Cents</i>
Potatoes, 10 lb.:									
Typical hand.....	0.352	0.189	0.179	0.720	0.828	4.14	2.29	0.74	7.17
Improved hand.....	.115	.129	.144	.388	.446	2.23	2.29	.73	5.25
Improved machine.....					.904	4.82	2.29	.73	7.84
Potatoes, 5 lb.:									
Typical hand.....	.284	.150	.129	.563	.647	3.24	1.22	.58	5.04
Improved hand.....	.113	.100	.117	.330	.380	1.90	1.22	.63	3.75
Improved machine.....					.603	3.02	1.22	.45	4.69
Onions, 3 lb.:									
Typical hand.....	.255	.116	.091	.462	.531	2.65	.97	.48	4.10
Improved hand.....	.103	.101	.095	.229	.344	1.72	.97	.57	3.26
Improved machine.....					.513	2.56	.97	.39	3.92
Apples, 4 lb.:									
Typical hand.....	.177	.120	.208	.505	.581	2.90	1.10	.53	4.53
Improved hand.....	.120	.085	.186	.391	.450	2.25	1.10	.74	4.09
Improved machine.....					.824	4.12	1.10	.62	5.84
Oranges, doz.:									
Typical hand.....	.190	.083	.128	.401	.461	2.30	1.10	.42	3.82
Improved hand.....	.124	.089	.132	.345	.397	1.98	1.10	.65	3.73
Improved machine.....					.778	3.89	1.10	.59	5.58
Grapefruit, 8 or 10:									
Typical hand.....	.274	.128	.121	.523	.601	3.00	2.29	.54	5.83
Improved hand.....	.126	.100	.125	.351	.404	2.02	2.29	.67	4.98
Improved machine.....					.657	3.28	2.29	.50	6.07

<sup>1</sup> Includes a 15-percent allowance for personal time and fatigue.<sup>2</sup> Based on an average store labor cost of \$3.00 per hour.<sup>3</sup> Cost of poly bag and closure.<sup>4</sup> For additional details see table 68.

TABLE 68.—Cost per consumer unit for packaging produce, by kind of cost, method, and point of packaging

Consumer unit of produce, point of packaging, and method	Packaging cost (labor, materials, burden, and warehouse to store container) <sup>1</sup>	Receiving cost (freight, con- tainer, and labor) <sup>2</sup>	Upcharge (grower-shipper packaging)	Total cost per consumer unit
Potatoes, 10 lb.:				
Store:				
Machine packaged.....	Cents 5.2	Cents 9.2	Cents	Cents 14.4
Manually packaged.....	7.8	9.2		17.0
Warehouse:				
Conventional containers (100-lb. sack).....	5.4	9.2		14.6
Pallet box:				
2-piece corrugated.....	5.4	9.5		14.9
Wood; received net weight and free return.....	5.4	8.4		13.8
Source packaged.....		7.8	9.1	16.9
Potatoes, 5 lb.:				
Store:				
Machine packaged.....	3.8	4.6		8.4
Manually packaged.....	4.7	4.6		9.3
Warehouse:				
Conventional containers (100-lb. sack).....	3.7	4.6		8.3
Pallet box:				
2-piece corrugated.....	3.7	4.8		8.5
Wood; received net weight and free return.....	3.7	4.2		7.8
Source packaged.....		3.9	6.0	9.9
Onions, 3 lb.:				
Store:				
Machine packaged.....	3.3	<sup>3</sup> 5.7		9.0
Manually packaged.....	3.9	<sup>3</sup> 5.7		9.6
Warehouse:				
Conventional container (50-lb. sack).....	3.0	<sup>3</sup> 5.7		8.7
Apples, 4 lb.:				
Store:				
Machine packaged.....	3.9	10.7		14.6
Manually packaged.....	5.8	10.7		16.5
Warehouse:				
Conventional containers:				
40-lb. tray-pack.....	3.9	13.0		16.9
40-lb. loose-pack.....	3.9	10.7		14.6
Pallet box.....	3.9	8.2		12.1
Source.....		7.7	5.5	13.2
Oranges, dozen:				
Store:				
Machine packaged.....	3.7	9.0		12.7
Manually packaged.....	5.6	9.0		14.6
Warehouse:				
Conventional container (1½ bu. box).....	3.9	8.4		12.3
Pallet box.....	3.9	7.9		11.8
Bulk load.....	3.9	6.6		10.5
Source.....		6.8	7.1	13.9
Grapefruit, 8 each or 6½ lb.:				
Store:				
Machine packaged.....	5.0	17.1		22.1
Manually packaged.....	6.1	17.1		23.2
Warehouse:				
Conventional container.....	5.2	16.0		21.2
Pallet box.....	5.2	15.0		20.2
Source.....		12.8	8.6	21.4
Weighted average cost per package:				
Store:				
Machine packaged.....	4.2	7.3		12.5
Manually packaged.....	5.8	7.3		14.2
Warehouse:				
Lowest cost method.....	4.2	5.6		11.4
Source <sup>4</sup> .....		5.5	7.2	14.2

<sup>1</sup> For details, see table 67.<sup>2</sup> For additional information, see tables, 56, 58, 59, and 60.<sup>3</sup> The 50-pound onion bag costs 15 cents closed and has a salvage value of

3 cents; freight is assumed to be \$1.55 per cwt.

 $(10 + 77.5 + 3) \div 10 = 5.7$  cents<sup>4</sup> Excludes onions.



