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Methods, Equipment, and Facilities for Receiving, Ripening, and Packing BANANAS

AGRICULTURAL MARKETING SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

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PREFACE

The study on which this report is based is part of a larger research project on the physical handling of various types of packages of perishable produce at various stages in the marketing system. This study was conducted under the supervision of William H. Elliott and Joseph F. Herrick, Jr., head and agricultural economist, respectively, of the Handling and Facilities Research Section, Transportation and Facilities Branch, Marketing Research Division, Agricultural Marketing Service.

The authors gratefully acknowledge the cooperation and assistance of R. E. Hardenburg, assistant horticulturist, and R. C. Wright, senior physiologist, Biological Sciences Branch, Marketing Research Division, Agricultural Marketing Service, in preparing the chapter on *Effect of Handling on Damage and Shrinkage of Bananas*.

The assistance of many individuals and organizations in the fresh fruit and vegetable distributive industry also is acknowledged. The authors wish especially to thank the following companies for making their facilities available for detailed studies of banana-handling operations:

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Other reports on the handling of perishable food products issued by the U. S. Department of Agriculture include:

How Fresh Fruit and Vegetable Distributors Can Get More Out of Their Materials-Handling Equipment, June 1950.

Use of Recording and Transcribing Equipment in Loading Delivery Trucks of Produce Wholesalers, May 1951, Agriculture Information Bulletin No. 43.

An Analysis of Some Methods of Loading Out Delivery Trucks of Produce Wholesalers, May 1952, Marketing Research Report No. 15.

Apple Handling Methods and Equipment in Pacific Northwest Packing and Storage Houses, June 1953, Marketing Research Report No. 49.

Handling Empty Apple Boxes in Pacific Northwest Packing and Storage Houses, June 1954, Marketing Research Report No. 71.

Innovations in Apple Handling Methods and Equipment, January 1955, Marketing Research Report No. 68.

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The study on which the report is based was conducted under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

CONTENTS

SUMMARY

Seven principal methods involving different combinations of equipment are used by wholesale distributors for receiving bananas from railroad cars or motortrucks to ripening rooms, and for moving the ripe fruit to the cutting and packing area: (1) Manual, (2) 2-wheel bunch truck and hydraulic bunch lift truck, (3) 4-wheel banana truck, (4) continuous powered monorail conveyor, (5) manual monorail conveyor, (6) manual monorail *ripen-on-carrier* conveyor, and (7) forklift truck. Cutting and packing operations, which require about twice as much labor as receiving operations, involve bringing up bunches to the work area, cutting, packing, and storing packed boxes. Proper crew size and job assignments become particularly important to maintain minimum labor requirements.

Use of the 4-wheel banana truck (capacity varies from 8 to 13 bunches) incurs the lowest labor and equipment costs for receiving, ripening, and packing fruit at all volumes up to 500 cars annually. At 300 cars annually these costs are $29.62 per carload equivalent. The manual monorail *ripen-on-carrier* conveyor is the highest-cost method at $45.27 per carload equivalent when 300 cars are handled annually.

For an annual volume of 300 carloads, combined labor and equipment costs for 1 car equivalent of bananas through the receiving, ripening, and packing operations are:

Type of equipment and method	Cost per car Dollars
4-wheel banana bunch truck method	29.62
Continuous powered conveyor method	32.07
2-wheel bunch truck method and hydraulic bunch lift truck	33.11
Manual monorail method	34.16
Manual method	36.02
Forklift truck method	38.30
Manual monorail *ripen-on-carrier* method	45.27

The number of cars handled annually has little effect on labor and equipment costs for the various methods. The best methods for a 100-car annual volume are also best for 500 cars.

Methods requiring high-cost equipment must be justified through decreased labor costs and savings in damaged fruit. Labor savings are not sufficient, up to the maximum volume studied, to lower total receiving and packing costs per car below that of the 4-wheel bunch truck method.

An exact cost figure covering fruit damaged by each method could not be determined. During handling, fruit is damaged in several ways, but causes cannot always be determined. Also, the amount of shrinkage is affected by seasons, variety of fruit, and degree of ripeness of fruit handled. Although the exact amount could not be determined, it was found that damage to fruit resulting from handling in the warehouse is a relatively small percentage of the total shrinkage. This would be a small part of the total cost of handling a car of bananas through the warehouse.

Fruit damage caused by manual handling of bunches is virtually eliminated with two of the methods studied. One of these is the manual monorail *ripen-on-carrier* conveyor system.

However, the high equipment costs of this system would more than offset the savings from reduction of fruit damage. The other method employs 2-wheel bunch trucks with a hydraulic bunch lift truck and has a relatively low labor and equipment cost. The latter method eliminates all manual handling of bunches, and if savings in damaged fruit are considered, it may prove the most economical of all methods studied.

Green fruit can withstand all normal handling pressures, but is easily damaged by abrasive action. At the cutting stage of ripeness, fruit is subject to damage from slight pressures as well as abrasion. Such damage can be minimized by (1) employing equipment that eliminates manual handling of bunches, (2) performing the cutting operation at the earliest practical stage of ripeness, and (3) encouraging workers to use extra care in handling fruit.

The location and layout of the banana receiving, ripening, and packing facility should (1) be separate from other warehouse operations, (2) provide for short transportation distances, (3) allow ample room for ripening, cutting, packing, and storing bananas and supplies, and (4) permit easy future expansion.

METHODS, EQUIPMENT, AND FACILITIES FOR RECEIVING, RIPENING, AND PACKING BANANAS

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BACKGROUND AND BASIS OF THE STUDY

Bananas are one of the few perishable products handled without packaging between the point of production and the wholesale outlet. Bunches are handled in bulk and require individual attention through every handling step from the plantation to the warehouses of wholesale distributors. Fruit is unripened when received by the wholesaler and is less susceptible than ripe fruit to deterioration or serious bruising from handling. When market-ripe, the fruit becomes a highly perishable commodity requiring prompt distribution to retail stores.

In recent years, distributors have become increasingly interested in improved methods for receiving, ripening, and packing bananas for retail trade. Because the business is highly competitive, wholesale dealers must maintain quality and price relationships to meet competition. Excessive waste due to deterioration, shrinkage, and overripe fruit caused by inadequate handling methods may mean the difference between profit or loss.

Handling operations such as receiving, ripening, cutting, and packing require varying amounts of labor and different combinations of materials-handling equipment. Labor-saving devices and efficient handling methods should lower the distribution costs. This study therefore was undertaken to (1) measure the relative efficiency of various work methods, including types or combinations of types of materials-handling equipment, for performing the handling operations; (2) determine the kinds and amounts of equipment needed by dealers for efficient handling of differing volumes of business; (3) appraise comparative labor and equipment costs of handling varying volumes of fruit through facilities of different sizes and designs with different methods and types of equipment; and (4) develop improved facility layouts and designs for the use of different handling methods and equipment.

Research Methods and Techniques

Research was conducted in wholesale banana houses to cover all basic types of materials-handling equipment currently used and all significant variables that affect the use of the equipment. Such variables include: (1) The layout and design of the facility, (2) size and weight of bunches handled prior to cutting, (3) type and size of containers used for packing and handling fruit after cutting, (4) number of workers in the assigned crew, and (5) the flow or sequence of operations.

Preliminary observations and secondary data indicated that the principal methods and types of equipment used in banana-handling plants were: (1) Manual, (2) 2-wheel bunch truck and hydraulic bunch lift truck, (3) 4-wheel banana truck, (4) continuous powered monorail conveyor system, (5) manual monorail conveyor system, (6) manual monorail *ripen-on-carrier* conveyor system, and (7) forklift truck.

In selected plants using these methods and equipment types, time studies of fruit-handling operations were made to (1) determine the elapsed time required; (2) determine total man-hours of labor and total machine-hours of equipment use required; (3) determine where delays, wait time, and other nonproductive time occurred during performance of operations; and (4) provide a basis for developing improved methods for performing the operation. Elapsed times were determined to provide a basis for computing total labor and equipment requirements and a basis for comparing the relative efficiency of methods for performing the same operation.

From these time study data, labor and equipment costs for performing various fruit-handling operations by use of specified methods and types of equipment have been computed. These cost comparisons show the relative efficiency of different methods and types of equipment under variable conditions. Labor costs shown in these computations are based on the productive labor required to perform the operation plus the amount of idle time inherent in the method. Equipment costs have been computed on an annual per car basis and allocated to the separate operations according to the elapsed time in machine-hours of use.

Management and facility costs have not been included. Therefore these data do not reflect total costs to the plant. Although these cost data should not be used for budgetary purposes, in plants that allocate labor and equipment costs to various operations, they may serve as desirable goals to be attained in achieving cost reductions.

Assumed Wage Rates Used in Computing Labor Costs

A wage rate of $1.25 per hour is assumed as the average rate for unskilled labor employed for banana-handling operations and is used for computing labor costs. As forklift truck operators must have a greater degree of skill than some other workers, a wage rate of $1.50 per hour is used for computing costs for this type of semiskilled labor. Supervisory personnel are not included in the computations that follow.

Costs of Materials-Handling Equipment

Data on equipment costs were obtained from equipment dealers, equipment manufacturers, and cooperating wholesalers. These costs are grouped into 2 major categories: (1) Ownership and (2) operational. (See tables 50, 51, and 52 in the Appendix.)

Ownership costs include depreciation, taxes, interest, and insurance, all considered to be fixed and are computed on an annual basis. Interest on the average investment is fixed at 5 percent, and 4 percent is allowed for insurance and taxes.

Operational costs include maintenance, repairs, inspection and servicing, fuel oil, and electricity.

Cost Comparisons for Fruit-Handling Operations

Total labor and equipment costs for performing identifiable operations or groups of operations by different types or combinations of types of equipment have been computed on a per car basis. Equipment costs are based on annual hours of use required for handling a volume of 300 carload equivalents. Where equipment is used only for a single cycle of operations, the total per car cost of the equipment is charged to groups of operations rather than to all cycles involved in moving a carload of fruit into and in the plant. For example, the 2-wheel bunch truck is used only for receiving bananas, and the entire cost per car of the equipment is charged to receiving operations. However, the 4-wheel banana truck is used for both receiving operations and for moving fruit from ripening rooms to the cutting table. Therefore the per car cost of the equipment is divided between these two operations on the basis of hours of use.

Labor costs for each operation consist of the total productive labor (with fatigue and personal time allowances) plus the wait time multiplied by an assumed wage rate.

Obviously, these costs do not include the value of fruit quality losses from rough or excessive handling or storage life losses from improper storage conditions. Since these losses are difficult to evaluate in economic terms, cost comparisons have been limited to direct labor and equipment costs.

Principal Types of Equipment Used for Handling Bananas

As specific types of equipment usually are known in the trade by several different names, each type discussed in this report is defined.

Equipment Used for Receiving Bananas

Because bananas are received in bunches, equipment used in these operations is usually designed to transport bunches in a hanging position.

One of the more widely used types of 2-wheel 2-bunch capacity hand trucks (fig. 1) is equipped with pivoted arms which can be operated separately. Each arm ends in a special attachment for carrying bunches suspended by strings. The truck is loaded in the railroad car by lowering the pivoted arms, tilting the truck, and looping the strings over the head attachment. As the truck is raised for traveling, the bunches are lifted from the car bed and suspended from the truck pivot arms. In transit, the bunches rest against the canvas sling drawn across the space between the frame uprights. In hanging bunches in the ripening room, the pivot arms are used to transfer bunches to the ropes.

Another type of 2-bunch capacity 2-wheel banana truck is illustrated in figure 2. The truck frame is made of tubular metal over which canvas is drawn, and has no pivot arms or a nose plate. Therefore, the bunches are manually hung by ropes to projections at the top of the frame. When the truck is tipped for transporting, the bunches are lifted and cradled in the canvas sling. In the ripening room the bunches are manually transferred from the truck to the ceiling hooks or ropes.

The 3-bunch capacity 2-wheel hand truck shown in figure 3 is essentially a stevedore-type 2-wheel hand truck with the regular chisel-type nose replaced with a large padded

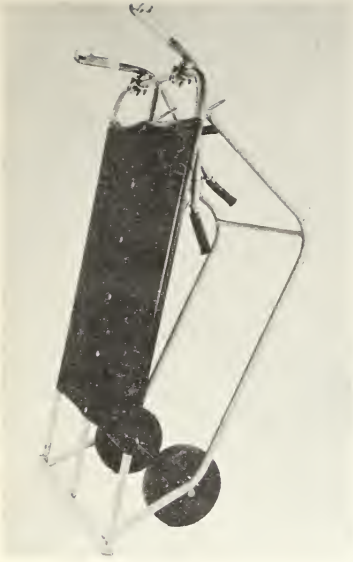


Figure 1.--Two-wheel bunch truck (2-bunch capacity).

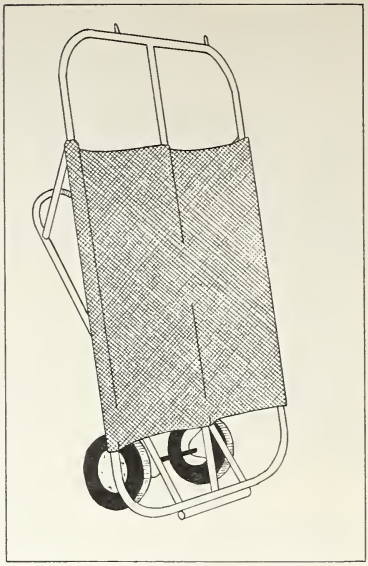


Figure 2.--Another type 2-wheel bunch truck.

flat nose. A canvas or burlap sling is drawn across the space between the frame uprights. Three bunches rest side by side on the sling with the stem ends supported by the padded flat nose rather than by the string around the stem. Although the truck is often made of tubular steel, this type of truck can be made from any regular warehouse-type 2-wheel hand truck.

The hydraulic bunch lift truck is used in ripening rooms to receive bunches of bananas from 2-wheel bunch trucks and hang them on high hooks. It is also used to unhook both high and low hanging bunches and transfer them to transporting equipment. The hydraulic bunch lift truck shown in figure 4 is maneuvered manually. The lift attachment is hydraulically operated by power from an enclosed storage battery. A protruding arm attached to the lift extends about 12 inches forward, and ends in a special clamping device. When a bunch string is inserted between the jaws of the clamp, the lift unit is activated and the weight of the bunch causes the grab head to hold the string firmly. The bunch can then be raised or lowered and is released by looping the string over a hook and lowering the head at the same time the truck is pulled back so that the grab head releases the string.

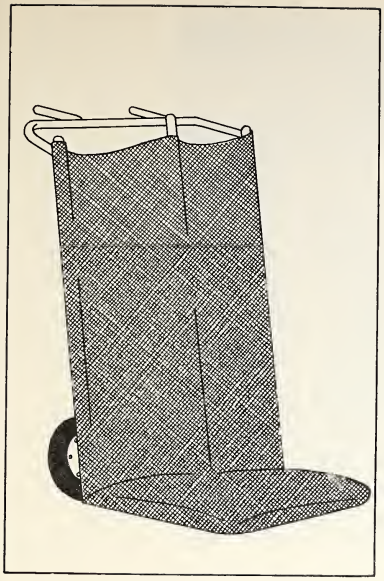


Figure 3.--Two-wheel bunch truck (3-bunch capacity).

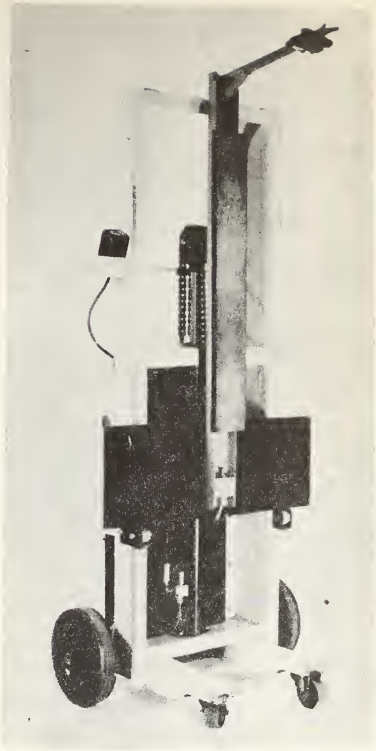


Figure 4.--Hydraulic bunch lift truck.

The 4-wheel banana truck is basically a 4-wheel platform hand truck equipped with a superstructure made of tubular metal to which are attached hooks or ropes on which bunches of bananas are hung. Two of the 4 wheels are swivel casters which permit easy maneuvering of the truck. Although there are several variations of this truck, one of the more widely used types is shown in figure 5. One variation, entirely of angle iron, has no platform. Another type has a removable tubular metal superstructure so that by substitution of a handle the truck can be used as a regular 4-wheel platform hand truck. Four-wheel banana trucks are built with capacities of from 8 to 13 bunches. Some versions of this truck have 6 wheels, 2 high center wheels, and 2 swivel casters on each end.

Monorail conveyors of 3 types are used to transport bananas from the rail car or motortruck to the ripening room and from the ripening room to the cutting table. These conveyors are permanently installed and are hung from the ceiling on brackets.

The continuous powered monorail conveyor consists of an endless chain or cable suspended from an overhead track by a series of carriers to each of which a hook is

Figure 5.--Four-wheel banana truck.

attached (fig. 6). Bunches are hung from these hooks for conveyance from the refrigerator car or motortruck to the ripening room. The endless chain or cable is powered by an electric motor, which moves it at a constant speed. These conveyors extend only from the receiving dock to and beyond the front of the ripening rooms. Because the conveyor does not enter these rooms, bananas must be manually removed from the conveyor, carried into the ripening room, and hung. This type of conveyor can be used for moving bunches to basement or upper floor storage rooms.

The manual monorail conveyor system can be installed either as a closed or open circuit of overhead track. The closed circuit system extends from the receiving platform past the door of each ripening room. Loaded carriers are moved on one track and empty carriers returned on another track. Loops at terminal points close the circuit to permit the empty carriers to be transferred to the other track to avoid interference with the loaded carriers. In some installations a system of switches is used to move loaded carriers down the aisle in each ripening room and take empty carriers out of the room. With proper trackage and switches, this equipment can be used to bring ripe fruit to the cutting table. An open circuit system consists of a single track and all terminal points are dead end. With either the open or closed system, bunches are transported on 1-bunch carriers, usually in groups of from 2 to 10 carriers. Figure 7 shows this type of equipment in use in a ripening room.

Figure 6.--Bunches of bananas being removed from refrigerator car to ripening room by use of a continuous powered monorail conveyor.

The manual monorail *ripen-on-carrier* conveyor system consists of a closed main circuit track which extends from the receiving platform past the front of each ripening room. A series of 6 evenly spaced parallel tracks, which run the length of each ripening room, is connected to the main circuit by a series of switches. The carriers, which hold 6 bunches each, are supported on the track and are moved manually (fig. 8). A track loop connects the cutting area with the main track and permits ripe fruit to be brought from the ripening room to the cutting table and empty carriers to be returned. A lowerator (fig. 9) is installed on the receiving platform and another at the cutting station. The lowerator is a 4-foot length of track which can be mechanically raised or lowered. The ends of the track ride in channels, so that only vertical movement is possible.

Figure 7.--Worker removing a bunch of bananas from a 1-bunch carrier on a manual monorail conveyor prior to hanging it on ceiling hook.

The forklift truck is a cantilever-type truck designed to carry its load on two forks extended in front. For handling bananas a special rack is fitted to the front of the truck to replace the regular forks (fig. 10). Between the frames of the rack is a thick sheet of sponge rubber to protect the bunches. At the top of the rack two forks extend perpendicular to the mast of the truck. These forks hold the bunches, which are cradled in the sponge rubber apron.

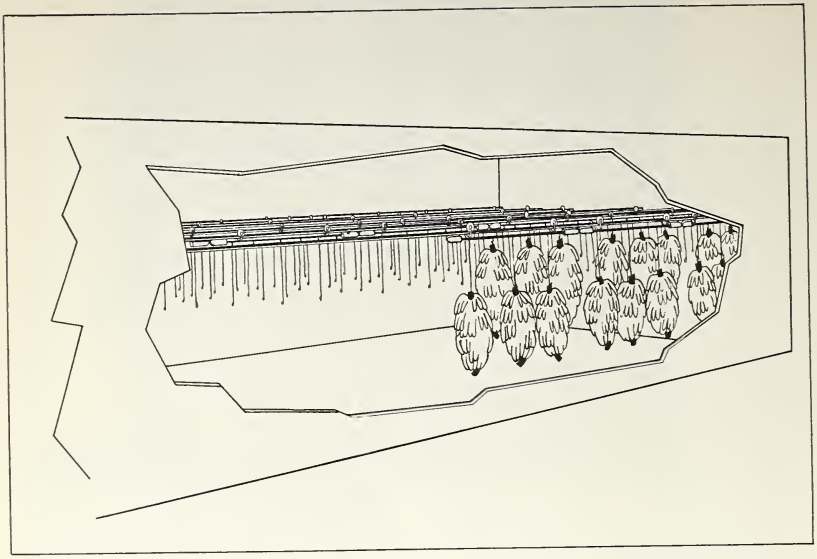


Figure 8.--Interior view of ripening room showing a portion of the manual monorail "ripen-on-carrier" conveyor system. Carriers loaded with 6 bunches each are shown in foreground; empty carriers in background are withdrawn a rail at a time and taken to the receiving station for loading.

The 6-bunch carrier is made of 4- by 4-inch lumber about 48 inches long to which are attached 3 hooks and 3 ropes. Six bunches of bananas are hung on the hooks and ropes and make up a unit load. To permit easier hanging of the bunches on the 6-bunch carriers a lowerator is installed on the receiving platform (fig. 11).

Equipment Used for Moving Packed Boxes of Bananas

Semilive skids and jack.--The semilive skid is a load-carrying platform with 2 rigid wheels at one end and 2 skid legs at the other (fig. 12). A jack or lever-type handle equipped with 2 wheels is mounted on a rigid axle, with a load-carrying device over the wheels for attachment to semilive skids. The jack is applied to the skid in a near-vertical position and lowered approximately 30° for lifting and transporting the load, which can be stored intact on the skid. Packed boxes of bananas are usually loaded on skids in 4 stacks of 4 boxes each or a total 16 boxes per load.

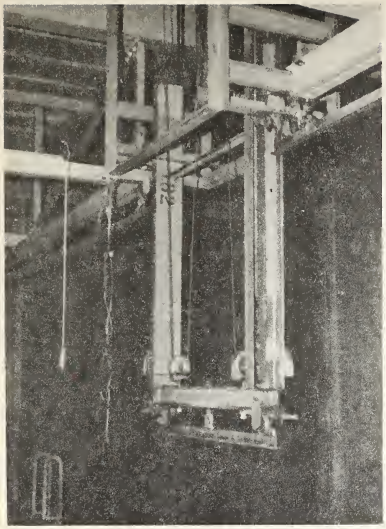


Figure 9.--Lowerator used with manual monorail "ripen-on-carrier" conveyor system in the lowered position. A lowerator is needed at each point where bananas are received and at each cutting station.

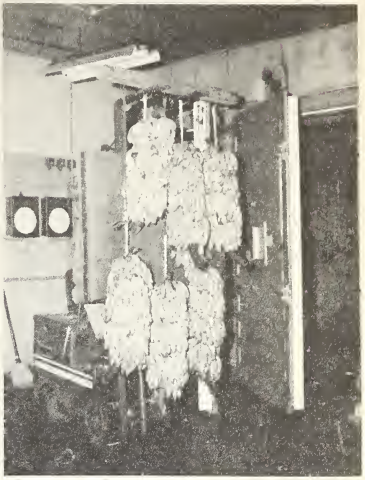


Figure 10.--A loaded 6-bunch banana carrier being moved by use of a forklift truck fitted with special attachment.

Two-wheel warehouse-type hand truck.--This is a lever-type hand vehicle (fig. 13). To load this truck its nose first is placed under the bottom box of the stack to be carried; then by pulling down on the handles the load is lifted off the floor. After the load is pushed to storage position it is deposited by tilting the truck and sliding the nose from under the stack of boxes. Five packed boxes of bananas usually make a hand truckload.

Pallet transporter.--A pallet transporter is a type of equipment capable of lifting, transporting, and positioning loaded pallets (fig. 14). The transporter may be either battery or hand powered. This equipment is not capable of tiering loads. A pallet load of packed boxes of bananas for handling by this equipment usually consists of 12 boxes.

Forklift truck.--This equipment is the same as that used to receive bunches, but without the special attachments. The forks are in a normal position so that the equipment is capable of picking up, transporting, and tiering pallet loads (fig. 15). Pallet loads handled this way usually consist of 12 packed boxes in three 4-high stacks.

Figure 11.--Lowerator used with forklift truck system to facilitate hanging of bunches of bananas on carriers.

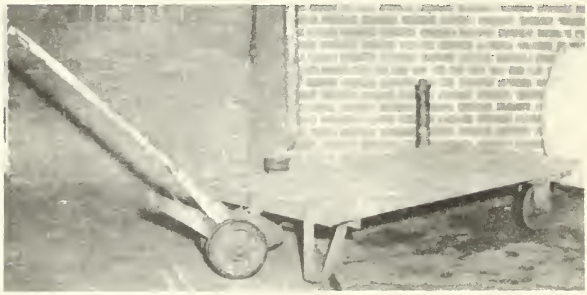


Figure 12.--Semilive skid and jack.

Figure 13.--Warehouse type 2-wheel hand truck.

Figure 14.--Battery powered pallet transporter.

Definition of Terms

The tables in the sections that follow show productive labor, wait time, and total labor to perform identifiable operations or groups of operations. They also show elapsed times and crew organization.

Productive labor or productive time is the amount of work time necessary to perform an operation or group of operations. It includes a base time which is adjusted or leveled for differences in rate of worker activity. It also includes fatigue and personal allowances to give it value. Productive labor is taken from the data shown in the Appendix.

Allowances include estimated time allowed for fatigue and for personal needs. To adjust for this factor a percentage allowance of the base time has been made for fatigue. Another allowance is made for personal needs. In this report a personal allowance of 5 percent of the base time has been made. For complete list of fatigue and personal allowances see page 116 of the Appendix.

Wait time in an operation or group of operations is the time that 1 worker or members of a crew spend in waiting on other workers.

The total labor inputs shown in the tables also include labor involved in setup and cleanup operations for a banana carload. Setup operations include assembling of the crew and equipment and preparing the work area for receiving or packing operations. Cleanup is the time required to store the equipment and clean the work area at end of receiving or packing operation.

Figure 15.--Forklift truck picking up 12 packed 40-pound boxes of bananas.

Elapsed time is the length of time in hours and fractions thereof from the beginning to the end of an operation or cycle of operations.

Carload equivalent is an average size refrigerator railroad carload of bunch bananas. For purposes of this study, it is assumed to be 250 bunches of bananas having a gross weight of 22,500 pounds of fruit including stems. A carload equivalent of packed fruit represents 18,000 pounds net weight of marketable fruit or 450 boxes of 40 pounds each.

A bunch of bananas is a stem of fruit as received by the wholesale dealer. The average bunch includes from 12 to 14 sections of bananas (or *hands*) and weighs from 79 to 90 pounds. To the small end of the stem a string is attached to facilitate handling and storage in the wholesale plant. In this study, it is assumed that strings are attached to all bunches prior to arrival at the wholesale plant.

A banana box is the nesting-type metal reinforced plywood container with stacking irons, built to an overall dimension of approximately 34½ by 15½ inches at the top, 34 by 14½ inches at the bottom, and 16 inches high. The weight of the empty box averages slightly less than 11 pounds. Jobbers usually pack these boxes with 40 pounds net weight of fruit.

A packed box is a banana box in which a cushion of shredded paper or a more durable blanket or pad has been placed and then filled with 40 pounds of cut fruit to be delivered to the retail store.

A rotary packing table is a motor-driven revolving circular platform fitted with canvas or rubber tiers which carry fruit from the cutter to the packers. It may be made with 1, 2, or 3 tiers or shelves, as desired. Fruit can be sorted into 2 grades with this type of table. Self-taring banana packing scales are most often used in conjunction with the rotary packing table.

A stationary packing table is a flat top banana packing table about 2½ feet above the floor usually equipped with a metal top. These tables vary in size.

METHODS AND EQUIPMENT FOR RECEIVING BANANAS INTO RIPENING ROOMS

Receiving operations include: (1) Unloading bananas from the refrigerator car or truck, (2) transporting fruit to the ripening room, and (3) hanging it. These operations must be promptly performed to preserve the quality and maintain the ripening schedule of bananas.

Most plants receive shipments at least twice each week--the first in the early part of the week and the second 3 or 4 days later. Crews usually are assigned from other work to perform receiving operations. In most plants these crews are made up of the workers regularly assigned to cutting and packing bananas. These workers leave the packing line long enough to unload the fruit and place it in ripening rooms and return to their regular work after the car is unloaded.

An important factor in the selection of equipment and in the cost of receiving bananas is the annual volume handled, particularly when consideration is given to some of the newer types of equipment which require relatively large capital investments. The comparisons of various methods in this section include equipment costs based on an annual volume of 300 carloads, or about 6 cars weekly.

Bananas are transported from boats to wholesale distributors either by tractor-trailer trucks or by refrigerator railroad cars which usually are loaded with 250 or more bunches standing in one tier on the car floor or truck bed. Trailers sometimes are loaded by laying all bunches lengthwise of the bed. For purposes of this report it is assumed that all bananas are received by wholesalers with ropes attached.

In performing receiving operations a number of variations in the *break points* of specific operations, depending on the type or combinations of types of equipment used, may occur. For instance, by the 4-wheel banana truck method, as soon as space is available the truck is maneuvered directly into the car or trailer to pick up the load. When the forklift truck method is used, bunches of bananas are manually carried to the dock outside the car and hung on the carrier to be transported by the forklift truck. Certain operations are repeated to complete the receiving cycle.

As used in this report, the operation *pick up load* consists of raising the bunches of fruit from the floor of the car or motortruck and placing them on the handling equipment. This equipment is either brought into the car or truck or stopped on the dock just outside the threshold of the carrier. In the forklift truck method, this operation also includes

positioning the forks, lifting the unit load, moving back a short distance, and turning in the direction of travel. Pickup time starts when the worker begins positioning the handling equipment to pick up the load and ends when the loaded equipment starts in the direction of travel.

The operation *transport* begins when the worker with the loaded handling equipment first moves in the direction of travel and ends when the worker reaches the hanging point in the ripening room. It does not include maneuvering for the purpose of hanging bunches. In those methods in which the materials-handling equipment enters the car the transportation operation begins when the loaded equipment crosses the bridgeplate and is in direct transportation on leaving the car. In those methods in which the handling equipment is loaded on the dock at or near the car door, the transportation operation begins within a 5-foot area of the car door.

Return empty with the transportation equipment is combined with *transport loaded* in this report and the combination is shown as *transportation labor*. *Return empty* begins when the worker completes his maneuver, turns, and starts in the direction of the carrier for the next load. It ends when the worker crosses the bridgeplate of the car or motortruck or when he begins to position the equipment on the dock to pick up the next load. Transportation distances from the carrier to the ripening room have been standardized at 100 feet.

The operation *hang* or *store* consists either of removing the fruit from the equipment and hanging it on the hooks or ropes in the ripening room or of positioning and releasing the loaded carriers in storage. When performed by the worker who transports the fruit, the hang operation begins when the worker reaches the storage area and starts to maneuver the load for hanging or for release in the storage position. When other workers hang bunches by transferring them to the hooks or ropes in the ripening room, the operation begins when these workers start their move in the direction of the loaded equipment. In all methods the operation ends when the workers have completed the turn (after releasing the load in storage) or start to move empty in the direction of the refrigerator car or motortruck.

The principal methods used to receive bananas are: (1) Manual, (2) 2-wheel bunch truck and hydraulic bunch lift truck, (3) 4-wheel banana truck, (4) continuous powered monorail conveyor, (5) manual monorail conveyor, (6) manual monorail *ripen-on-carrier* conveyor, and (7) forklift truck. Other methods and equipment used to a limited extent include belt or roller conveyors, 4-wheel hand platform trucks, and the 2-wheel stevedore-type hand trucks with A-frame attachments. These are discussed briefly as optional equipment in connection with the other equipment types.

Manual Method

The manual method of receiving bananas, used principally by smaller dealers, requires no capital investment for equipment (fig. 16). Most other methods evaluated involve manual pickup and hanging or storage as bunches must be handled individually by workers in unloading the car and in hanging the bunches in the ripening room. At distances under 40 or 50 feet from the carrier to the ripening room the manual method of receiving incurs relatively low labor and equipment costs.

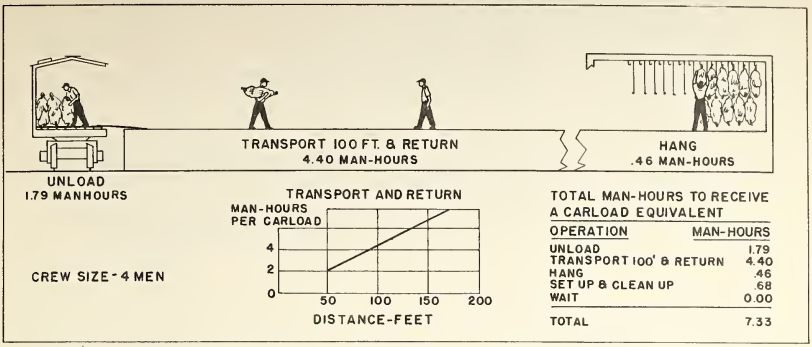


Figure 16.--Unloading bananas from a refrigerator railroad car and hanging them in the ripening room by manual method. Each worker picks up a bunch in the car, transports it to the room and hangs it in the ripening room without assistance and returns for another bunch.

Disadvantages of the manual method are that workers dislike the heavy manual labor involved in handling individual bunches of bananas weighing from 75 to 100 pounds; and for distances over 40 or 50 feet labor requirements are so increased that the method is comparatively costly. In addition, rough manual handling causes excessive damage and shrinkage.

Two manual methods of receiving bananas are: (1) Handling of single bunches throughout the entire cycle of operations--pickup, transport, and hang--by each worker without assistance from the other workers; and (2) performance of all operations by transporters with the assistance of other crew members in picking up and hanging the bunches.

Manual Method Without Assistance of Loader or Unloader

By this method each crew member performs his work independent of other members. Little wait time is involved regardless of difference in crew size, but the latter does affect elapsed time required. Each worker enters the carrier, lifts a bunch of bananas to his shoulder, transports it to the hanging point in the ripening room, loops the string over the hook or rope, releases the bunch, and returns empty to repeat the cycle.

As shown in table 1, labor requirements for receiving a 250-bunch carload equivalent by this method, when a 4-man crew is used, is 7.33 man-hours. This includes productive labor for each man to pick up the bunches, transport them 100 feet, hang them in the ripening room and return empty for another trip. It also includes necessary setup and cleanup time. Of the total labor, 66 percent is spent in transporting the fruit and 34 percent to pick up and hang. The hanging operation requires only one-fourth as much labor as the pickup operation.

Table 1.--Labor required for a 4-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by the manual method 1/

Time item	Labor required
	Man-hours
Productive labor:	
Set up	0.40
Pick up bunches and carry to threshold of car	1.79
Transport 100 feet to ripening room	4.40
Hang bunches in ripening room	.46
Clean up	.28
Total productive labor	7.33
Unproductive labor:	
None	.00
Total labor	7.33
Elapsed hours	1.83

1/ Crew organization: Four men set up, then 4 men individually pick up bunches, carry to threshold of car, transport 100 feet to ripening room, and hang bunches in ripening room. On completion 4 men clean up.

Since elapsed time required per car is 1.83 hours, about 4 cars of 250 bunches each could be received by a 4-man crew during an 8-hour day.

In this method the fatigue factor is high because each worker performs all operations without assistance and there is little wait time for energy rebuilding. Moreover, the fruit may receive rough handling as fatigue increases, especially when individual bunches weigh 100 pounds or more and when the hooks in the ripening room are over 7 feet high. One important advantage of this method is that the crew size can be increased without any substantial increase in total labor requirements. For instance, 6 workers can unload a car in a shorter elapsed time, but setup and cleanup time would be increased 0.34 man-hour. Therefore, workers can be added or removed from the crew during the unloading operation with but little change in total labor requirements.

Manual Method with Assistance of Loader and Unloader

Although various crew sizes were observed, for comparative purposes a 6-man crew is used, which includes 4 transporters, 1 loader to assist in picking up bunches, and 1 unloader to assist in hanging bunches. Total labor requirements per carload for this method are summarized in table 2. Though the elapsed time for unloading the car is the

same as in the previous method--1.83 hours--labor requirements are 50 percent greater. Of the total labor, 21.6 percent, or 2.37 man-hours, is wait time. Although this method involves less fatigue, the increased labor makes it more costly than the method previously described. In addition, the crew arrangement must remain constant throughout the operation to minimize wait time and labor costs.

Table 2.--Labor required for a 6-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by the manual method when 1 worker assists in picking up and 1 worker assists in hanging 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
Pick up bunches in car:		
1 worker to assist transporters pick up in car	0.89	
4 transporters pick up and carry to threshold of car	1.83	
Total pickup		2.72
Transport 100 feet to ripening room		4.40
Hang bunches in ripening room:		
1 worker to assist transporters hang bunches	.40	
4 transporters hang bunches	.40	
Total hang		.80
Clean up		.28
Total productive labor		8.60
Unproductive labor:		
2 men wait while 4 men set up		.20
Pickup worker in car waits on transporters		.77
Hangman in room waits on transporters		1.26
2 men wait while 4 men clean up		.14
Total unproductive labor		2.37
Total labor		10.97
Elapsed hours		1.83

1/ Crew organization: Four men set up while 2 men wait, then 1 man in car assists transporters in loading, 4 men transport 100 feet to ripening room, 1 man in ripening room assists transporters in hanging bunches. On completion 4 men clean up while 2 men wait.

Comparison of Two Manual Methods

As shown in table 3, at a wage rate of $1.25 per hour the cost of unloading a carload equivalent of bananas with a 4-man crew performing independently is $9.16. No equipment costs are involved. When 2 additional workers are added to the crew to assist in pickup and hanging operations, the labor required increases to 10.97 man-hours at a cost of $13.71. With no equipment involved, the total cost by this method with a 6-man crew is about 50 percent greater than by the 4-man crew.

Table 3.--Comparative labor and equipment costs to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of 2 variations of the manual method

Method	Crew size	Elapsed time	Labor and equipment required		Labor and equipment costs		
			Labor	Equipment	Labor	Equipment	Total
	Number	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
Workers pick up, transport 100 feet, and hang bunches without assistance	4	1.83	7.33	0	9.16	0	9.16
One worker in car assists in lifting bunches to shoulder of transporter, 4 workers transport bunches 100 feet, and 1 worker in ripening room assists in hanging bunches	6	1.83	10.97	0	13.71	0	13.71

2-Wheel Bunch Truck and Hydraulic Bunch Lift Truck

The use of 2-wheel bunch trucks and a hydraulic bunch lift truck for receiving bananas is a recent innovation (fig. 17). In this method, workers transport bunches from the carrier to the ripening room by 2-wheel bunch trucks designed so that bunches hang upright.

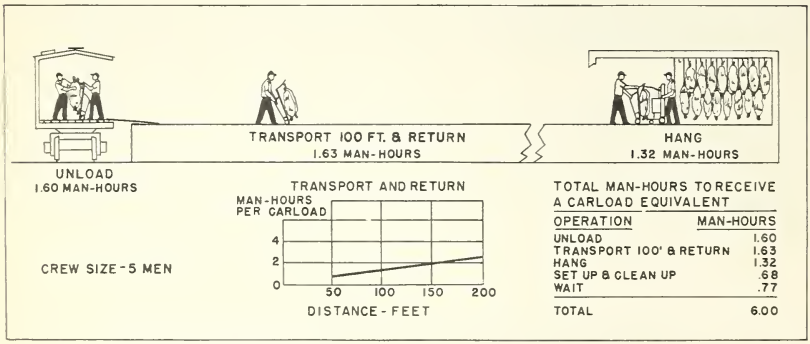


Figure 17.--Unloading bunches of bananas and hanging them in ripening rooms by use of 2-wheel bunch trucks and hydraulic bunch lift truck.

In the ripening room 1 of the 2 bunches is transferred from the 2-wheel bunch truck to the hydraulic bunch lift truck for hanging from a ceiling hook in a high position (fig. 18). The hand trucker hangs the other bunch on a rope in a low position.

The crew includes 1 worker in the car to assist in the pickup operation, 1 worker in the ripening room to hang bunches in the high positions by the hydraulic bunch lift truck, and 3 hand truckers. As the 2-wheel bunch trucks carry 2 bunches at a time, total labor requirements are affected by transportation distances.

Based on a transportation distance of 100 feet, the total labor required to receive a carload equivalent by a 5-man crew is 6 man-hours (table 4). Twenty-seven percent of the total labor is used for transportation, 27 percent for loading bunches on the bunch trucks and maneuvering to the threshold of the car, 22 percent for hanging bunches in the ripening room, 11 percent for setup and cleanup, and 13 percent for wait time. Wait time is 0.77 man-hour. The worker in the car and the hydraulic lift operator in the ripening room account for 0.60 man-hour of wait time. At shorter distances crew interference would necessitate a reduction in the number of hand truckers to have a balanced crew.

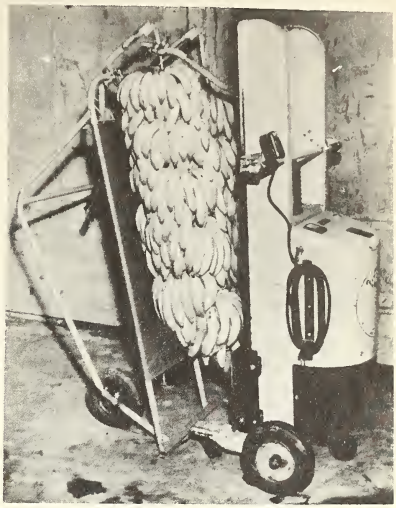


Figure 18.--Hydraulic bunch lift truck in position to remove 1 bunch from 2-wheel bunch truck for hanging from a ceiling hook in the ripening room.

This method requires 1.20 hours of elapsed time to receive a carload equivalent of bananas. At this rate, about 6½ carloads could be received during an 8-hour day.

Although this use of equipment reduces worker fatigue below that in the manual method, the labor is not fully utilized. With the 2-wheel bunch trucks unadaptable to other handling operations, some other type of equipment must be used to move bananas in subsequent operations.

As shown in table 5, labor and equipment costs for receiving bananas by 2-wheel bunch trucks and hydraulic bunch lift truck with a 5-man crew is $7.99 per carload equivalent. Of this amount, $7.50 is for labor and $0.49 is for equipment.

4-Wheel Banana Truck

This truck is a 4-wheel platform vehicle equipped with a superstructure capable of transporting 8 to 13 bunches of bananas. The height of the superstructure is designed to allow for variations in bunch lengths.

Table 4.--Labor required for a 5-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of 2-wheel bunch trucks and hydraulic bunch lift truck 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
Pick up and load bunches on 2-wheel bunch truck and move to threshold of car:		
1 worker in car assists pickup	0.69	
3 transporters load trucks and move to car door	.91	
Total pickup		1.60
Transport 100 feet to ripening room and return		1.63
Remove load from 2-wheel bunch truck and hang in ripening room:		
1 hydraulic bunch lift truck operator hangs high bunches	.77	
3 transporters hang low bunches	.55	
Total hang		1.32
Clean up		.28
Total productive labor		5.23
Unproductive labor:		
1 man waits while 4 men set up		.10
Worker in car waits on transporters		.34
Hydraulic bunch lift truck operator waits on transporters		.26
1 man waits while 4 men clean up		.07
Total unproductive labor		.77
Total labor		6.00
Elapsed hours		1.20

1/ Crew organization: Four men set up and 1 man waits, then 1 man in car assists transporters load trucks, 3 men transport and hang low bunches, and 1 man in room hangs high bunches with hydraulic bunch lift truck. On completion 4 men clean up and 1 man waits.

Table 5.--Labor and equipment costs for a 5-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of 2-wheel bunch trucks and hydraulic bunch lift truck

Method	Crew size	Elapsed time	Labor and equipment required		Labor and equipment costs		
			Labor	Equipment	Labor	Equipment	Total
	Number	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
Receiving with 5-man crew (3 transporters) using 2-wheel bunch trucks and hydraulic bunch lift truck	5	1.20	6.00	4.80	7.50	1/ 0.49	7.99

1/ Includes total cost of three 2-wheel bunch trucks $0.40, and hydraulic bunch lift truck used 1.20 machine-hours $0.09, total cost $0.49.

In plants where fruit is received over a platform, the 4-wheel banana truck is pushed into the refrigerator car or motortruck from the platform and loaded with bunches by workers who manually lift the bunches from car bed level to the hook on the truck superstructure (fig. 19). The loaded truck is then maneuvered out of the carrier to the receiving platform, and another worker transports it to the ripening room. In the ripening room other workers manually lift the bunches from the superstructure of the truck and hang them individually from the ceiling on a rope or hook. For a balanced operation, at least three 4-wheel banana trucks should be used in order to minimize wait time between the unloading, transporting, and hanging operation.

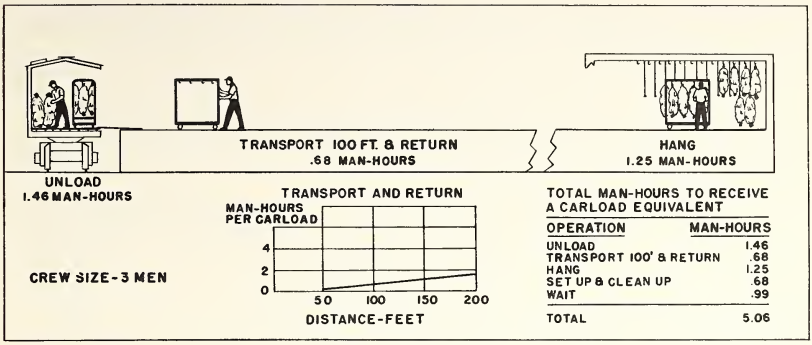


Figure 19.--Unloading bananas from a refrigerator railroad car and hanging them in the ripening room by use of 4-wheel banana trucks.

Either 1 or 2 workers are stationed in the carrier to pick up the bunches, load the 4-wheel banana truck, and maneuver the loaded equipment to the receiving platform. One worker transports loaded trucks from the receiving platform to the ripening room and returns empty trucks to the receiving platform. In the ripening room either 1 or 2 workers remove the bunches from the equipment and hang them on the hooks and ropes. The principal variation in the use of 4-wheel banana trucks for receiving bananas is in the crew size and assignment. Analyses of methods are based on a standard transportation distance of 100 feet from a pickup point, 5 feet around the threshold of the car door to the center of the ripening room.

This equipment also can be used efficiently to unload bananas from cars on team tracks to motortrucks when direct rail facilities to the plant are not available. 1/

1/ *How Fresh Fruit and Vegetable Distributors Can Get More Out of Their Materials-Handling Equipment*, U. S. Dept. of Agr., Marketing and Facilities Research Branch, June 1950, pp. 77-82.

3-Man Crew

With a 3-man crew, 1 worker loads the 4-wheel truck in the carrier, 1 worker transports the equipment, and 1 worker removes the bunches from the equipment and hangs them in the ripening room. Receiving by this method requires 5.06 man-hours of labor per carload, of which 0.99 man-hour or 20 percent is nonproductive (table 6). The labor is about equally divided among the operations of loading bunches on the equipment, transporting, and removing the bunches and hanging on hooks or ropes in the ripening room. However, about 50 percent of the transporter's time and 14 percent of the hanger's time is nonproductive.

By this method, a crew of 3 workers can receive a carload of 250 bunches of bananas in an elapsed time of 1.69 hours, or about 5 cars at one receiving platform during an 8-hour day.

Table 6.--Labor required for a 3-man crew to unload, transport, and hang a 250-bunch carload equivalent of bananas in a ripening room by use of 4-wheel banana trucks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
Load 8 bunches on 4-wheel banana trucks and push outside car		1.46
Transport:		
Pick up loaded truck after release of empty	0.05	
Move 100 feet to ripening room	.59	
Release loaded and pick up adjacent empty truck	.04	
Total transport		.68
Remove bunches from 4-wheel banana truck and hang in ripening room		1.25
Clean up		.28
Total productive labor		4.07
Unproductive labor:		
Transporter waits on load man		.78
Hangman in room waits on transporter		.21
Total unproductive labor		.99
Total labor		5.06
Elapsed hours		1.69

1/ Crew organization: Three men set up, then 1 man loads 4-wheel banana trucks, 1 man transports, and 1 man hangs bunches in ripening room. On completion 3 men clean up.

5-Man Crew

Another method of receiving bananas by 4-wheel banana trucks employs a 5-man crew. Two workers in the car or motortruck load the equipment and maneuver it to the receiving platform, 1 worker transports loaded banana trucks to the ripening room and returns with empty trucks, and 2 workers in the ripening room remove bunches from the trucks and hang them.

As shown in table 7, total labor requirements by this method are 5.73 man-hours per carload equivalent, or 11 percent more than when a 3-man crew is used. This is true even though the crew is somewhat better balanced and wait time is reduced to 0.66 man-hour.

The elapsed time required is 1.15 hours per carload equivalent. Therefore, approximately 7 cars of 250 bunches of bananas each can be received in an 8-hour day.

Table 7.--Labor required for a 5-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of 4-wheel banana trucks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
Load 8 bunches on 4-wheel banana truck and push outside car		1.95
Transport:		
Pick up loaded truck after release of empty	0.05	
Move 100 feet to ripening room	.59	
Release loaded and pick up adjacent empty truck	.04	
Total transport		.68
Remove bunches from 4-wheel banana truck and hang in ripening room		1.76
Clean up		.28
Total productive labor		5.07
Unproductive labor:		
1 man waits while 4 men set up		.10
Transporter waits on men in car		.30
Hangers in room wait on transporter		.19
1 man waits while 4 men clean up		.07
Total unproductive labor		.66
Total labor		5.73
Elapsed hours		1.15

1/ Crew organization: Four men set up while 1 man waits, then 2 men load 8 bunches on 4-wheel trucks and push outside car, 1 man transports and 2 men in ripening room hang bunches. On completion 4 men clean up and 1 man waits.

Comparison of 3-Man Crew and 5-Man Crew

Total labor and equipment costs for receiving a carload equivalent of bananas is $6.40 when a 3-man crew is used and $7.22 when a 5-man crew is used (table 8). The least costly method uses the smaller crew but the elapsed time for doing the job is one-half hour greater, changing the equipment cost per car very little.

Table 8.--Comparative labor and equipment costs to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of 4-wheel banana trucks when 2 specified crew sizes are used

Method	Crew size	Elapsed time	Labor and equipment required		Labor and equipment costs		
			Labor	Equipment	Labor	Equipment	Total
	Number	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
1 worker loads 4-wheel banana trucks in car, 1 worker transports 100 feet to ripening room, and 1 worker hangs bunches in ripening room	3	1.69	5.06	1/ 5.07	6.33	2/ 0.07	6.40
2 workers load 4-wheel banana trucks in car, 1 worker transports 100 feet to ripening room, and 2 workers hang bunches in ripening room	5	1.15	5.73	1/ 3.45	7.16	3/ .06	7.22

1/ Three 4-wheel banana trucks were used for the entire elapsed time of the operations.

2/ Cost based on three 4-wheel banana trucks used 5.07 machine-hours for receiving operations and 10.26 machine-hours for packing operations.

3/ Cost based on three 4-wheel banana trucks used 3.45 machine-hours for receiving operations and 10.26 machine-hours for packing operations.

Methods employing the 4-wheel banana truck have a number of advantages over some other methods. In addition to efficient utilization of labor, initial cost of equipment is low, and the trucks are flexible enough to permit economical use in facilities of almost any layout or design. Where platforms of proper height are available, the equipment can be moved directly into the car or truck for loading. In addition, it can be moved directly into the ripening room for the hanging operation.

The equipment also can be efficiently used to move the ripe fruit from the ripening rooms to the cutting table. At the cutting table it is used to hold the bunches for cutting. This flexibility in the use of the equipment permits more freedom in the design and layout of the cutting and packing area. Trucks with the superstructure removed can be used for other handling operations.

This equipment is relatively efficient for receiving bananas from rail cars at team tracks. Banana trucks are wheeled into empty motortrucks and transported to the cars on team tracks. After the motortruck is backed to the open door of the refrigerator car, a bridgeplate is dropped over the car rack and truck bed or tailgate so that the banana trucks can be wheeled into the refrigerator car for loading. Loaded banana trucks are wheeled back into the motortruck and transported to the warehouse. At the warehouse, the motortruck is backed against the receiving platform and the loaded banana trucks are pushed from the motortruck to the ripening room. No individual handling of the bunches is required in unloading from the motortruck to the platform as is necessary when bunches are transported on the truck bed.

This equipment also has some disadvantages. Each bunch must be manually handled in both loading and unloading the equipment, which is particularly important when considered in terms of spoilage and deterioration. When fully loaded, the 4-wheel banana truck is difficult to maneuver inside a railroad car and requires a reasonably level approach from the car floor rack to the receiving platform. In some instances 2 men are required to position the equipment in the car. If the refrigerator car racks are in poor condition, the casters may catch and make maneuvering difficult. Unless the superstructure has sufficient height above the platform of the truck, long stems strike against the bed of the truck. This may cause serious damage to the lower hands of fruit.

Continuous Powered Monorail Conveyor

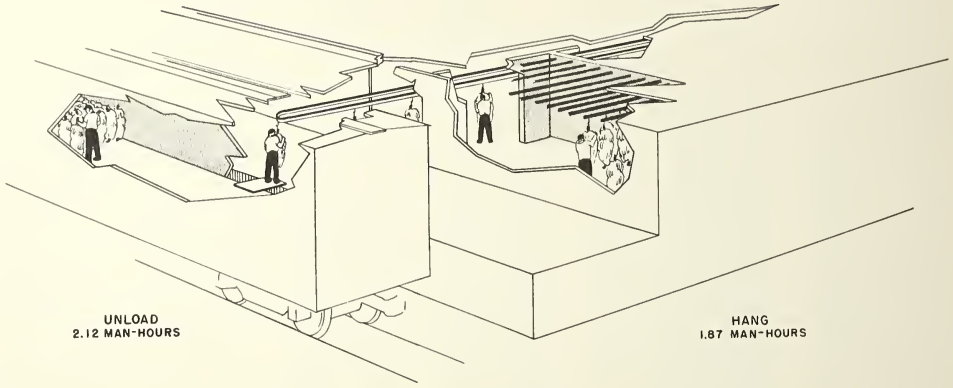
The continuous powered monorail conveyor consists of a chain or cable suspended from an endless overhead track by a series of carriers which are spaced at regular intervals. The cable or chain, which is powered by an electric motor, passes around special pulleys at the turns, and bunches of bananas are suspended from hooks attached to the carriers.

The conveyor is designed to carry bunches from the receiving platform to a point outside the ripening rooms (fig. 6). It can be used for moving bananas from one floor level to another in receiving operations. For instance, to receive bananas into basement ripening rooms fromthe receiving platform at first floor level, the continuous powered monorail conveyor operates as efficiently as if the rooms were all on the first floor.

By this method, workers manually carry bunches of bananas from the car to the receiving platform and hang them on the conveyor carriers. The conveyor transports the fruit to the door of the ripening room where other workers remove the bunches, carry them into the room, and hang them. The typical crew arrangement consists of 2 workers in the car or motortruck and 2 workers in the ripening room (fig. 20).

As shown in table 9, 4.92 man-hours of labor are required to receive a carload of bananas by use of the continuous powered monorail conveyor. Of this, 43 percent is for loading the equipment with bunches from the car. Removing the fruit outside the ripening room and hanging it in the room requires about an equal amount of labor. However, the workers in the room wait 0.25 man-hour or 5 percent of their time. Setup and cleanup time requires 0.68 man-hour or 14 percent of the total labor.

With this method it is difficult to maintain a balanced crew. At the beginning of the unloading operation the workers in the car must wait a short interval for each carrier of the conveyor to reach the load point. At the other end, the workers removing the bunches



CREW SIZE - 4 MEN

TOTAL MAN-HOURS TO RECEIVE A CARLOAD EQUIVALENT

OPERATION	MAN-HOURS
UNLOAD	2.12
TRANSPORT 100' & RETURN	0.00
HANG	1.87
SET UP & CLEAN UP	.68
WAIT	.25
TOTAL	4.92

Figure 20.--Receiving bananas by use of continuous powered monorail conveyor.

from the conveyor and hanging them in the room are rushed to keep the bunches ren from the conveyor. As the unloading proceeds the two jobs begin to balance out, a crew is most nearly in balance when the car is about half unloaded and the ripeni is about half filled. At this point, the situation changes and the workers in the ca rush to catch each carrier and the workers in the room are able to work at a slower pace.

Table 9.--Labor required for a 4-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of a continuous powered monorail conveyor 1/

Time item	Labor required
	Man-hours
Productive labor:	
Set up	0.40
Pick up bunches in car, carry to threshold of car and hang on conveyor	2.12
Transport	0
Remove bunches from conveyor, carry inside ripening room, and hang	1.87
Clean up	.28
Total productive labor	4.67
Unproductive labor:	
Men in ripening room wait on conveyor	.25
Total unproductive labor	.25
Total labor	4.92
Elapsed hours	1.23

1/ Crew organization: Four men set up then 2 men place bunches on conveyor and 2 men remove bunches from conveyor and hang in ripening room. On completion 4 men clean up.

The powered monorail conveyor method compares favorably with other methods in labor requirements for receiving bananas. Where the fruit is moved to basement or to second floor rooms, this equipment is very efficient.

One problem in the use of this method is the synchronization of the crew size to the rate of travel of the conveyor. Over a sustained period the speed of the slowest operation in the cycle sets the pace of all operations. Thus, delays which develop in any one operation are automatically transmitted to the other operations so that delay costs are multiplied. Another disadvantage is the height that individual bunches must be lifted for hanging on the carrier system. When only one worker performs this operation it soon becomes fatiguing, but this strain can be lessened by providing a dip in the conveyor at the load point or by providing the worker with a ramp under the load point of the conveyor.

Table 10 shows total labor and equipment costs of receiving by use of a continuous powered monorail conveyor by a 4-man crew. Equipment costs are about 30 percent of the total per car cost for receiving and labor costs are about 70 percent. For other transportation

quipment costs would vary, but the labor costs would remain about the same
wn.

.0.--Labor and equipment costs for a 4-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of continuous powered monorail conveyor

Method	Elapsed time	Labor and equipment required		Labor and equipment costs		
		Labor	Equipment	Labor	Equipment	Total
	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
2 workers unload car by placing bunches on conveyor and 2 workers remove bunches from conveyor and hang in ripening room	1.23	4.92	1.23	6.15	2.63	8.78

Manual Monorail Conveyors

The manual monorail conveyor method uses overhead open end or endless track conveyors on which wheel units operate as load carriers. Loads are carried suspended from load pendants attached to the wheel units. Switches and other accessories are employed so that the system operates as a free trolley manually propelled system (fig. 21).

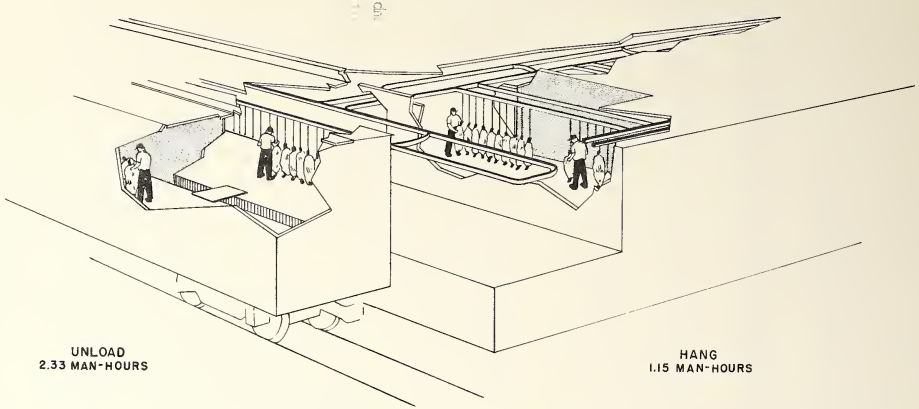
The usual layout in a plant using this system provides overhead trackage which extends directly into each of the ripening rooms, making it possible to transport bananas to within easy reach of the hooks and ropes. In transporting fruit a worker pushes a number of loaded carriers along the track from the load point to the hang point and returns empty carriers to the car. Switches are used to route the carriers over the shortest track distance between the receiving platform and the ripening room.

In this method, workers perform somewhat the same duties as in the one previously described. Workers enter the car or motortruck, manually raise the bunches, and carry them to the receiving platform outside the car. There the bunches are lifted and hung on the carrier of the monorail system.

When 8 or 10 bunches have been placed on the equipment, another worker pushes the loaded carriers along the track into the ripening room. He then returns empty carriers to the receiving platform. In the ripening room another worker manually removes the individual bunches from each carrier and carries them to the hang point.

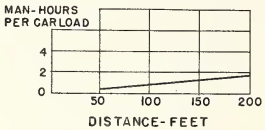
A typical crew consists of 4 workers: 2 in the car to load the equipment, 1 to transport fruit, return empty carriers, and when necessary help to hang; and 1 in the ripening room to take bunches off the carriers and hang them.

Though labor requirements match those for the powered monorail conveyor system, this method provides a more even flow of work. Crew balance and synchronization of the work are less difficult to maintain. Temporary stoppages of equipment do not multiply as is the case with the previously described method.



CREW SIZE - 4 MEN

TRANSPORT AND RETURN



TOTAL MAN-HOURS TO RECEIVE A CARLOAD EQUIVALENT

OPERATION	MAN-HOURS
UNLOAD	2.33
TRANSPORT 100' & RETURN	.94
HANG	1.15
SET UP & CLEAN UP	.68
WAIT	.24
TOTAL	5.34

Figure 21.--Receiving bananas by use of a manual monorail conveyor.

By this method, a carload equivalent of bananas can be received with 5.34 man-hours of labor, one-half of which is for unloading the car and placing the bunches on the carriers of the monorail system. The remainder is about equally divided between transporting to the room and removing bunches from the equipment and hanging. About 5 percent of the labor of the transporter and hanger is nonproductive, the majority of which is wait time on the part of the transporter. Setup and cleanup time for the crew requires 0.68 of a man-hour or about 13 percent of the total labor (table 11).

Table 11.--Labor required for a 4-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of a manual monorail conveyor 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
Pick up bunches in car, carry to threshold of car, and hang on monorail		2.33
Transport:		
Move group of 10 loaded carriers 100 feet to ripening room	0.69	
Release loaded carriers, assemble, and return empty carriers	.25	
Total transport		.94
Remove bunches from monorail and hang in ripening room		1.15
Clean up		.28
Total productive labor		5.10
Unproductive labor:		
Transporter waits on load men in car		.22
Hangman waits on transporter		.02
Total unproductive labor		.24
Total labor		5.34
Elapsed hours		1.33

1/ Crew organization: Four men set up, then 2 men in car load monorail, 1 man transports, and 1 man hangs bunches in room. On completion 4 men clean up.

Some plants have attempted to modify these systems by installing a portable extension to the monorail conveyor directly into the car or motortruck. However, the additional labor required to set up, adjust, and remove this extension is greater than the amount it saves in unloading.

One disadvantage of this system is the difficulty of moving loaded carriers in groups of 10 or more along the track, around curves, and through switches. Unless the overhead trackage is well maintained and the carrier wheels are kept lubricated, bunches frequently strike each other and bruise the fruit. Another disadvantage is that this system requires manual handling of each bunch by workers loading and unloading the equipment. When receiving heavier bunches of fruit, extra workers may be required.

As in the other monorail conveyor methods, the manual monorail conveyor is a low obstruction to the operation of other handling equipment, such as forklift trucks. Therefore, an effort must be made to locate such equipment in the plant layout so that there will be a minimum of interference with other handling equipment employed.

As shown in table 12, total labor and equipment costs per carload equivalent for receiving by this method with a 4-man crew are $7.39, of which $6.68, (90 percent) is for labor and $0.71 (10 percent) is for equipment.

Table 12.--Labor and equipment costs for a 4-man crew to unload, transport, and hang in a ripening room a 250-bunch carload equivalent of bananas by use of a manual monorail conveyor system

Method	Elapsed time	Labor and equipment required		Labor and equipment costs		
		Labor	Equipment	Labor	Equipment	Total
	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
2 workers unload car by placing bunches on monorail conveyor, 1 worker transports 100 feet to ripening room and 1 worker hangs bunches in ripening room	1.33	5.34	1.33	6.68	0.71	7.39

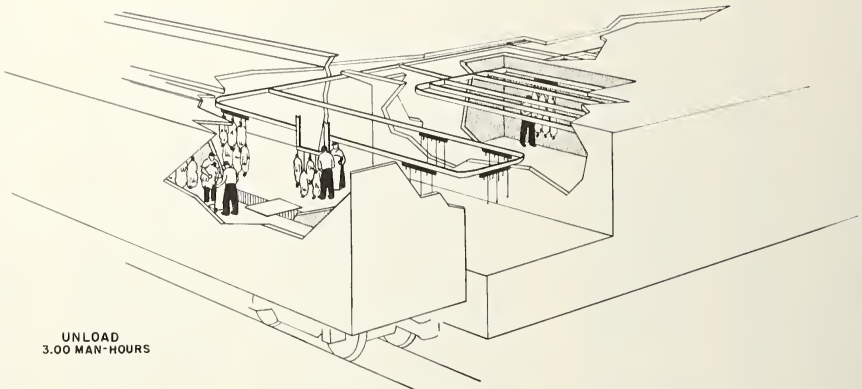
Manual Monorail *Ripen-on-Carrier* Conveyor System

The manual monorail *ripen-on-carrier* conveyor is similar to the manual monorail system. This system is designed to handle unit loads of 6 bunches per carrier and to hold the bunches during the ripening process. A series of individual holding tracks, suspended from the ceiling of the ripening room, are connected to the rest of the system by a series of switches. This system also includes at least 2 *lowerators* at the point the carriers are loaded and at the cutting table. These lowerators raise and lower full or empty carriers to and from the overhead track.

In this system, the carriers are loaded at the receiving platform with 6 bunches of bananas which are not individually rehandled in subsequent operations. Loaded carriers are manually pushed to the ripening room where they are switched onto the hold tracks. The fruit is left on the carriers to ripen. When it is ready for cutting, the loaded carriers are moved on the overhead monorail conveyor to the cutting table. Thus, fruit is moved into the ripening room, stored for ripening, and then moved out of the room for cutting with only one manual handling of each individual bunch (fig. 22).

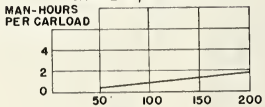
Installations of this system involve the use of specially designed rooms having sufficient overhead track to hold the fruit on carriers during the ripening process. The heavy duty carriers hold 6 bunches--3 at the high level on hooks and 3 at the lower level on ropes.

In this method, workers unload refrigerator cars or motortrucks either by manually moving the bunches to the receiving platform and hanging them on the carriers of the



CREW SIZE - 5 MEN

TRANSPORT, POSITION CARRIERS, & RETURN



TOTAL MAN-HOURS TO RECEIVE A CARLOAD EQUIVALENT

OPERATION	MAN-HOURS
UNLOAD	3.00
TRANSPORT 100', POSITION CARRIERS, & RETURN	.93
SET UP & CLEAN UP	.68
WAIT	.88
TOTAL	5.49

Figure 22.--Receiving by use of manual monorail "ripen-on-carrier" conveyor system.

monorail system, or with the 3-bunch 2-wheel hand trucks. Loading the carriers by hand trucks is less difficult, because much of the strenuous lifting is eliminated and much of the other labor is less fatiguing (fig. 23).

To unload by banana trucks, a worker pushes a truck into the car and, with the assistance of another worker, loads the truck with 3 bunches of bananas. The loaded truck then is wheeled out of the car to a position on the receiving platform just under the lowerator. With the lowerator in the down position, the string on each bunch is looped over the hooks of the carrier. The lowerator raises the carrier toward the monorail track, lifting the 3 bunches from the banana truck to a level just above the level at which bunches are hung on the ropes of the carrier. The hand trucker then returns the empty truck to the car for another load.

Figure 23.--Use of 3-bunch 2-wheel banana truck in transporting bananas from rail car to the lowerator of a manual monorail "ripen-on-carrier" conveyor system.

The second hand trucker brings a loaded truck out of the car and positions it under the lowerator as was done by the first worker. The strings of 3 bunches are looped over the carrier ropes and the carrier is then raised in line with the overhead track and pushed off the lowerator onto the fixed monorail track (fig. 24). An empty carrier is then placed on the lowerator, and the cycle repeated. After 2 carriers are loaded they are moved into position in the ripening room.

The typical crew consists of 2 hand truckers, 1 worker stationed in the car to help load the trucks, 1 lowerator operator, and 1 worker to transport loaded carriers along the monorail and position them in the ripening room. In a smaller crew the hand truckers can load the 2-wheel banana trucks without assistance and operate the lowerator. No appreciable increase in elapsed time is required by a 3-man crew.

As shown in table 13, total labor requirements per carload equivalent by this method with a 5-man crew, are 5.49 man-hours. Sixteen percent of this labor is unproductive and is accounted for by wait time of the worker in the car and the lowerator operator plus the wait time of 1 worker during setup and cleanup. Most of this unproductive labor can be eliminated by reducing the crew size so that the hand truckers load their own equipment, operate the lowerator, and transfer bunches from the 2-wheel banana trucks to the monorail carrier.

The elapsed time required by this method to receive a carload equivalent with a 5-man crew is 1.10 hours. At this rate, up to 7 cars can be received in 8 hours. If additional workers are added to speed the unloading, interference around the car door and lowerator reduces the productivity of the workers and a great deal of wait time results.

Setup and cleanup account for 15 percent of the total labor. About one-fifth of this is the wait time of 1 worker. Transporting the loaded carriers from the receiving platform to the ripening room and positioning them, including manipulation of the necessary switches, requires only 0.93 of a man-hour, or 18 percent of the total labor required.

In this system, no strenuous manual lifting of the bunches is required, and therefore damage to fruit is held to a minimum. The equipment utilizes the unit-load principle both in receiving operations and in moving fruit from the ripening room to the cutting area.

As with other conveyor systems, the fruit must move over a fixed route and between fixed points. As a result subsequent changes in the flow pattern become difficult and costly. The initial investment in equipment is high, and a large volume must be handled to keep down the cost per carload. Moreover, the equipment can be used only for handling bananas.

Figure 24.--A carrier of a manual monorail "ripen-on-carrier" conveyor system being moved off the lowerator and onto the fixed overhead monorail track.

When using this method the total labor and equipment costs per carload equivalent of bananas is $9.72 (table 14). Nearly 30 percent of this cost, or $2.86, is for equipment, and about 70 percent, or $6.86, is for labor. In computing equipment costs for all banana-handling operations, only 17 percent of the total is charged to receiving operations. The remaining 83 percent is charged to packing operations. The manual monorail *ripen-on-carrier* conveyor system has the highest equipment cost for receiving of all the methods studied. In addition, it is 40 times greater than the equipment cost when receiving by 4-wheel banana trucks. However, there is little difference in labor required by the two methods.

Forklift Truck

The forklift truck is a recent innovation for handling bunches of bananas (fig. 25). This equipment has received wide attention for several reasons: (1) A number of wholesale fruit and vegetable houses already are using lift trucks for other materials-handling operations: (2) lift trucks utilize the unit-load principle of materials handling; and (3) lift trucks eliminate much of the back-breaking labor required with many of the manual methods of receiving and placing bananas in the ripening room and of moving the ripe fruit from the ripening room to cutting table.

In the forklift truck method of handling bananas in the receiving operation, a load-lift or lowerator is installed on the receiving platform for making up unit loads.

Table 13.--Labor required for a 5-man crew to unload, transport, and position in ripening room a 250-bunch carload equivalent of bananas by use of a manual monorail *ripen-on-carrier* conveyor system and 3-bunch 2-wheel banana trucks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
Remove bunches from car and hang on carriers at lowerator by use of 2-wheel banana trucks:		
1 man loads trucks in car	0.64	
2 men hand truck from car and hang on lowerator	1.85	
1 man operates lowerator and pushes loaded carrier off lowerator	.51	
Total		3.00
Transport carriers 100 feet and position in ripening room and return:		
Pick up	.0	
Move loaded carriers 100 feet and return 2/	.89	
Position loaded carriers in storage and assemble empty carriers	.04	
Total		.93
Clean up		.28
Total productive labor		4.61
Unproductive labor:		
1 man waits while 4 men set up		.10
Worker in car waits on hand truckers		.29
Lowerator operator waits on hand truckers		.42
1 man waits while 4 men clean up		.07
Total unproductive labor		.88
Total labor		5.49
Elapsed hours		1.10

1/ Crew organization: Four men set up while 1 man waits; then 1 man in car loads 3 bunches on trucks; 2 men hand truck to lowerator on dock and hang bunches on monorail carrier; 1 man operates lowerator; and 1 man transports loaded carriers, 2 at a time, and positions them in ripening room. On completion 4 men clean up while 1 man waits.

2/ Loaded carriers are moved 2 at a time to the ripening room by the worker performing the transport operation.

Workers enter the car or motortruck, manually carry the bunches to the lowerator, and hang each bunch on the 4- by 4-inch carrier (fig. 26). The lowerator is in the lowered position when the 3 upper bunches are hung and in the raised position when the 3 lower bunches are hung. When a unit load of 6 bunches has been assembled, it is removed by the forklift truck which is equipped with a special rack for handling the loaded carriers.

Table 14.--Labor and equipment costs for a 5-man crew to unload, transport, and position in a ripening room a 250-bunch carload equivalent of bananas by use of a manual monorail *ripen-on-carrier* conveyor system and 3-bunch 2-wheel banana trucks

Method	Elapsed time	Labor and equipment required		Labor and equipment costs		
		Labor	Equipment	Labor	Equipment	Total
	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
1 worker in car helps load 2-wheel 3-bunch banana trucks, 2 workers move bananas from car to lowerator by use of 2-wheel 3-bunch bananas trucks, 1 worker operates lowerator, and 1 worker transports carriers 100 feet and positions them in ripening room	1.10	5.49	3.30	6.86	1/ 2.86	9.72

1/ Based on 2-wheel 3-bunch banana trucks used only in receiving operation $0.06, and manual monorail *ripen-on-carrier* conveyor used 1.10 machine-hours $2.80.

A typical crew consists of 3 carmen and 1 forklift truck operator. One of the carmen places a 6-bunch carrier on the lowerator in the lower position while 2 carmen bring out and hang bunches of fruit. After the lowerator has been prepared, the first worker joins the other 2 in picking up, transporting, and hanging bunches on the carrier. After hanging 3 bunches on the upper level hooks of the carrier, the lowerator is raised so that the bunches can be hung on the ropes at the lower level. After the 6 bunches are hung, the loaded carrier is picked up by the forklift truck (fig. 27).

With the 6-bunch loaded carrier resting on the special forks of the truck, it is transported in a hanging position to the ripening room (fig. 28). At the ripening room, which is equipped with specially designed storage beams to receive the 6-bunch carriers from forklift trucks, the fork truck maneuvers the loaded carrier through the door and over the storage beams (fig. 29). After the load has been positioned the forks of the truck are lowered and the carrier is left suspended across the beams with the fruit hanging from it.

As shown in table 15, use of this method with a 4-man crew required 5.08 man-hours of labor to receive a 250-bunch carload equivalent of bananas. Of this amount, 3.30 man-hours or 65 percent is for labor to unload the car and make up the unit loads for the forklift truck. Transportation to the ripening room and the positioning of the loaded carriers in the room with the forklift truck require 0.91 man-hour.

However, the forklift truck operator waits 0.19 man-hour for the unit loads to be assembled, which accounts for about 4 percent of the total labor. All workers participate in setup and cleanup and these operations require 0.68 man-hour or 13 percent of the total labor. Productive time for all operations is 4.89 man-hours of labor and wait time of 0.19 man-hour makes up the total of 5.08 man-hours. The elapsed time for receiving a carload equivalent is 1.27 hours. At this rate, about 6 carloads can be received in an 8-hour working day.

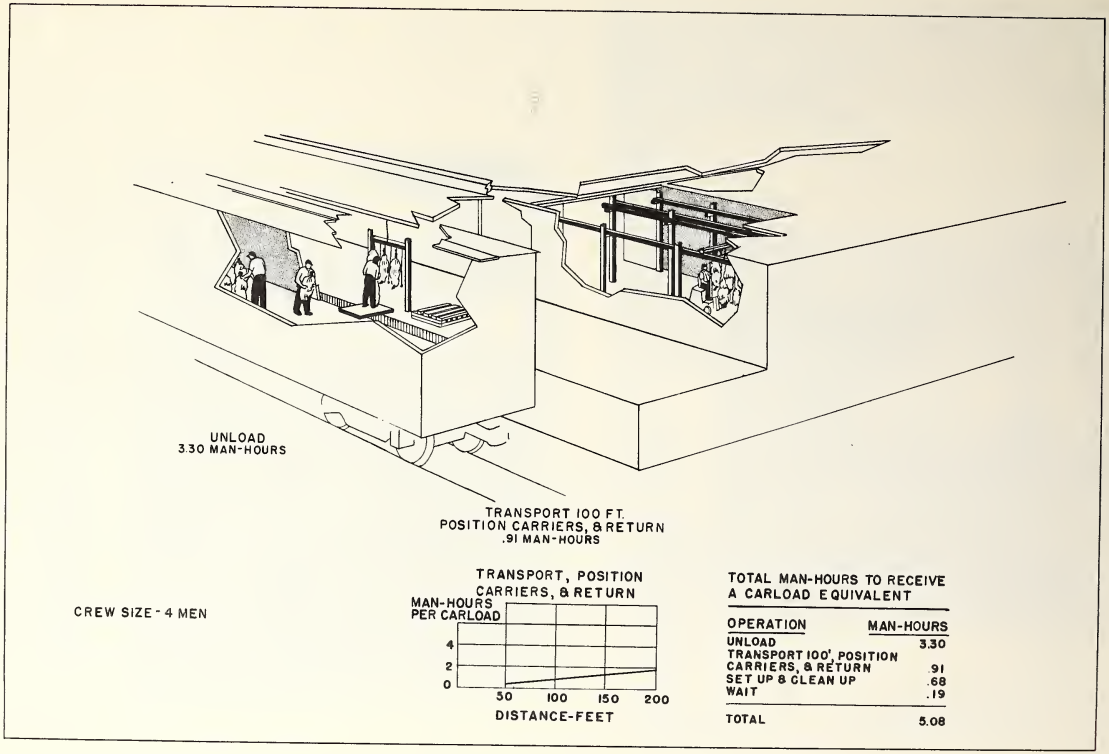


Figure 25.--Receiving bananas by use of forklift truck.

Figure 26.--Lowerator on receiving platform being used to make up unit loads of 6 bunches of bananas for the forklift truck receiving operation.

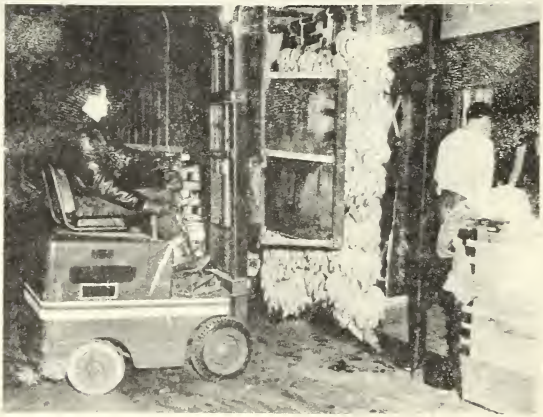


Figure 27.--Forklift truck being used to lift 6-bunch carrier from lowerator on receiving platform for transportation to and positioning in the ripening room.

Figure 28.--Forklift truck with loaded 6-bunch carrier in position to perform the transportation operation.

Figure 29.--Forklift truck with loaded 6-bunch carrier being maneuvered into ripening room to store bananas for ripening.

Total labor and equipment costs for receiving a carload equivalent of bananas with a 4-man crew using the forklift truck method is $7.75 (table 16). Eighty-six percent of this cost, or a total of $6.67, is for labor. The equipment costs are 14 percent of the total or $1.08.

As the forklift truck utilizes the unit-load principle in receiving bananas, transporting from the receiving platform to the ripening room, and storing or positioning in the room are combined into a comparatively simple operation. Assembling unit loads on the receiving platform is the limiting factor and accounts for the bulk of labor required. The size of the unloading crew is limited by the capacity of the lowerator. In a crowded area crew interference also becomes greater. When too many workers are added to the job, congestion around the car door and the lowerator makes efficient operation difficult.

The forklift truck is used to perform all transportation jobs in the receiving, packing, removing to storage, and loading-out operations. Furthermore, when the forklift truck is not in use in banana-handling operations, it is available for use in other materials-handling operations in the warehouse.

This method should be considered thoroughly by dealers before adoption, since the forklift truck requires a large capital investment, and facilities are costly. If the

Table 15.--Labor required for a 4-man crew to unload, transport, and position in ripening room a 250-bunch carload equivalent of bananas by use of forklift truck 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.40
3 workers pick up bunches, carry outside car to lowerator, and hang on 6-bunch carrier		2/ 3.30
Transport:		
Pick up by forklift truck	0.09	
Move 100 feet into ripening room	.76	
Place in storage by forklift truck	.06	
Total transport		.91
Clean up		.28
Total productive labor		4.89
Unproductive labor:		
Forklift operator waits on carmen		.19
Total unproductive labor		.19
Total labor		5.08
Elapsed hours		1.27

1/ Crew organization: Four men set up; then 3 workers manually remove bunches from car, carry to lowerator, and hang on carrier (1 of these workers also operates the lowerator and places the 4- by 4-inch carriers in position on the lowerator) on receiving platform; 1 man transports loaded 6-bunch carriers with forklift truck, and places them in ripening room. On completion 4 men clean up.

2/ Includes the time required to handle the empty carriers and to operate the lowerator.

Table 16.--Comparative labor and equipment costs for a 4-man crew to unload, transport, and position in ripening room a 250-bunch carload equivalent of bananas by use of forklift truck

Method	Elapsed time	Labor and equipment required		Labor and equipment costs		
		Labor	Equipment	Labor	Equipment	Total
	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
3 workers manually remove bunches from car, carry them to the lowerator, and hang them on 6-bunch carrier; 1 worker transports loaded carriers to and positions them in ripening room by use of forklift truck	1.27	5.08	2/ 3.81	6.67	1.08	7.75

1/ Forklift truck operator assumed wage is $1.50 per hour and all other workers' assumed wage is $1.25 per hour.

2/ Equipment-hours of 1.27 hours for each type of equipment to include forklift truck, lowerator, and 6-bunch carriers.

equipment is integrated into other materials-handling operations in the warehouse, its use for bananas can be more readily justified. However, if one carload of fruit is received and packed each day, a forklift truck would be needed for banana operations from 6 to 8 hours daily, which would require the assignment of a forklift truck on a full-time basis. If the warehouse loads out delivery trucks during the night, this forklift truck could be used for that operation.

For use with the forklift truck, ripening rooms must be equipped with special racks or beams on which the loaded 6-bunch carriers are released (fig. 30). Dual doors are required on each ripening room to allow the forklift truck to enter either side of the room. These features also increase the required investment. A lift-hoist or lowerator, which is needed in connection with loading the carriers, must be available on the receiving platform.

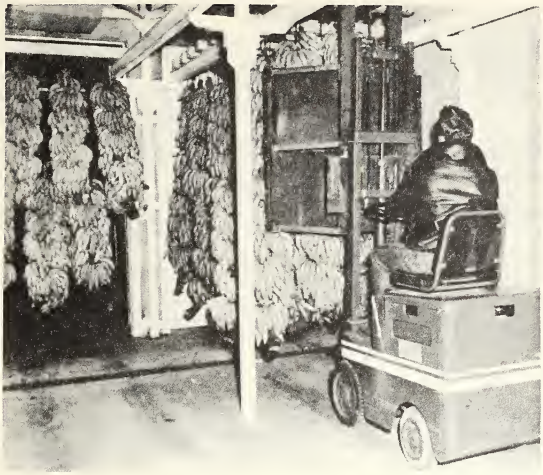


Figure 30.--Worker with forklift truck positioning a loaded 6-bunch carrier in the ripening room. Note special beams for holding the 6-bunch carrier.

Another consideration is that the forklift truck operator must be skilled in banana handling to avoid significant damage to the fruit. The skill of the forklift truck operator in correctly spacing the carriers on the storage racks also determines the capacity of the room. When the carriers are positioned too near to each other the bunches are jammed together and the fruit may be bruised and damaged. When they are set too far apart the loss of space between bunches may result in the loss of storage space for a carload of fruit. Moreover, an unskilled operator can slow down or stop the work and the productivity of the entire crew.

By comparison with other types of equipment, the forklift truck is less flexible with respect to the volumes that can be handled. The crew size cannot be changed to increase the volume of receipts in a normal working day without adding additional equipment. When the volume of a plant exceeds one car for receiving and packing each day, it is necessary either to operate two shifts or two separate crews.

Comparisons of Selected Methods for Receiving Bananas from Carriers to Ripening Room

Table 17 presents a comparison of labor and equipment costs for receiving a 250-bunch carload from carriers and storing the bunches in the ripening rooms, 100 feet away, with the methods previously discussed. This carload is being received by the optimum crew sizes. In each method a change in the crew size shown increases nonproductive labor because an unbalanced crew arrangement results, even though the elapsed time for performing the job may be reduced.

Table 17.--Comparative labor and equipment costs to unload, transport, and position in ripening room a 250-bunch carload equivalent of bananas by use of specified methods and types of materials-handling equipment 1/

Method	Crew size	Elapsed time	Labor cost	Equipment cost	Total cost
	Number	Hours	Dollars	Dollars	Dollars
Manual: Workers enter car, manually pick up, transport, and hang bunches in ripening room	4	1.83	9.16	0	9.16
Manual: 1 worker in car to help load, 1 worker in room to help hang bunches, and 4 transporters	6	1.83	13.71	0	13.71
2-wheel bunch truck and hydraulic bunch lift truck: 1 worker helps load, 3 workers transport, and 1 worker hangs high bunches in ripening room with hydraulic bunch lift truck	5	1.20	7.50	2/ 0.49	7.99
4-wheel banana truck: 1 worker in car lifts and hangs 8 bunches on 4-wheel banana truck, 1 worker transports, and 1 worker hangs them on hook or rope in ripening room	3	1.69	6.33	3/ .07	6.40
4-wheel banana truck: 2 workers load, 1 worker transports, and 2 workers hang bunches in ripening room	5	1.15	7.16	4/ .06	7.22
Continuous powered monorail conveyor: 2 workers place bunches on conveyor, 2 workers remove bunches from the conveyor, carry them into ripening room, and hang them	4	1.23	6.15	5/ 2.63	8.78
Manual monorail conveyor: 2 workers load, 1 worker transports, and 1 worker hangs the bunches in the ripening room	4	1.33	6.68	6/ .71	7.39
Manual monorail "ripen on carrier" conveyor: 1 worker loads 3-bunch 2-wheel banana trucks, 2 workers transport to lowerator, and 1 worker transports carriers and positions in ripening room	5	1.10	6.86	7/ 2.86	9.72
Forklift truck: 3 workers manually load 6-bunch carriers, 1 worker transports and stores 6-bunch carriers in ripening room with forklift truck	4	1.27	6.67	8/ 1.08	7.75

1/ The computations in this table are based on transportation distances standardized at 100 feet and an annual volume of 300 carload equivalents.
2/ Based on total cost of three 2-wheel bunch trucks $0.40 and hydraulic bunch lift truck used 1.20 machine-hours $0.09.
3/ Based on three 4-wheel banana trucks used 1.69 machine-hours each in receiving operation.
4/ Based on three 4-wheel banana trucks used 1.15 machine-hours each in receiving operation.
5/ Total cost of continuous powered monorail conveyor charged to receiving operation.
6/ Based on 1.33 machine-hours of use for the manual monorail conveyor system in the receiving operation.
7/ Based on total cost of two (3-bunch) 2-wheel banana trucks $0.06 and monorail "ripen on carrier" system used 1.10 machine-hours $2.80.
8/ Based on forklift truck use of 1.27 machine-hours $0.75; total cost of lowerator $0.23; and 6-bunch carriers use 1.27 machine-hours $0.10.

When the annual volume handled is 300 cars, the lowest cost method for receiving bananas at the wholesale warehouse is with 4-wheel banana trucks. The cost per carload by this method is $6.40--with $6.33 for labor and $0.07 for equipment. Equipment costs are only 1 percent of the total cost. A 3-man crew can receive about 5 carloads of bananas in an 8-hour working day by this method. Although a 5-man crew can receive a

carload in an elapsed time of 1.15 hours, total labor and equipment costs increase from $6.40 to $7.22. In an 8-hour working day the 5-man crew could receive 7 cars of fruit, but the per-car cost for receiving would be 12 percent greater. However, the total labor and equipment cost still is less than for any other method considered in the comparative analysis.

Other types of equipment having higher labor and equipment costs include the following: Manual monorail conveyor system with a total cost of $7.39; the forklift truck with a total cost of $7.75; the 2-wheel bunch truck with hydraulic bunch lift truck with a total cost of $7.99; the continuous powered monorail conveyor with a total cost of $8.78; and the manual monorail *ripen-on-carrier* conveyor system with a total cost of $9.72. The continuous powered monorail conveyor has the lowest labor cost--$6.15 per car. However, equipment costs of $2.63 per carload make this one of the more costly methods.

In all methods except manual methods, the labor costs remained about the same--ranging from $6.15 by the continuous powered monorail conveyor to $7.50 by the 2-wheel bunch truck and hydraulic bunch lift method. Equipment costs of these same methods range from $0.06 to $2.86 per car.

The highest cost method for receiving is the manual method (using a 6-man crew) with total labor and equipment costs per carload of $13.71. No equipment costs are incurred. The transportation distance of 100 feet and number of trips required are responsible for the high labor costs. At a transportation distance of from 40 to 50 feet the manual method would probably incur the lowest cost of all the methods studied.

A carload equivalent of bananas can be received in 1.10 hours by the manual monorail *ripen-on-carrier* conveyor method and in 1.83 hours by the manual method.

The minimum crew size for the most efficient operation by each method and type of equipment at 100 feet of transportation distance ranges from 3 to 6 workers (see table 17). In most methods a crew of 4 workers is most productive.

Other Methods and Types of Equipment

Methods for receiving bananas which have not been completely analyzed include: (1) Portable belt conveyors, (2) roller conveyors, (3) 4-wheel platform trucks, and (4) 2-wheel hand trucks with V-extension.

Portable Belt Conveyors

Some wholesale produce houses use portable belt conveyors which are adaptable to receiving bananas. Plant operators who own such equipment might consider using it to handle bananas. As a rule, low-volume dealers could not afford to purchase this equipment for handling bananas alone.

For handling bananas a power-driven portable belt conveyor should extend from inside the railroad car or motortruck to a point near the center of the ripening room. The equipment is used to best advantage at warehouses having house tracks and truckbed height platforms, as shown in figure 31, where distances between the car and the banana room are not over 40 feet. Two sections of conveyor, each 20 feet long, are sufficient to bridge

this distance. Workers in the railroad car or truck pick up and place bunches on the conveyor. Other workers in the ripening room remove the bunches from the conveyor and hang them on the ceiling hooks or ropes.

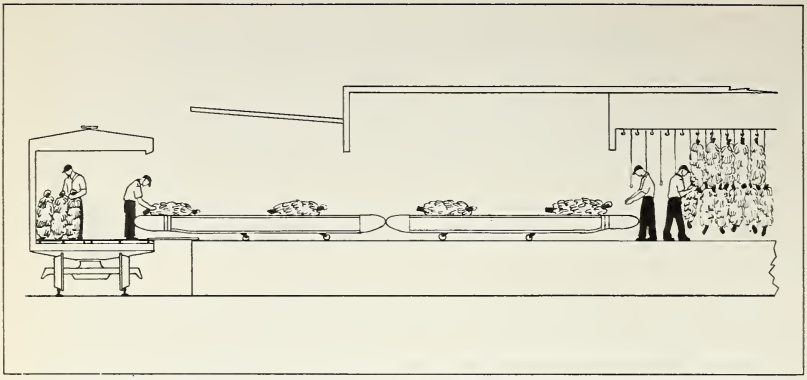


Figure 31,--Unloading, transporting, and hanging bunches of bananas in the ripening room by use of portable belt conveyors.

The principal advantage of this equipment is that transportation is accomplished by mechanical means. In comparison with manual receiving, fewer men are required. Little or no time is lost by workers in the carrier for moving out of loaded equipment and position-empty equipment, as is true with some methods. Nor is time lost waiting for the return of equipment.

Portable belt conveyors are not efficient when the distance from the end of the conveyor in the ripening room to the hanging point becomes too great. Therefore, the conveyor should always be long enough to bring the fruit from the carrier to a point near the hanging position. In appraising this method, the time required to set up and clean up for each carload should not be overlooked. Unproductive time of some crew members during set up and clean up increases total labor and makes savings impossible.

Gravity Roller Conveyors

In some instances, gravity roller or wheel conveyors and plywood flats, which hold the bunches and carry them down the conveyor, can be efficiently used for handling bananas over relatively short distances (fig. 32). This method is especially adaptable in those facilities where the height of the car or truck above the platform is so great that it precludes the possibility of moving handling equipment into the carrier or when the floor of ripening rooms is below the receiving dock.

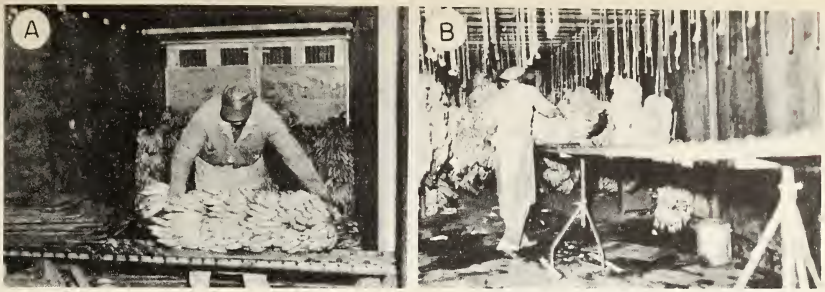


Figure 32.--Gravity-type wheel conveyor being used to move bunches of bananas from railroad car (A) to ripening room (B). (Note the plywood boards which are utilized as runners for transporting the bunches.)

As in the previous method, a significant amount of setup and cleanup time is required. Approximately five 10-foot sections of conveyor are required to bridge the usual distance between the car and the hanging point in the room. These must be set up and properly adjusted before the unloading operation can start.

During the unloading operation, workers must be careful to prevent fruit falling off the conveyor. A disadvantage, which may limit the use of this method in many plants, is that when the equipment is set up it may block *thoroughfares* needed for other warehousing operations. Therefore, its use appears to be limited to those houses in which other types of equipment cannot be effectively utilized. 2/

4-Wheel Platform Hand Truck

Although the 4-wheel platform or warehouse truck is not specifically designed for handling bananas, it can be used effectively for this purpose and is generally available in most fresh fruit and vegetable wholesale stores. This truck consists of a platform equipped with 2 rigid wheels on one end, 2 swivel casters on the other end, and a hand rail for pushing the truck, which is fixed to the end of the truck fitted with the swivel casters. Bunches are loaded onto the padded platform of the truck 2 to 3 deep in *cordwood fashion*, as shown in figure 33. A usual load consists of 10 to 12 bunches. The loaded hand truck is pushed into the ripening room where bunches are hung as shown in figure 34. As in the 4-wheel banana truck method, the 4-wheel platform truck can be taken directly into the carrier for loading and pushed directly to the hanging point in the room. It also can be used to receive bananas from cars on team tracks in much the same manner.

The crew should be particularly careful in loading and unloading the platform trucks to prevent excessive bruising and damage to the fruit.

2/ For a more thorough discussion of the use of belt conveyors and gravity roller conveyors in banana handling, see *How Fresh Fruit and Vegetable Distributors Can Get More Out of Their Materials-Handling Equipment*, USDA, PMA, MFRB, June 1950.

Figure 33.--A 4-wheel platform hand truck being loaded with bunches of bananas at a refrigerator car.

Figure 34.--Hanging bunches in ripening room from 4-wheel platform hand truck.

2-Wheel Hand Truck with V-Extension

Another method of receiving bananas is the use of a 2-wheel hand truck with V-extension (fig. 35). This equipment transports from 4 to 6 bunches per load which is made up by laying the bunches in the pocket formed by the V-extension and the handles of the truck. Two-wheel hand trucks are usually available around most warehouses, and the V-extension can be constructed inexpensively from scrap wood found around the premises. The V-extension attachment is easily removed and stored, thus permitting the 2-wheel hand truck to be used for other warehouse operations.

Figure 35.--Two-wheel hand truck with V-extension which is suitable for banana-handling operations. To reduce bruising and scarring of the fruit a blanket padding is placed over the truck to form a V-shaped pocket to carry the load of from 4 to 6 bunches of bananas.

A blanket or pad is thrown over the handles of the truck and the V-extension to reduce scarring and bruising. This equipment is used similarly to the 4-wheel platform hand truck. The load capacity of the equipment is great enough so that unloading crews can take full advantage of its capabilities even over relatively long distances. This equipment reduces considerably the number of trips required to receive a carload equivalent of fruit from that required for either manual handling or the special 2-wheel bunch truck previously discussed. Accordingly, less time is spent in transporting from car to room and wait time is decreased so that a reduction in man hours may be effected. The equipment is best utilized by small crews in which each worker loads his own truck in the carrier, transports the load to the ripening room, and hangs the load before returning for the next trip.

METHODS AND EQUIPMENT FOR MOVING BANANAS FROM RIPENING ROOM TO CUTTING AREA

In most warehouses the same type of equipment used for receiving the green bananas into ripening rooms is used to move the ripe fruit from the ripening room to the cutting and packing table. The methods studied are: (1) Manual, (2) 4-wheel banana truck, (3) manual monorail conveyor, (4) monorail *ripen-on-carrier* conveyor, (5) forklift, and (6) hydraulic bunch lift truck in combination with 4-wheel banana trucks or a manual monorail conveyor system. The latter method involves the use of new equipment which eliminates the manual handling of ripe bunches when they are removed from the hooks or ropes in the ripening room. Therefore, bruising and damage is reduced during this operation. Each of these methods and types of equipment is analyzed in the following sections.

Manual Handling

When fruit is needed at the cutting table, a worker enters the ripening room, manually removes a bunch of ripe bananas from the hook or rope, carries it to the cutting area, and hangs it on a stationary cutting stand which usually holds 3 or 4 bunches so as to provide a supply of uncut fruit ahead of the cutter.

This method usually is limited to facilities where congestion from a defective layout prevents the effective use of materials-handling equipment, and where the volume is inadequate to justify the cost of improving handling methods. Some plants have moved the banana packing operation into the ripening room to eliminate the necessity for moving fruit from the room for cutting and packing. However, this location would not be acceptable in most banana houses, because the work is performed in a highly congested area and more labor is required per unit of output.

In the manual method the worker delivering bunches to the cutting rack often interferes with the worker cutting hands of fruit. Moreover, the transporter often must wait as he is unable to perform other operations.

As shown in table 18, the labor required for one worker manually to move a carload equivalent of bananas from the ripening room to the cutting area over a distance of 60 feet is 3.67 man-hours. Almost three-fourths of this labor is required for transportation. The remainder is required for removing the bunches from the hanging position in the room and for releasing or hanging the bunches on the cutting rack.

Table 18.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from ripening room to cutting area by the manual method

Time item	Productive time
	Man-hours
Pick up bunches from hooks and ropes in ripening room	0.57
Manually transport bunches 60 feet	2.69
Release bunches by hanging on cutting stand	.41
Total labor	3.67

4-Wheel Banana Truck

In the 4-wheel banana truck method, trucks are used for moving bunches of fruit from the ripening room to the cutting area and for holding a temporary bank of supply at the cutting table. This permits the worker bringing up the fruit to perform other duties. In this operation one worker enters the ripening room with an empty 4-wheel banana truck, manually loads 8 bunches on the truck superstructure, and pushes the loaded truck to the packing line. Here he either takes an empty truck to the ripening room for more bananas or does other work--usually weighing and boxing hands of bananas at the packing table. When additional fruit is needed this worker leaves the packing line to repeat the handling cycle.

This operation usually is performed by one man. However, in some plants where only 2 workers are assigned to the cutting and packing crew, both workers leave the packing line and bring up a new supply of fruit on the 4-wheel banana trucks and then return to the cutting and packing operations.

The 4-wheel banana truck is one of the most efficient methods for moving fruit from the ripening room to the packing line. The equipment is inexpensive to own and operate and is adaptable to most plant layouts. Furthermore, this equipment provides a convenient rack for holding bunches at the cutting table.

With minor adjustments, the 4-wheel banana truck can be used for all banana-handling operations throughout the warehouse. By replacing the superstructure with a push-type handle, this truck also can be used as a regular 4-wheel platform truck. Packed boxes of bananas can be stacked on the truck platform and transported to the temporary storage area. It also can be used efficiently as a stem cart. Stems from which the bananas have been cut are stacked on the truck platform during the packing operation, eliminating rehandling of stems during cleanup at the end of the day.

Use of the 4-wheel banana truck for moving fruit from the ripening room to the cutting area over a distance of 60 feet requires 1.54 man-hours of labor per carload equivalent (table 19). Seventy-five percent of the total, or 1.15 man-hours, is required for loading trucks in the ripening room and releasing loaded trucks at the packing line. Only 0.39 man-hour or 25 percent of the total labor is required for transportation.

Table 19.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from ripening room to cutting area by use of 4-wheel banana truck

Time item	Productive time
	Man-hours
One worker loads 8 bunches on 4-wheel banana truck in ripening room	1.10
One worker transports loaded truck a distance of 60 feet and returns empty	.39
One worker releases loaded truck at cutting area and picks up empty	.05
Total labor	1.54

Manual Monorail Conveyor System

In houses where the manual monorail conveyor system has been installed for receiving fruit, it is the most efficient means for supplying the fruit directly to the packing table and placing the bunches in the most convenient position for the cutter. By a slight adjustment of the rope on each carrier, bunches can be placed at the proper height for any worker cutting fruit.

In operation, one worker assembles a supply of empty carriers and switches them into the ripening room. Bunches of fruit are manually removed from the hooks or ropes in the room, carried to the center aisle, and hung on the carrier of the monorail. When 8 or 10 bunches have been loaded on carriers, the worker pushes the last carrier and moves the train of carriers along the track and around switches to or within convenient reach of the cutting table. When an ample supply of fruit has been brought up, this worker performs other duties around the packing table until more fruit is needed.

With the manual monorail conveyor, the packing line can be supplied with ripe fruit from one room at the same time another room is being filled with green fruit. This feature is important in warehouses handling large volumes of bananas in which packing and receiving operations must go on simultaneously.

Powered monorail conveyor systems, which include intricate switching arrangements along a combination powered main line and nonpowered feeder lines, also are available. However, this system did not show sufficient savings in labor and equipment costs for development in this report. As a result of the manual handling required to transfer ripe fruit from the hooks or ropes in the ripening room to the monorail carriers, some bruising and other damage is caused. Some bruising of the soft fruit also is caused by pushing the train of carriers along the track to the cutting area. With this equipment, as with other types, caution should be taken by workers to prevent the bunches from swinging and bumping against each other during transportation.

By this method, 2.10 man-hours of labor are required to move a 250-bunch carload equivalent of bananas from the ripening room to the cutting area over a distance of 60 feet (table 20). Of the total labor, 1.66 man-hours, or 79 percent are required to assemble the empty carriers, load the equipment, and release the train at the cutting area. Only 21 percent of the total labor is required for transportation.

Table 20.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from the ripening room to the cutting area by use of manual monorail conveyor system

Time item	Productive time
	Man-hours
One worker removes bunches from hooks or ropes in ripening room, and hangs them on carriers	1.41
Transports 10 bunches per trip a distance of 60 feet and returns with empty carriers	.44
Releases carriers at cutting area and assembles empty carriers	.25
Total labor	2.10

Manual Monorail *Ripen-on-Carrier* Conveyor System

As fruit remains on the carriers during the ripening period, moving ripe bananas from the ripening room to the cutting area by this method merely involves the time of one worker to push loaded carriers from their position in the ripening room to the cutting area. One worker enters the room, selects 1 or 2 carriers of 6 bunches each and pushes them through switches and along the monorail track to within easy reach of the cutter. When more fruit is needed this worker leaves the packing area, enters the ripening room and pushes out 1 or 2 more loaded carriers. He then is available for other work. When one track in the ripening room has been emptied of the loaded carriers, the empty carriers from the cutting and packing line are assembled, pushed into the room, and stored on an empty track.

Each operation in the cycle of removing ripe fruit to the cutting area requires only 1½ to 2 minutes of elapsed time for 12 bunches over a distance of 60 feet. Thus, one worker can do this work in addition to regularly assigned duties on the packing line without noticeably upsetting the work balance of the crew. Of all methods studied, this equipment requires the least direct labor for moving fruit from the ripening room to the cutting area. As shown in table 21, only 0.67 man-hour of labor is required to handle 250 bunches. Of this labor, 0.62 man-hour, or 93 percent of the total, is required for transportation. Pickup and release require only 0.05 man-hour, or 7 percent of the total labor.

Table 21.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from the ripening room to the cutting area by use of the manual monorail *ripen-on-carrier* conveyor system

Time item	Productive time
	Man-hours
Pick up loaded carriers on track in ripening room	1/
Transport 2 loaded carriers (12 bunches) to cutting area a distance of 60 feet and return empty carriers	0.62
Release loaded carriers at cutting area and assemble empty carriers	.05
Total labor	.67

1/ This operation requires a small, almost insignificant amount of labor. The release of empty carriers on one track is immediately followed by grasping the loaded carriers on an adjacent track to begin transportation loaded.

Forklift Truck

As in receiving, with the special banana fork attachment on the lift truck, 6-bunch loaded carriers are lifted from the rack in the ripening room, transported to the packing line, and released on a position conveyor. No manual handling of individual bunches is necessary.

The position conveyor is accessory equipment in the forklift truck method which is used to maintain a bank of supply. It is designed to receive a supply of from 12 to 14 loaded carriers and to bring up and position each carrier for the cutter as needed. The position conveyor is a relatively expensive item of equipment designed for a single job--bringing up and positioning fruit for the cutter.

This method has several disadvantages. The forklift truck has a high initial cost and relatively high maintenance and operating costs. Ripening rooms having double doors at each end of the room are necessary. A position conveyor is needed to receive loaded 6-bunch carriers from the forklift truck and to position the bunches for the cutting operation. When ripe fruit is moved from the ripening room to the packing line by forklift truck, care must be taken by the truck operator to prevent damage to the fruit while maneuvering out of the room and into the position conveyor. Ample maneuver space is required in the cutting area to allow efficient operation of the equipment.

With an experienced operator the forklift truck method requires 1.29 man-hours of labor to move a carload equivalent of bananas a distance of 60 feet from the ripening room to the cutting area (table 22). Forty-nine percent of this labor is for transportation and 36 percent is for pickup and release of the load. Fifteen percent of the labor or 0.19 man-hour is required for changing the standard forks to the special attachment for handling unit loads of bananas.

Table 22.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from the ripening room to the cutting area by use of the forklift truck

Time item	Productive time
	Man-hours
Change forks to special attachment for handling 6-bunch carriers 1/	0.19
Pick up 6-bunch carriers in ripening room	.14
Transport loaded 6-bunch carriers a distance of 60 feet and return empty	.63
Maneuver into and release 6-bunch carriers on position conveyor	.33
Total labor	1.29

1/ This operation is performed a minimum of 3 times during the process of removing a carload of fruit from the ripening room to the cutting area. The time also includes changing back to regular forks.

Hydraulic Bunch Lift Truck in Combination With Transportation Equipment

A recent innovation for handling bunches of fruit from the ripening room to the cutting area is the hydraulic bunch lift truck. This truck is designed to remove bunches of bananas from the hanging position in the ripening room and transfer them to other equipment for

transportation to the cutting area (fig. 36). It is used in combination with 4-wheel banana trucks or with a manual monorail conveyor system. When the bunches are removed by this equipment, no manual handling of the fruit is required, thereby reducing the possibility of damage to the ripe fruit.

Figure 36.--Hydraulic bunch lift truck used to transfer ripe bunches of bananas from hanging position in the ripening room to the transporting equipment.

One worker first positions the transporting equipment in the ripening room. Then with the hydraulic bunch lift truck, he removes one bunch at a time from the hanging position and transfers it to the transporting equipment. When the load is complete, the hydraulic bunch lift truck is left in the room and the loaded equipment is pushed to the cutting area.

When this equipment is used in combination with 4-wheel banana trucks, the labor required to move 250 bunches from the ripening room to the cutting area is 2.36 man-hours (table 23). Eighty-one percent of this labor is required for loading the 4-wheel trucks by use of the hydraulic bunch lift truck, and 19 percent for transporting the bunches to the cutting areas.

When the hydraulic bunch lift truck is used in combination with the manual monorail conveyor system, the labor required is 2.75 man-hours per carload equivalent (table 24). Loading the manual monorail system with the hydraulic bunch lift truck uses three-fourths of this time. The other 25 percent, or 0.69 man-hour, is the same as the labor required by the regular manual monorail conveyor system.

Table 23.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from the ripening room to the cutting area by use of a hydraulic bunch lift truck and 4-wheel banana trucks

Time item	Productive time
	Man-hours
Load 8 bunches on 4-wheel banana truck with hydraulic bunch lift truck in ripening room	1.92
Transport a distance of 60 feet to cutting stand and return with empty truck	.39
Release loaded truck at cutting area and pick up empty truck	.05
Total labor	2.36

Table 24.--Labor required for 1 worker to move a 250-bunch carload equivalent of bananas from the ripening room to the cutting area by use of a hydraulic bunch lift truck and manual monorail conveyor system

Time item	Productive time
	Man-hours
Worker removes bunches from hooks or ropes and transfers them to monorail carrier in ripening room with hydraulic bunch lift truck	2.06
Transport 10-bunch trains to cutting area a distance of 60 feet and return empty carriers	.44
Release loaded carriers at cutting area and assemble empty carriers.	.25
Total labor	2.75

Comparative Labor and Equipment Costs for Moving Fruit from Ripening Rooms to the Cutting Area by Specified Methods

Table 25 shows that the manual monorail *ripen-on-carrier* conveyor system requires the least amount of direct labor for removing fruit 60 feet from the ripening room to the cutting area. This labor is 0.67 man-hour per 250-bunch carload equivalent. The forklift truck and the 4-wheel banana truck require about the same amount of labor--1.29 man-hours and 1.54 man-hours, respectively. The manual method requires 3.67 man-hours, which is the largest of all methods analyzed.

Table 25.--Comparative labor and equipment costs for moving a 250-bunch carload equivalent of bananas from ripening room to cutting area by use of specified methods and types of equipment 1/

Method	Labor and equipment required		Labor and equipment costs		
	Equipment	Labor	Equipment	Labor	Total
	Machine-hours	Man-hours	Dollars	Dollars	Dollars
Manual	0	3.67	0	4.59	4.59
4-wheel banana truck	2/ 4.62	1.54	0.06	1.92	1.98
Manual monorail conveyor system.	2.10	2.10	1.11	2.62	3.73
Manual monorail *ripen-on-carrier* conveyor system	.67	.67	1.71	.84	2.55
Forklift truck	3/ 4.41	1.29	1.95	1.93	3.88
Hydraulic bunch lift truck with 4-wheel banana truck	4/ 9.44	2.36	.55	2.95	3.50
Hydraulic bunch lift truck with manual monorail conveyor system.	5/ 5.50	2.75	2.02	3.44	5.46

1/ Transportation distance standardized at 60 feet.

2/ Three 4-wheel banana trucks used 1.54 machine-hours each, total cost $0.06.

3/ Forklift truck used 3.12 machine-hours (1.29 operation and 1.83 standby) $1.85; and 6-bunch carriers used 1.29 machine-hours $0.10, total cost $1.95.

4/ One hydraulic bunch lift truck used 2.36 machine-hours $0.47, and three 4-wheel banana trucks used 2.36 machine-hours each $0.08, total $0.55.

5/ One hydraulic bunch lift truck used 2.75 machine-hours $0.56; and manual monorail conveyor system used 2.75 machine-hours $1.46, total cost $2.02.

The method which incurs the lowest labor and equipment costs for moving fruit from the ripening room to the cutting area is the 4-wheel banana truck, or $1.98 per carload equivalent. The next least costly method is the manual monorail *ripen-on-carrier* conveyor system at $2.55 per carload. The hydraulic bunch lift truck used in combination with either 4-wheel banana truck or the manual monorail conveyor shows no savings in labor and equipment costs. However, this equipment eliminates all manual handling of bunches of ripe fruit, and consideration should be given to possible savings through reductions in damage to ripe fruit.

METHODS AND EQUIPMENT FOR CUTTING BANANAS

Few bananas now are sold by the bunch by distributors. The practice of cutting hands of bananas from the stem for retail distribution has become nationally accepted. Cutting bananas consists of positioning the bunch, removing the hands from the stem by slicing with a sharp knife, placing the hands on a packing table, and removing the stem. Operations involved in packing fruit are usually performed simultaneously with the cutting operation, and by other workers. These operations also may be performed in sequence by the same worker, depending upon the crew assignment.

One worker usually is assigned to the cutting operation. However, in large volume houses 2 workers may be used to insure an adequate supply of fruit for subsequent operations to minimize idle time. The cutting rate usually establishes the production rate of the entire packing crew, and it is important that the cutter maintain a rate of high productivity.

Several factors contribute to the rate of production in the cutting operation. They are: Equipment for delivering bunches to the cutting station, equipment for holding the bunches in position for cutting, requirements for grading, inspecting, sorting, and removing the ropes from stems.

Where practicable, the same equipment used to move ripe fruit from the ripening room to the cutting area is utilized to hold the bunches in position for cutting. Such equipment includes the 4-wheel banana truck, manual monorail conveyor system, and the manual monorail *ripen-on-carrier* conveyor system. By the forklift truck and the manual methods, accessory equipment must be used to hold bunches for cutting. With the manual method a stationary cutting stand is used. With the forklift truck method a position conveyor is needed to hold the 6-bunch carriers.

Stationary Cutting Stand

A stationary cutting stand, used in conjunction with the manual method of bringing up fruit, is shown in figure 37. In this method ripe bunches of fruit are brought out of the ripening room and hung on the stand. As each stem is stripped of bananas it is removed from the cutting stand and placed on a stem cart, and the cutter proceeds with the next bunch on the stand. A supply of bunches is kept on hand for the worker performing the cutting operation.

This method has limitations and is used only in plants having small volumes or where the layout of the facility is not suitable for mechanical equipment. In this method, 1 worker usually performs several operations, and frequently performs in sequence all operations. They are: Moving the bunch from the ripening room to the cutting stand, cutting the hands from the stems, and grading, weighing, and placing the hands in boxes.

Figure 37.--Stationary cutting stand for holding 2 bunches of bananas.

The cutting operation from a stationary stand requires 4.70 man-hours of labor per carload equivalent.

4-Wheel Banana Truck

The 4-wheel banana truck is used for the cutting operation as shown in figure 38. The loaded equipment is wheeled within easy reach of the cutter who cuts 4 bunches on one side of the truck and removes the stems. He then rotates the truck to place the 4 on the opposite side of the truck in position for cutting and repeats the cycle. After all bunches on one truckload are cut and the stems removed, the cutter pushes the empty equipment aside and positions another loaded truck and continues the cutting operation.

A desirable feature of this equipment is that either 1 or 2 workers can operate efficiently at the same cutting station with no apparent crew interference. Moreover, the cutters can, within limits, adjust the position of each bunch to place it at or near the proper cutting height. The cutter also can leave the stems on the truck to be removed by another worker as a fill-in job, thereby reducing his time about 10 percent.

Use of this equipment for holding bunches creates some minor difficulties in the cutting operation. After removing the hands from each stem the cutter must shift to the next bunch on the equipment which, in some instances, places him farther from the table. An alternative is to reposition the truck to place the next bunch in the correct cutting position. Unless the superstructure of the 4-wheel banana truck is of proper height, the bottom hands may be low and require much bending and additional movement. Larger bunches frequently are crowded on the truck, which hampers the work of the cutter.

The productive time required for cutting 250 bunches on 4-wheel banana trucks is 4.90 man-hours. This is about 20 percent more labor than is required by the manual monorail conveyor system which requires less labor than any of the methods analyzed.

Figure 38.--Four-wheel banana truck used for positioning bunches for the cutting operation.

Manual Monorail Conveyor System

A typical method of using the manual monorail conveyor system for banana cutting operations is shown in figure 39. A train of 10 to 12 bunches is made up on carriers on the monorail in the ripening room and pushed to a location near the cutting stand so that each bunch can be moved to the cutter as needed. The height of each bunch can be regulated to the most convenient position so as to give maximum productivity by shortening or lengthening the carrier rope. After the stems have been stripped of fruit, the cutter either removes them from the carrier or leaves them hanging on the carrier to be removed later by another worker. When stems are left on the carriers, cutting time is reduced about 12 percent. The productive labor required is 4.10 man-hours per carload equivalent.

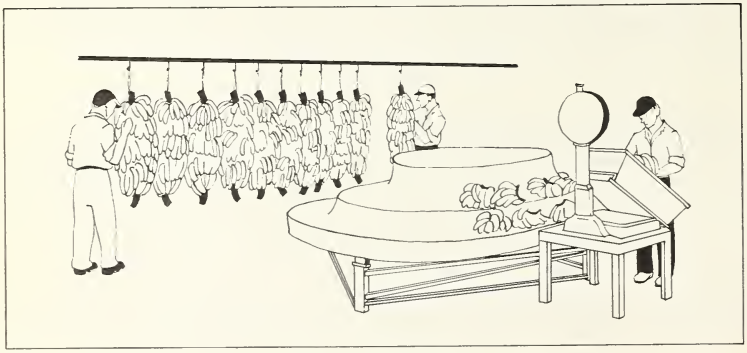


Figure 39.--Manual monorail conveyor system used for positioning bananas for banana-cutting operations.

Manual Monorail *Ripen-on-Carrier* Conveyor System

Positioning fruit on this equipment for cutting is accomplished by use of a lowerator (fig. 9). After the carrier has been pushed onto the lowerator, the 3 lower bunches, which are on ropes, are lowered to the correct cutting position where they are cut and the stems removed. The lowerator is lowered further until the 3 top bunches, which are on hooks, are in cutting position. After these 3 bunches are cut and the stems removed from the carrier the lowerator is raised until the carrier is level with the overhead track. The empty carrier is then pushed off the lowerator onto the monorail conveyor track, the next loaded carrier pulled onto the lowerator, and the cutting cycle is repeated.

When the method is properly used, cutting is done rapidly and efficiently. By proper alignment of the packing table with the monorail system, the cutter can work with a minimum of effort. Furthermore, 2 workers can cut simultaneously with a minimum of interference. For greatest efficiency, stems must be removed by the workers during the cutting operation.

The labor required for cutting 250 bunches is 4.94 man-hours. This is about equal to the labor required by use of the 4-wheel banana truck, and is 20 percent greater than the time required by the manual monorail conveyor system.

Forklift Truck

When a forklift truck is used to deliver ripe fruit to the cutting area, a position conveyor is required for holding bunches for the cutter (fig. 40). Positioning individual bunches at the cutting stand by this conveyor is more of a problem than with other methods.

Positioning is accomplished by use of a motorized hoist which is part of the position conveyor. The loaded 6-bunch carriers are moved forward on the conveyor until one carrier is in the cutting zone. At that point the hoist is manipulated to lift the carrier from the position conveyor and lower it to the correct cutting position. The lower 3 bunches, or the ones on ropes, are cut first and the stems removed. The 3 top bunches then are lowered into cutting position.

When all hands of fruit have been cut, the stems are removed from the carrier and the carrier is removed from the hoist and stacked on a nearby pallet. The hoist then is raised for the next loaded carrier, the position conveyor is started, and the next unit load is moved into the cutting zone.

The position conveyor is a bulky piece of equipment which is unwieldy to operate. Also, if it is improperly arranged, the cutter is required to take unnecessary steps to get into the cutting position after each carrier is lowered into position. Additional time also may be required to remove hands from the stems when the outer bunches are farther away from the cutting table. This encourages the cutter to toss hands of fruit onto the table, thus increasing the possibility of damage from bruising and scarring.

A major objection to this equipment is that only 1 worker can effectively cut fruit, which limits the crew to 1 cutter. As the cutter sets the work pace for other workers, the production rate is only two-thirds that of the best method analyzed. By the position conveyor method, cutting operations require 5.65 man-hours of productive labor per

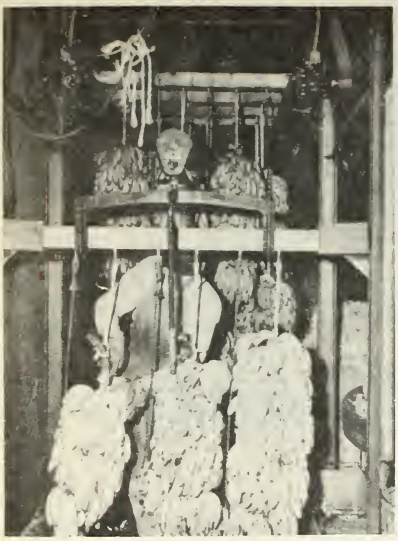


Figure 40.--Position conveyor used for holding unit load of bananas brought by forklift truck during cutting operations.

carload equivalent. This is the highest labor requirement of all methods analyzed, and is about 40 percent higher than the manual monorail conveyor system.

Comparison of Specified Methods and Types of Equipment for Cutting Fruit

Table 26 presents the comparative labor and equipment costs for cutting a carload equivalent of bananas by specified methods and types of equipment. For all methods cutting operations involve positioning the equipment, cutting hands from the stem, inspecting and sorting damaged fruit, and removing the stems.

The lowest labor input, 4.10 man-hours, is required by the manual monorail conveyor system. One worker can cut about 2 carloads of bananas in an 8-hour day. The highest labor input is required by the forklift truck method. One worker can cut 1 carload equivalent in 5.65 hours of elapsed time or about 1.5 cars in an 8-hour working day. The 4-wheel banana truck and the manual monorail *ripen-on-carrier* conveyor systems require about the same amount of labor for cutting fruit. Each of these methods requires about 5 hours of elapsed time to cut a carload of 250 bunches. During an 8-hour day approximately 1.6 cars or 410 bunches can be cut by 1 worker by either method.

The lowest cost method for cutting fruit is by the stationary cutting stand. The total labor and equipment cost of this equipment is $5.89 per carload equivalent. Nearly all of this total cost is labor, as the equipment costs only $0.02 per car. However, this method is not the most desirable because of preceding operations involved.

The next lowest cost method is by use of the 4-wheel banana truck. Labor and equipment costs for 250 bunches are $6.19 or about 5 percent more than the costs when a stationary cutting stand is used. However, use of the 4-wheel banana truck has other advantages over the stationary cutting stand. By the 4-wheel banana truck method, from 8 to 13 bunches are available to the cutter in each unit load, reducing the number of times the cutter waits for fruit. Furthermore, with the stationary stand it is much more difficult to synchronize the bring-up operation with the cutting operation.

The highest cost method is the manual monorail *ripen-on-carrier* conveyor system. By this method, labor and equipment costs are $17.77 per carload equivalent, two-thirds of which is for equipment. The forklift truck method also is a high-cost method. The total of $8.36 per car by this method is about 35 percent more costly than by the 4-wheel banana truck.

Table 26.--Comparative labor and equipment costs per 250-bunch carload equivalent of bananas for performing the cutting operation by specified methods and types of equipment

Method	Labor and equipment required		Labor and equipment costs		
	Equipment	Labor	Equipment	Labor	Total
	Machine-hours 1/	Man-hours	Dollars	Dollars	Dollars
Stationary stand	4.70	4.70	0.02	5.87	5.89
4-wheel banana truck	2/ 5.64	4.90	.07	6.12	6.19
Manual monorail conveyor system	3.63	4.10	1.72	5.10	6.82
Manual monorail *ripen-on-carrier* conveyor system	4.58	4.94	11.68	6.09	17.77
Position conveyor in forklift truck system: 3/	10.71	5.65	1.30	7.06	8.36

1/ Equipment hours in this operation are based on the total hours of use at the packing line minus the machine-hours for the bring-up operation.

2/ Three 4-wheel banana trucks used 1.88 machine-hours each, total cost $0.07.

3/ Forklift truck is not chargeable to cutting since it transfers loads to position conveyor; total cost of position conveyor charged to this operation, 6.00 machine-hours $0.94; 6-bunch carriers used 4.71 machine-hours $0.36, total cost $1.30.

In a typical crew the worker cutting fruit usually sets the pace for the other workers. Thus, the productivity of the crew generally depends upon his rate of work. Consideration should be given to assisting the cutter wherever possible by having other workers in the crew perform part of this work. Removing stems from the equipment can be done by other workers. This would reduce cutting time about 10 percent when equipment other than manual monorail *ripen-on-carrier* conveyor and forklift truck is used. By the forklift truck method, the cutter must perform this element as part of the normal cutting operation.

Another means of increasing the flow of work of the cutter is to relieve him of the job of inspecting and grading the fruit. As part of the cutting operation inspection and sorting require from 20 to 30 percent of the productive time, depending upon the quality of fruit. This work frequently can be delegated to other workers around the packing table, thereby increasing the productivity of the entire crew.

METHODS AND EQUIPMENT FOR WEIGHING AND BOXING BANANAS

There are two methods of weighing and boxing bananas. In one method, weighing and boxing are performed separately with weighing trays and platform scales. In the other, weighing and boxing are performed as a single operation by use of a self-taring scale.

Weighing Trays and Platform Scale at Stationary Table

When weighing trays and a platform scale are used, weighing and boxing are performed as 2 separate operations, usually by 2 workers at a flat or stationary packing table.

Weighing

Weighing by trays and platform scale follows the cutting and precedes boxing. One worker weighs and sorts bananas for each box so that fruit of comparable quality is placed in each lot (fig. 41). When performed separately from boxing, the elements of the weighing operation include: (1) Position empty tray on platform scale, (2) fill tray with hands of fruit until correct weight--usually 40 pounds--is measured, and (3) push the full tray to the packer. As shown in table 27, this operation requires 5.00 man-hours per carload equivalent of 450 packed boxes.

Figure 41.--Weighing bananas by use of weighing trays and platform scale.

Table 27.--Labor required for a 2-man crew to weigh and box a carload equivalent of 450 packed boxes of bananas by use of platform scales, weigh trays, and stationary packing table

Time item	Productive time
	Man-hours
One worker positions weighing tray on scale, fills tray with 40 pounds of fruit, and pushes full trays to packer	1/ 5.00
One worker positions boxes on rack, covers with pad material, transfers bananas from weigh trays to box, and stacks boxes in 5-high stacks on floor	6.15
Total productive labor	11.15

1/ When this job is performed by a 2-man crew, the worker performing the weighing operation requires 1.15 man-hours less time per carload equivalent than the worker who performs the boxing operation. Normally this labor is nonproductive time lost in waiting for the empty trays to be returned by the worker performing boxing.

Boxing

Boxing fruit after it has been weighed in trays is performed in 4 elements: (1) Position empty banana box on packing rack, (2) cover bottom of box with pad material, (3) transfer fruit from weighing trays to box, and (4) stack box on handling equipment. This operation requires 6.15 man-hours and brings the total labor for weighing and boxing a carload equivalent of 450 boxes to 11.15 man-hours (table 27). As fruit is handled twice, the possibility of damage is increased at a time when the fruit is most susceptible to bruising.

Self-Taring Banana Scale and Rotary Table

The self-taring banana scale makes it possible to weigh bananas as they are packed, thereby eliminating one handling operation. This scale is shown in figure 42. Weighing and packing by this method involves the following sequence of operations: (1) An empty box is placed on the special box rack of the scale, (2) the bottom of the box is covered with pad material and the scale adjusted to zero; (3) bananas are packed to the desired net weight; and (4) the packed box is removed from the scale and stacked. This method most frequently is used in connection with a rotary packing table (fig. 38).

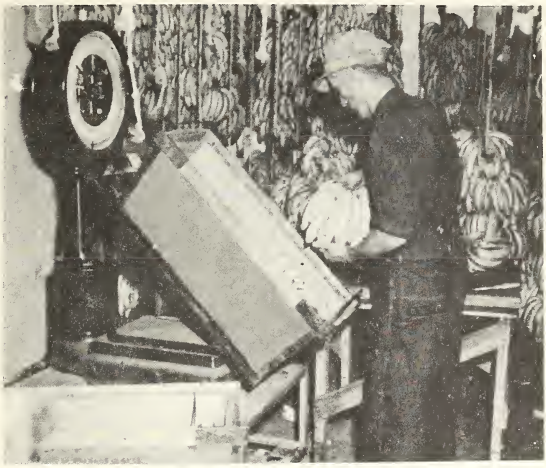


Figure 42.--Weighing and boxing bananas in a single operation by use of self-taring scale.

The labor required for weighing and boxing fruit by this method, as shown in table 28, is 7.43 man-hours per carload equivalent. This method reduces the labor required by the weighing trays and platform scale by more than a third. There also is some reduction in the wait time resulting from the interdependence of two operations.

Table 28.--Labor required for 1 man to weigh and box a carload equivalent of 450 packed boxes with self-taring banana scale and rotary table

Time item	Productive time
	Man-hours
Place boxes on scale, cover bottom with pad material and adjust scale dial to zero, fill boxes with 40 pounds of fruit, and remove filled boxes and place in 5-high stacks on floor	7.43

Comparison of Methods and Types of Equipment for Weighing and Boxing

Weighing and boxing with the self-taring scale and rotary table results in a total labor and equipment cost of $10.25 per carload equivalent of 450 packed boxes, as compared with $14.12 by the platform scale-weighing trays method (table 29). This represents a saving of 27 percent or $3.87. Although equipment costs are 5 times greater when using the self-taring scale and rotary table, the magnitude of savings in labor makes it the less costly method. Savings in the labor costs on 300 carloads would about equal the initial investment in a rotary table and self-taring scale.

Table 29.--Comparative labor and equipment costs for weighing and boxing a carload equivalent of 450 boxes of bananas by specified methods and types of equipment in plants handling an annual volume of 300 carloads

Method	Labor and equipment required		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	Machine-hours	Dollars	Dollars	Dollars
Two workers					
Weighing and boxing by use of platform scale and weigh tray at stationary packing table	11.15	1/ 12.30	13.94	0.18	14.12
One worker					
Weighing and boxing by use of self-taring scale at rotary packing table	7.43	2/ 14.86	9.29	.94	10.25

1/ Platform scale and weigh trays 6.15 machine-hours, stationary table 6.15 machine-hours; total 12.30 machine-hours.

2/ Self-taring scale 7.43 machine-hours, rotary packing table 7.43 machine-hours; total 14.86 machine-hours.

METHODS AND EQUIPMENT FOR MOVING PACKED BOXES OF BANANAS TO STORAGE AND SUPPLYING EMPTY BOXES

Packed boxes of bananas usually are stored in a ripening room or in a corner of the packing area before they are loaded onto delivery trucks. Where they are stored usually depends on the space available and length of time the fruit is to be held. Empty boxes are generally brought from the empty box storage area to the packing area in the nested stacks in which they are placed when returned from the retail stores.

For purposes of comparison an annual volume of 300 carloads is used. Sixty feet is the assumed distance from the packing area to the storage point both for full boxes and for empty boxes. Four different types of equipment for performing this work were studied: (1) Warehouse-type 2-wheel hand truck, (2) semilive skids and jacks, (3) pallets and pallet transporter, and (4) forklift truck and pallets.

Moving packed boxes to storage includes the following work elements: (1) Pick up the load and make ready to transport, (2) transport load, (3) set down load, and (4) return empty to work station. Supplying the packing operation with empty boxes includes: (1) Transport empty to stack of boxes, (2) pick up load of empty boxes, (3) transport empty boxes to work area, and (4) set down empty boxes at packing line.

Warehouse-Type 2-Wheel Hand Truck

The warehouse-type 2-wheel hand truck carries 5 full or 10 nested empty boxes at a time. Packers who weigh and box bananas also move the packed boxes to temporary storage and bring up empty boxes. A 2-wheel hand truck is provided each packer. A stack of 5 packed boxes is built on the floor near the scale. After the fifth box is in place the worker leaves the scale, picks up a hand truck, tilts the stack, and slides the noseplate of the truck under the bottom box. He then pulls the stack back onto the equipment and transports the full boxes to the temporary storage point where the load is positioned and released in storage as a unit. Next he returns with the empty hand truck to the packing area.

When a supply of empty boxes is needed, a worker stops packing fruit and brings up a stack of 10 empty boxes by the 2-wheel hand truck. Use of this equipment requires 90 trips per carload to move packed boxes to storage and 45 trips to supply empties. Table 30 shows that 2.19 man-hours of labor are required for placing full boxes in storage and supplying empty boxes by warehouse-type 2-wheel hand trucks.

Semilive Skids and Jacks

Skid loads consisting of 16 packed boxes are made up by the packer. When the load has been completed, the packer leaves the scale, picks up the skid jack, attaches it to the dead end of the skid, and pulls the loaded skid from the packing line to the temporary storage point. Here the skid is maneuvered into position and released. The packer then returns with the skid jack to the packing area. He moves an empty skid from a nearby supply, positions it near the scale, and resumes packing.

A supply of empty boxes is stored on a skid near the packer. When the skid load of empty boxes has been used, the empty skid is set aside for stacking packed boxes. The packer moves the skid jack to the empty box storage area, attaches it to a loaded skid,

and returns with the load to the packing area. Here he positions it and resumes the packing operation.

Table 30.--Labor required for 1 worker to move a carload equivalent of 450 packed boxes of bananas from the packing area to temporary storage and supply 450 empty boxes to packing line by use of warehouse-type 2-wheel hand trucks

Time item	Productive time
	Man-hours
Pick up 5-high stacks of packed boxes by use of warehouse-type 2-wheel hand truck	0.33
Transport 5-high stacks of packed boxes 60 feet from packing area to temporary storage and return empty	.87
Release 5-high stacks of packed boxes in temporary storage	.26
Pick up 10-box loads of empty boxes with warehouse-type 2-wheel hand truck	.16
Transport 10-box loads of empty boxes to packing area and return empty	.44
Release 10-box loads of empty boxes at packing area	.13
Total	2.19

The entire carload of 450 packed boxes can be stored on 28 skids. Only 12 skids are needed to store an equal number of empty boxes. When empty, the semilive skids are stacked 6-high or leaned against a wall so that only a relatively small amount of storage space is needed. An advantage of this system is that unit loads remain intact until packed boxes are loaded onto delivery trucks. Only 28 trips are made to transport 450 packed boxes of fruit to the loading dock.

As shown in table 31, picking up skid loads of full boxes, transporting these boxes to temporary storage, releasing the loaded skids, and returning with empty skids to the work station requires 0.83 man-hour of labor for the 28 trips that must be made. Bringing up empty boxes from the storage area requires 12 trips when 40 empty boxes are transported on each skid. This job is performed with 0.34 man-hour of labor. The labor required for both storing full boxes and supplying empties to the packing area is 1.17 man-hours.

Pallets and Pallet Transporter

A number of plants use pallets and a pallet transporter to handle both empty banana boxes and packed boxes. Pallets (40 by 48 inches) carry 30 empty banana boxes or 15 packed boxes--the latter stacked 5-boxes high with 3 stacks to a pallet. The pallet transporter cannot tier packed boxes, which limits the stacks to a maximum of 5-boxes high.

Table 31.--Labor required for 1 worker to move a carload equivalent of 450 packed boxes of bananas from the packing area to temporary storage and supply 450 empty boxes to the packing line by use of semilive skids and jacks

Time item	Productive time
	Man-hours
Pick up skid loads of 16 packed boxes of bananas at packing line by skid jack and replace empty skid	0.09
Transport packed boxes 60 feet to temporary storage and return with skid jack	.66
Release skid loads of 16 packed boxes in storage and pick up adjacent empty skid	.08
Pick up skid loads of 40 empty boxes in box storage area by skid jack	.03
Transport skid loads of empty boxes 60 feet to packing area and return with skid jack	.28
Release skid loads of 40 empty boxes in packing area	.03
Total	1.17

The method of using this equipment is similar to the semilive skid and jack method. Each packer moves his packed boxes to storage and brings up empty boxes as needed. To move a loaded pallet the forks of the pallet transporter are inserted into the pallet, the forks are raised (either electrically or hydraulically), and the load is transported to temporary storage. Pallet transporters are powered by batteries. At the storage point the pallet is maneuvered into position and lowered to the floor, the forks are withdrawn, and the worker returns to the packing area. An empty pallet is placed on the floor and the worker proceeds to load it with full boxes as they are packed. When empty boxes are needed a pallet load of 30 boxes is brought up with the pallet transporter.

Table 32 shows that the productive time required for picking up a pallet load of full boxes, transporting to temporary storage, releasing the load in storage, returning to the work station, and laying down an empty pallet is 0.97 man-hour for the 30 trips. Bringing up empty boxes in 15 trips required 0.43 man-hour of productive labor. The total labor required for transporting full pallet loads to storage and supplying empty boxes is 1.40 man-hours per carload equivalent.

Forklift Truck and Pallets

Pallets handled by a forklift truck are of the same capacity as those used with a pallet transporter. However, loaded pallets are tiered in storage, and only 12 packed boxes are placed on each pallet.

Table 32.--Labor required for 1 worker to move a carload equivalent of 450 packed boxes of bananas from the packing area to temporary storage and supply 450 empty boxes to packing line by use of pallets and pallet transporter

Time item	Productive time
	Man-hours
Pick up pallet loads of 15 packed boxes at packing area by pallet transporter	0.21
Transport pallet loads of packed boxes 60 feet to temporary storage and return empty	.57
Release pallet loads of packed boxes in temporary storage	.19
Pick up pallet loads of 30 empty boxes in storage by pallet transporter	.06
Transport pallet loads of empty boxes 60 feet to packing area	.29
Release pallet loads of empty boxes at packing area	.08
Total	1.40

If the workers who pack bananas can operate a forklift truck, each packer removes his loaded pallets and supplies himself with empty boxes as needed. However, if another worker operates the forklift truck he is called whenever pallets are to be moved.

When operated by packers the forklift truck is kept in the packing area. To move a loaded pallet to temporary storage, the forklift truck operator maneuvers the forks into the pallet, lifts it clear of the floor, and transports it to the storage area. At this point the pallet is positioned and deposited either on the floor or tiered on another pallet load of packed boxes. The forks are then withdrawn and the forklift truck returned to the packing area. When empty boxes are needed they are brought up, 30 to a pallet, by the forklift truck.

The loaded pallets are picked up, transported to temporary storage, placed in storage, and the forklift truck returned empty in 0.86 man-hour of productive time per carload equivalent (table 33). Empty boxes are brought to the work area in 0.32 man-hour of productive time. The entire job is performed by 1.18 man-hours of labor.

The forklift truck is the only equipment capable of tiering pallet loads, and in warehouses where space is at a premium this is an advantage. Pallet loads of packed boxes are tiered 2-pallets or 8 boxes high by forklift truck. When the delivery trucks are being loaded the forklift truck moves packed boxes from storage and transports them to the loading dock in a relatively short time. This also is an important consideration.

Table 33.--Labor required for 1 worker to move a carload equivalent of 450 packed boxes of bananas from the packing area to temporary storage and supply 450 empty boxes to packing line by use of pallets and forklift truck

Time item	Productive time
	Man-hours
Pick up pallet loads of 12 packed boxes each at packing area by forklift truck	0.13
Transport pallet loads of packed boxes 60 feet to temporary storage and return empty	.56
Release pallet loads of packed boxes in storage	.17
Pick up pallet loads of 30 empty boxes in storage by forklift truck	.06
Transport empty boxes 60 feet to packing line	.22
Release pallet loads of empty boxes at packing area	.04
Total	1.18

Comparison of Specified Methods and Types of Equipment Used for Moving Packed Boxes from Packing Area to Storage and Empty Boxes from Storage to Packing Area

In this comparison the annual volume handled is assumed to be 300 carloads of bananas and the transportation distances 60 feet. For purposes of this report the storing of packed boxes is considered to be the last of the banana-handling operations. Although packed bananas still must be picked up, transported to the loading dock, and stowed on delivery trucks, this work is an integral part of the loading-out operation which has been covered in a previous report. 3/

The method employing warehouse-type 2-wheel hand trucks cost $2.79 per carload (table 34). The pallets and pallet transporter cost was 57 percent greater, or $4.39 per carload. The cost of semilive skids and jacks was $2.68 per carload, and pallets and forklift truck $3.82 per carload.

The warehouse-type 2-wheel hand trucks, semilive skids and jack, and pallets and pallet transporter are used only to store full boxes and bring up empty boxes. The entire cost of the equipment must be charged to this operation. The forklift truck is used for receiving and bringing up ripe bananas, as well as for storing packed boxes and moving empty boxes to the packing area, and its cost is distributed among all operations.

3/ Marketing Research Report No. 15, *An Analysis of Some Methods of Loading Out Delivery Trucks of Produce Wholesalers*, USDA.

Table 34.--Comparative labor and equipment costs for moving 450 packed boxes of bananas from packing area to temporary storage and 450 empty boxes from storage to packing area by 4 specified methods 1/

Method	Labor and equipment required		Labor and equipment costs		
	Labor	Equipment	Labor 2/	Equipment	Total
	Man-hours	Machine-hours	Dollars	Dollars	Dollars
Warehouse-type 2-wheel hand trucks	2.19	3/ 4.38	2.74	0.05	2.79
Semilive skids and jacks	1.17	4/ 1.17	1.46	1.22	2.68
Pallets and pallet transporter	1.40	5/ 2.80	1.75	2.64	4.39
Pallets and forklift truck	1.18	6/ 2.36	1.77	2.05	3.82

1/ Based on annual volume of 300 cars and a transportation distance of 60 feet in moving packed boxes from packing area to temporary storage, and in moving empty boxes from storage to the packing area.

2/ Based on $1.25 per hour for unskilled labor, $1.50 per hour for forklift truck operator.

3/ Based on cost of 2 warehouse-type 2-wheel hand trucks charged entirely to this operation $0.05.

4/ Thirty semilive skids with jacks 1.17 machine-hours. Charged entirely to this operation $1.22.

5/ Forty pallets and pallet transporter 1.40 machine-hours each; total 2.80 machine-hours. Entire cost charged to this operation $2.64.

6/ Forty pallets and forklift truck 1.18 machine-hours each; total 2.36 machine-hours. Pallets charged entirely to operation $0.35. Forklift truck charged 1.18 machine-hours $1.70.

The warehouse-type 2-wheel hand truck has the advantage of low equipment costs ($0.05 per car) but is limited in the number of boxes that can be handled. This equipment cannot tier and the full boxes are stacked only 5 high. During the loading-out operation the boxes must be transported to the dock in units of 5 boxes, or restacked onto another piece of transporting equipment.

The semilive skid and jack method has the lowest labor cost ($1.46 per car) and, except for the warehouse-type 2-wheel hand truck, the lowest equipment cost ($1.22 per car). Each skid has a capacity of 16 packed or 40 empty boxes. Fewer trips are made with the semilive skid and jack method than with any other, which accounts for lower labor requirements.

When pallets are used with a pallet transporter both labor and equipment requirements are relatively high ($1.75 and $2.64 per car). Each pallet carries 15 packed or 40 empty boxes. The packed boxes remain on the pallets during storage and until ready for loading into delivery trucks. A disadvantage of this equipment is that it is not adaptable to any other banana-handling operation.

When the pallets are transported and stored with a forklift truck, only 12 packed boxes are placed on a pallet, permitting tiering the loaded pallets and fuller utilization of the storage space. The forklift truck also is used in receiving and bringing up bunches, thus distributing its cost over 3 operations. The total labor and equipment costs for storing packed boxes and supplying empty boxes to the packing line is $3.82 per carload of bananas. This is $1.14 more per car than the lowest cost method, and $0.57 less than the pallet and pallet transporter method.

With all these methods, the equipment must be available to the workers at all times. Even though used only intermittently during the operation, the equipment must be on hand when it is needed. Some of the equipment is relatively costly and is in actual use but a small part of the time. However, it would be inefficient to schedule its use for other warehouse operations while bananas are being handled.

COMBINATIONS OF EQUIPMENT FOR PACKING-OUT RIPE BANANAS

In previous sections, moving bananas from the ripening room to the cutting area, cutting, weighing and packing, placing packed boxes in temporary storage, and supplying empty boxes have been discussed as separate groups of operations. They are, however, performed either simultaneously or in sequence, depending on the crew arrangement, and together make up a cycle of operations.

The rate at which fruit is cut and packed sets the pace for other operations, including the rate at which fruit is brought from the ripening room to the packing area, and the rate packed fruit is moved from the packing area to temporary storage. The rate of output of the packing crew is determined by the number of assigned workers and the method used. Generally, less unproductive time results when small crews are used.

In combining these operations in the sections that follow, the minimum crew size necessary to pack out at least a carload equivalent of 450 packed boxes per day is shown.

Method A--Manual Handling, Stationary Cutting Stand, Rotary Table, Self-Taring Scales, and Warehouse-Type 2-Wheel Hand Trucks

By Method A 4 workers can pack out 450 boxes of bananas in an elapsed time of 5.11 hours (table 35). The total labor required is 20.44 man-hours. About 6 percent of this labor is unproductive time, most of which is lost by the worker moving fruit from the ripening room to the cutting area. Normally, when distances are short, this man works at the packing table between trips to the ripening room. However, at a distance of 60 feet, it is more important that the worker devote full time to the job of supplying fruit to the cutting area. One worker cuts fruit on a stationary stand and places it on the rotary table. Two packers supply empty boxes for the line and move all packed boxes to temporary storage. By this method a 4-man crew can pack out about 1½ carload equivalents, or about 700 boxes, during an 8-hour day.

Method B--Hydraulic Bunch Lift Truck, 4-Wheel Banana Trucks, Rotary Table, Self-Taring Scales, and Semilive Skids and Jacks

In this method the bring-up man uses a hydraulic bunch lift truck to remove ripe fruit from the hanging position in the ripening room and transfer it to a 4-wheel banana truck. The loaded banana truck then is pushed to the cutting area. Fruit is cut from bunches on this truck. By using the lift truck ripe fruit is handled mechanically, which reduces the damage and bruising caused by manual handling.

Table 35.--Labor required by a 4-man crew to pack out a carload equivalent of 450 boxes of bananas by manual handling, stationary cutting stand, rotary table, self-taring scales, and warehouse-type 2-wheel hand trucks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.42
Move fruit manually from ripening room to cutting area:		
Pick up bunches in ripening room	0.57	
Manually transport 60 feet and return empty	2.69	
Hang bunches on cutting stand	.41	
Total transport		3.67
Cut fruit from bunches on stationary stand		4.70
Weigh and pack 40-pound boxes using self-taring scales and rotary table; stack boxes 5-high on floor		7.43
Move full boxes from packing area to temporary storage by warehouse-type 2-wheel hand truck:		
Pick up 5-high stacks of packed boxes	.33	
Transport 60 feet and return empty	.87	
Release in temporary storage	.27	
Total transport		1.47
Supply empty boxes to packing line by warehouse-type 2-wheel hand truck:		
Pick up 10-high stack of empty boxes in storage	.16	
Transport 60 feet to packing line and return empty	.44	
Release at packing line	.12	
Total transport		.72
Clean up		.78
Total productive labor		19.19
Unproductive labor:		
Bring-up man waits on cutter		1.14
Cutter waits on packers		.11
Total unproductive labor		1.25
Total labor		20.44
Elapsed hours		5.11

1/ Crew organization: Four men set up, then 1 man manually moves bunches from ripening room to packing line, 1 man cuts hands, 2 men supply empty boxes to packing line, weigh and pack, and move full boxes from packing area to temporary storage. On completion 4 men clean up.

One worker devotes full time to cutting fruit. Although he waits a total of 0.62 hour per carload equivalent, this wait time is in short intervals which would be difficult to utilize for other operations. Packing is done by 1 worker, who also brings up empty boxes and moves full boxes to temporary storage, and by the bring-up man when he is not moving fruit from the ripening room to the cutting area.

With a 3-man crew, a total of 17.59 man-hours of labor per carload equivalent of 450 packed boxes is required, in an elapsed time of 5.86 hours (table 36). In an 8-hour day this crew can pack out 615 boxes.

Table 36.--Labor required by a 3-man crew to pack out a carload equivalent of 450 boxes of bananas by hydraulic bunch lift truck, 4-wheel banana trucks, self-taring scales, rotary table, and semilive skids and jacks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.41
Move fruit from ripening room to cutting area:		
Load 8 bunches on 4-wheel banana truck with hydraulic bunch lift truck	1.92	
Transport 60 feet and return empty truck	.39	
Release loaded 4-wheel truck at packing line and pick up adjacent empty truck	.05	
Total transport		2.36
Cut fruit from bunches on 4-wheel banana truck		4.90
Weigh and pack 40-pound boxes using self-taring scales and rotary table; stack boxes 4-high on skid		7.51
Move full boxes from packing area to temporary storage:		
Pick up 16-box skid load with jack	.09	
Transport 60 feet and return empty	.66	
Release in temporary storage	.08	
Total transport		.83
Supply empty boxes to packing line:		
Pick up 40-box skid load of empty boxes in storage with jack	.03	
Transport 60 feet and return empty	.28	
Release at packing line	.03	
Total transport		.34
Clean up		.62
Total productive labor		16.97
Unproductive labor:		
Cutter waits on packers		.62
Total unproductive labor		.62
Total labor		17.59
Elapsed hours		5.86

1/ Crew organization: Three men set up, then 1 man loads bunches on 4-wheel banana truck with hydraulic bunch lift truck, moves load from ripening room to packing line and helps pack. One man cuts fruit, 1 man supplies empty boxes to packing line, weighs and packs, and moves full boxes from packing area to temporary storage with help of bring-up man. On completion 3 men clean up.

Method C--4-Wheel Banana Truck, Rotary Table, Self-Taring Scales, and Warehouse-Type 2-Wheel Hand Trucks

As shown in table 37, by Method C, 17.10 man-hours are required to pack out 450 boxes of bananas, which is 16 percent less labor than that required by Method A and 3 percent less than that required by Method B. Only 0.03 man-hour of wait time is recorded.

Table 37.--Labor required by a 5-man crew to pack out a carload equivalent of 450 boxes of bananas by 4-wheel banana truck, rotary table, self-taring scales, and warehouse-type 2-wheel hand trucks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.36
Move fruit from ripening room to cutting area by 4-wheel banana truck:		
Load 8 bunches on trucks	1.10	
Transport 60 feet and return empty	.39	
Release loaded 4-wheel trucks at packing line and pick up adjacent empty trucks	.05	
Total transport		1.54
Cut fruit from bunches on 4-wheel banana truck		4.90
Weigh and pack 40-pound boxes using self-taring scales and rotary table; stack boxes 5-high on floor		7.43
Move full boxes from packing area to temporary storage by warehouse-type 2-wheel hand truck:		
Pick up 5-high stacks of packed boxes	.33	
Transport 60 feet and return empty	.87	
Release in temporary storage	.27	
Total transport		1.47
Supply empty boxes to packing line by warehouse-type 2-wheel hand truck:		
Pick up 10-high stacks of empty boxes in storage	.16	
Transport 60 feet and return empty	.44	
Release at packing line	.12	
Total transport		.72
Clean up		.65
Total productive labor		17.07
Unproductive labor:		
Packers wait on cutters		.03
Total unproductive labor		.03
Total labor		17.10
Elapsed hours		3.42

1/ Crew organization: Five men set up, 1 man moves bunches from ripening room to packing line with 4-wheel bunch truck, then helps cut, 1 man cuts with help of bring-up man, 3 men weigh and pack, supply empty boxes to packing line and move full boxes from packing area to temporary storage. On completion 5 men clean up.

Although a 5-man crew has the greatest labor efficiency by this method, it is sufficiently flexible to permit any size crew from 2 to 5 workers to operate productively at the packing line with little wait time. In a 5-man crew, 2 workers supply fruit to the packing line and cut it from the stems while the other 3 workers weigh and pack the fruit, get empty boxes as needed, and move packed boxes to temporary storage.

By this method a 5-man crew can pack out 450 boxes in an elapsed time of 3.42 hours. In an 8-hour day this crew can pack out 1,050 boxes.

Method D--Manual Monorail Conveyor System, Rotary Table, Self-Taring Scales, and Semilive Skids and Jacks

Method D requires about the same amount of labor as Method C. Table 38 shows that 17.18 man-hours of labor are required to pack out 450 boxes. Only 3 workers are needed for a balanced crew. Of these, the cutter spends 1.29 man-hours waiting. This wait time could be utilized if the cutter helped other workers move fruit from the ripening room to the packing area, thus reducing total labor requirements about 8 percent.

By this method a 3-man crew can pack out 450 boxes in 5.73 hours. In an 8-hour day this 3-man crew can handle about 1.4 carload equivalents, or 630 boxes.

Method E--Manual Monorail *Ripen-on-Carrier* Conveyor System, Rotary Table, Self-Taring Scales, and Semilive Skids and Jacks

As shown in table 39, by Method E a 3-man crew can pack out 450 boxes of bananas with 15.76 man-hours of labor, the lowest of all methods studied. Cutting fruit requires 4.94 man-hours and sets the pace for other operations. Two workers perform all other required operations and still wait 0.54 man-hour. Three workers can pack out 450 boxes in 5.25 hours. During an 8-hour day they can pack about 685 boxes.

Method F--Forklift Truck, Position Conveyor, Rotary Table, Self-Taring Scales, and Pallets

As shown in table 40, a 3-man crew by this method can pack out 450 boxes with 18.01 man-hours, or only 12 percent less labor than Method A, even though the forklift truck used in Method F handles fruit in unit loads. Cutting fruit requires 5.65 man-hours of labor and sets the pace, and any savings that normally would accrue through the use of the lift truck is lost in wait time.

One worker and the forklift truck move all the fruit to and from the packing line. The cutter remains at his station full time. The third worker weighs and packs fruit. He is assisted by the forklift truck operator when the latter worker is not busy on other work. Although the forklift truck operator and the packer are idle 1.47 man-hours, they are unable to help the cutter perform his work because the position conveyor is so designed that only 1 worker can operate at the cutting station.

By this method a 3-man crew can bring up, cut, pack, and store 450 boxes in an elapsed time of 6.00 hours. At this rate, the crew can pack 75 boxes an hour, or 600 boxes during an 8-hour day.

Table 38.--Labor required by a 3-man crew to pack out a carload equivalent of 450 boxes of bananas by manual monorail conveyor, rotary table, self-taring scales, and semilive skids and jacks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.36
Move fruit from ripening room to cutting area by manual monorail conveyor system:		
Load bunches on monorail	1.41	
Transport 60 feet and return empty	.44	
Release carriers at packing line and assemble adjacent empty carriers	.25	
Total transport		2.10
Cut fruit from bunches on manual monorail conveyor system		4.10
Weigh and pack 40-pound boxes using self-taring scales and rotary table; stack boxes 4-high on semilive skids		7.51
Move full boxes to temporary storage by semilive skids and jack:		
Pick up 16-box skid load with jack	.09	
Transport 60 feet and return empty	.66	
Release in temporary storage	.08	
Total transport		.83
Supply empty boxes to packing line by semilive skids and jack:		
Pick up 40-box skid load of empty boxes in storage with jack	.03	
Transport 60 feet and return empty	.28	
Release at packing line	.03	
Total transport		.34
Clean up		.65
Total productive labor		15.89
Unproductive labor:		
Cutter waits on packers		1.29
Total unproductive labor		1.29
Total labor		17.18
Elapsed hours		5.73

1/ Crew organization: Three men set up, 1 man removes bunches from ripening room to packing line on manual monorail conveyor system, then assists in weighing and packing, 1 man cuts fruit, 1 man with help from bring-up man weighs and packs fruit, supplies empty boxes to packing line, and moves full boxes from packing area to temporary storage. On completion 3 men clean up.

Table 39.--Labor required by a 3-man crew to pack out a carload equivalent of 450 boxes of bananas by manual monorail *ripen-on-carrier* conveyor, self-taring scales, rotary table, and semilive skids and jacks 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.33
Move fruit from ripening room to cutting area by manual monorail *ripen-on-carrier* conveyor system:		
Pick up loaded carriers in room	0	
Transport 60 feet and return empty	0.62	
Release loaded carriers at packing line and assemble adjacent empty carriers	.04	
Total transport		.66
Cut fruit from bunches using manual monorail *ripen-on-carrier* conveyor system		4.94
Weigh and pack 40-pound boxes using self-taring scales and rotary table; stack boxes 4-high on semilive skids		7.51
Move full boxes from packing area to temporary storage by semilive skids and jack:		
Pick up 16-box skid loads with jack	.09	
Transport 60 feet and return empty	.66	
Release in temporary storage	.08	
Total transport		.83
Supply empty boxes to packing line by semilive skids and jack:		
Pick up 40-box skid loads of empty boxes in storage with jack	.03	
Transport 60 feet and return empty	.28	
Release at packing line	.03	
Total transport		.34
Clean up		.61
Total productive labor		15.22
Unproductive labor:		
Packers wait on cutters		.54
Total unproductive labor		.54
Total labor		15.76
Elapsed hours		5.25

1/ Crew organization: Three men set up, 1 man removes bunches from ripening room to packing line by use of manual monorail *ripen-on-carrier* conveyor system, then assists in weighing and packing, 1 man cuts fruit, 1 man with help from bring-up man weighs and packs fruit, supplies empty boxes to packing line, and removes full boxes from packing area to temporary storage. On completion 3 men clean up.

Table 40.--Labor required by a 3-man crew to pack out a carload equivalent of 450 boxes of bananas by forklift truck, position conveyor, rotary table, self-taring scales, and pallets 1/

Time item	Labor required	
	Man-hours	Man-hours
Productive labor:		
Set up		0.37
Move fruit from ripening room to cutting area by forklift truck:		
Change forks to special attachment	0.19	
Pick up loaded 6-bunch carriers in room	.14	
Transport 60 feet and return empty	.63	
Release loaded carrier on position conveyor	.33	
Total transport		1.29
Cut fruit from bunches on position conveyor		5.65
Weigh and pack 40-pound boxes using self-taring scales and rotary table, stack boxes 4-high on pallet		7.36
Move full boxes to temporary storage by forklift truck:		
Pick up 12-box pallet loads	.13	
Transport 60 feet and return empty	.56	
Release in temporary storage	.17	
Total transport		.86
Supply empty boxes to packing line by forklift truck:		
Pick up 30-box pallet loads of empty boxes	.06	
Transport 60 feet and return empty	.22	
Release at packing line	.04	
Total transport		.32
Clean up		.69
Total productive labor		16.54
Unproductive labor:		
Packers wait on cutter		1.47
Total unproductive labor		1.47
Total labor		18.01
Elapsed hours		6.00

1/ Crew organization: Three men set up, 1 man moves bunches 60 feet from ripening room to position conveyor in packing area by use of forklift truck. Forklift truck operator then weighs and packs fruit, supplies all empty boxes to packing line, and moves all full boxes from packing area to temporary storage. One man cuts fruit and 1 man weighs and packs boxes. On completion 3 men clean up.

Comparison of Labor and Equipment Costs for Packing Out Ripe Bananas by Selected Combinations of Equipment

Table 41 shows the labor and equipment costs for packing out a carload equivalent of 450 boxes of bananas by selected combinations of equipment. In these cost computations, the distances from the ripening room to the packing area and from the packing area to temporary storage both are standardized at 60 feet. The annual volume of banana receipts is assumed to be 300 carloads. Labor costs include all productive time plus the wait time that occurs in performing identifiable pack-out operations. Equipment costs are the hourly cost rate times the machine-hours of actual use in each operation. The cost of banana boxes is not included.

Table 41.--Comparative labor and equipment costs per carload equivalent of 450 boxes for packing out ripe bananas by 6 specified methods 1/

Method	Crew size	Elapsed time	Labor and equipment required: Labor	Equipment	Labor and equipment costs: Labor	Equipment:	Total
	Number	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
A	4	5.11	20.44	30.66	25.55	2/ 1.31	26.86
B	3	5.86	17.59	46.88	21.99	3/ 3.13	25.12
C	5	3.42	17.10	34.20	21.38	4/ 1.74	23.12
D	3	5.73	17.18	26.70	21.48	5/ 5.29	26.77
E	3	5.25	15.76	26.25	19.70	6/ 15.85	35.55
F	3	6.00	18.01	42.00	24.01	7/ 6.54	30.55

1/ Transportation distances from ripening room to packing area and from packing area to temporary storage standardized at 60 feet. Annual volume of 300 carload equivalents assumed.

2/ All equipment chargeable entirely to operations indicated: Stationary stand $0.02, rotary table $0.64, 2 self-taring scales $0.60, 2 warehouse-type 2-wheel hand trucks $0.05, total cost $1.31.

3/ Hydraulic bunch lift truck used 5.86 machine-hours $0.47. All other equipment chargeable to operations indicated: Three 4-wheel banana trucks $0.20, rotary table $0.64, 2 self-taring scales $0.60, and skids and jacks $1.22, total cost $3.13.

4/ Three 4-wheel banana trucks used 3.42 machine-hours each $0.13. All other equipment chargeable entirely to operations indicated: 3 self-taring scales $0.89, rotary table $0.64, 3 warehouse-type 2-wheel hand trucks $0.08, total cost $1.74.

5/ Manual monorail conveyor system used 5.73 machine-hours $2.83. All other equipment chargeable entirely to operations indicated: Rotary table $0.64, 2 self-taring scales $0.60, skids and jacks $1.22, total cost $5.29.

6/ Manual monorail *ripen-on-carrier* conveyor system used 5.25 machine-hours $13.39. All other equipment chargeable entirely to operations indicated: Rotary table $0.64, 2 self-taring scales $0.60, skids and jacks $1,22, total cost $15.85.

7/ Forklift truck and 6-bunch carriers used 6.00 machine-hours $4.01. All other equipment chargeable entirely to operations indicated: Rotary table $0.64, 2 self-taring scales $0.60, position conveyor $0.94, pallets $0.35, total cost $6.54.

Method C is the least costly method for packing-out bananas, with total labor and equipment costs of $23.12 per carload equivalent. Both labor and equipment costs are relatively low in comparison with other methods studied. By this method, a 5-man crew gives the lowest total cost. However, the crew size can be reduced to 4 or 2 workers without any appreciable increase in total cost. The adoption of Method C in preference to Method D should save $3.65 per carload equivalent, or about $1,100 annually on a 300 carload volume. Moreover, a 5-man crew by use of Method C should be able to efficiently pack out about 750 cars annually with no increase in cost per carload equivalent.

The next best method, when considering total labor and equipment costs, is Method B. By Method B the labor cost per car is about the same as for Method C, but the equipment cost is nearly doubled. Total labor and equipment costs per carload equivalent are $2.00 more than by Method C. However, manual handling of ripe fruit in moving it from the ripening room to the cutting area is eliminated, and it safely can be assumed that less damage is likely to occur.

Method E incurs the lowest labor costs of all methods studied. However, equipment costs of $15.85 per carload is the highest of all methods studied. Total labor and equipment costs for packing a carload equivalent amounts to $35.55--or $12.43 more than the lowest cost method. As in Method B, individual bunches of ripe fruit are not manually handled, and it safely can be assumed that a minimum of damage to fruit is likely to occur during pack-out operations.

Method F, which utilized the forklift truck to move bananas to and from the packing line, is the second most expensive method studied. Total labor and equipment costs per carload are $30.55, or $7.43 greater than the least costly method. Although this equipment utilizes the unit-load principle of handling, the method saves no labor. The cost of $6.54 per carload equivalent for equipment is almost 4 times that of Method C.

COMBINATIONS OF EQUIPMENT FOR RECEIVING AND PACKING OUT BANANAS

Estimates of labor and equipment costs for the entire cycle of receiving and packing out operations by various combinations of equipment previously discussed are shown in table 42. As there are several variations in methods for receiving incoming fruit and for handling packed fruit, the estimated costs for the entire operation depend on the combinations used. These costs are limited to those of labor and equipment as annual fixed costs for the building and indirect costs of office and management expenses are not included.

Estimated costs, based on a 300-carload annual volume of fruit handled, are shown for 7 different combinations of equipment and methods. These costs should reflect reasonably well their relative efficiency when the various operations are performed in different types of plants at comparable levels of efficiency. However, the costs shown for a given combination may not compare closely with actual costs if operating conditions in a plant are markedly different from the operating conditions on which the cost estimates are based.

The 4-wheel banana truck provides the lowest cost method for handling bananas in wholesale plants. When handled by this equipment, the cost per carload for receiving and

Table 42.--Comparative labor and equipment costs for receiving and packing out a carload equivalent (250 bunches and 450 packed boxes) of bananas by specified methods and combinations of types of equipment 1/

Method (by type of equipment and cycles of operations)	Crew size	Elapsed time	Labor and equipment required		Labor and equipment costs 2/		
			Labor	Equipment	Labor	Equipment	Total
	Number	Hours	Man-hours	Machine-hours	Dollars	Dollars	Dollars
Manual handling:							
Receiving manually from road trucks or railroad cars into ripening rooms	4	1.83	7.33	-	9.16	0	9.16
Packing by stationary cutting stand, rotary table, self-taring scales, and warehouse-type 2-wheel hand trucks	4	5.11	20.44	30.66	25.55	1.31	26.86
Total		6.94	27.77	30.66	34.71	3/ 1.31	36.02
2-wheel bunch trucks and hydraulic bunch lift truck:							
Receiving by 2-wheel bunch trucks and hydraulic bunch lift truck	5	1.20	6.00	4.80	7.50	.49	7.99
Packing by hydraulic bunch lift truck, 4-wheel banana trucks, rotary table, self-taring scales, and semilive skids and jacks	3	5.86	17.59	44.16	21.99	3.13	25.12
Total		7.06	23.59	48.96	29.49	4/ 3.62	33.11
4-wheel banana trucks:							
Receiving by 4-wheel banana trucks	3	1.69	5.06	5.06	6.33	.07	6.40
Packing by 4-wheel banana trucks, rotary table, self-taring scales, and warehouse-type 2-wheel hand trucks	5	3.42	17.10	34.20	21.38	1.74	23.22
Total		5.11	22.16	39.26	27.71	5/ 1.81	29.62
Continuous powered monorail conveyor and 4-wheel banana trucks:							
Receiving by continuous powered monorail conveyor	4	1.23	4.92	1.23	6.15	2.63	8.78
Packing by 4-wheel banana trucks, rotary table, self-taring scales, and warehouse-type 2-wheel hand trucks	5	3.42	17.10	34.20	21.38	1.81	23.29
Total		4.65	22.02	35.43	27.53	6/ 4.44	32.07
Manual monorail conveyor system:							
Receiving by monorail system	4	1.33	5.34	1.33	6.68	.71	7.39
Packing by monorail system, rotary table, self-taring scales, and semilive skids and jacks	3	5.73	17.18	26.70	21.48	5.29	26.77
Total		7.06	22.52	28.03	28.16	7/ 6.00	34.16
Manual monorail "ripen on carrier" conveyor system:							
Receiving by manual monorail "ripen on carrier" system	5	1.10	5.49	3.30	6.86	2.86	9.72
Packing by manual monorail "ripen on carrier" system, rotary table, self-taring scales, and semilive skids and jacks	3	5.25	15.76	26.25	19.70	15.85	35.55
Total		6.35	21.25	29.55	26.56	8/ 18.71	45.27
Forklift truck:							
Receiving by forklift truck	4	1.27	5.08	1.27	6.67	1.08	7.75
Packing by forklift truck, position conveyor, rotary table, self-taring scales, and forklift truck and pallets	3	6.00	18.01	42.00	24.01	6.54	30.55
Total		7.27	23.09	43.27	30.68	9/ 7.62	38.30

1/ Annual volume is assumed to be 300-carload equivalents. Transportation distances have been standardized as follows: (1) Receiving to storage in ripening room 100 feet, (2) removing fruit from ripening room to packing line 60 feet, (3) removing packed boxes from packing line to temporary storage 60 feet, and (4) supplying empty boxes from storage to packing line 60 feet.

2/ Labor costs computed from wage rates of $1.25 per hour for unskilled labor and $1.50 per hour for semiskilled (forklift truck operator) labor. Equipment costs computed from data on ownership and operating costs shown in table 50 of the Appendix.

3/ Cost of 1 stationary cutting stand, 1 rotary table, 2 self-taring scales, and 2 warehouse-type 2-wheel hand trucks.

4/ Cost of three 2-wheel bunch trucks, 1 hydraulic bunch lift truck, three 4-wheel banana trucks, 1 rotary table, 2 self-taring scales, and 30 semilive skids with jacks.

5/ Cost of three 4-wheel banana trucks, 1 rotary table, 3 self-taring scales, and 3 warehouse-type 2-wheel hand trucks.

6/ Cost of 1 continuous powered monorail conveyor, three 4-wheel banana trucks, 1 rotary table, 3 self-taring scales, and 3 warehouse-type 2-wheel hand trucks.

7/ Cost of 1 manual monorail conveyor, 1 rotary table, 2 self-taring scales, and 30 semilive skids with jacks.

8/ Cost of 1 manual monorail "ripen on carrier" conveyor, two 3-bunch 2-wheel banana trucks, 1 rotary table, 2 self-taring scales, and 30 semilive skids with jacks.

9/ Cost of 1 forklift truck and attachment, 1 lowerator, 312 6-bunch carriers, 1 position conveyor, 1 rotary table, 2 self-taring scales, and 40 pallets.

packing bananas amounts to $29.62. A crew of 5 workers can perform all receiving and packing operations in a plant handling 300 carloads annually. This crew can be reduced to 3 men on slow days, or when labor is not available with only a slight increase in labor costs; but with a significant increase in elapsed time. Both labor and equipment requirements are low in comparison to other methods studied. Labor costs are $27.71 and equipment costs are $1.81 per carload equivalent. The facility layout and minor differences in transportation distances have but little effect on the cost of handling by this method.

Some of the other types of materials-handling equipment are relatively efficient for receiving fruit and handling through the packing line. However, none of them afford sufficient labor savings over the 4-wheel banana truck method to justify the additional cost of the equipment. The manual monorail *ripen-on-carrier* conveyor, the most expensive equipment to operate, only reduces labor requirements about 1 man-hour per carload for all operations below that required when 4-wheel banana trucks are used.

When bananas are handled in multistory plants, the continuous-powered monorail conveyor has certain advantages over other types of equipment. Use of this equipment to transport and elevate in the receiving operations materially reduces handling costs compared with other methods and facilitates the easy movement of fruit between floors.

Manual handling requires about one-fourth more labor than the mechanized conveyor and forklift truck systems. In smaller plants, where the annual hours of equipment use are less, where elapsed time is not so important, and transportation distances are shorter, manual handling may be about as efficient as other methods. In fact, at distances of 50 feet or less, receiving fruit manually probably is the lowest cost of all methods.

Labor and equipment costs shown for handling bananas by different methods indicate that those employing relatively expensive equipment do not materially reduce labor costs for receiving and packing. Thus, equipment costs are increased with but little compensating decrease in labor costs. Therefore, expensive equipment installations would have to be justified through savings in damaged fruit and increased quality of the packed bananas.

Two methods have possibilities for reducing damage to the fruit. One, the manual monorail *ripen on carrier* is the most expensive of all methods studied, and it is unlikely that savings in reduced damage would compensate for the high cost of the equipment. The hydraulic bunch-lift truck, when used either with 2-wheel or 4-wheel hand trucks, is relatively inexpensive to own and operate and appears to offer possibilities for reducing damage to fruit.

Total labor and equipment costs by this method are only $3.49 per carload more than the least costly 4-wheel banana truck method. It is possible that reduced damage to fruit plus a higher quality packed fruit would compensate for or exceed this difference in cost. If savings in shrinkage and damage could be completed in exact monetary terms and combined with labor and equipment costs, it is possible that the 2-wheel bunch truck with hydraulic bunch-lift truck method would be the most economical of all methods studied.

Both the forklift truck and manual monorail *ripen-on-carrier* conveyor systems incur relatively high equipment costs. Although some savings in labor are effected by use of this equipment, they are not sufficient to pay for the extra equipment costs. However, other features of these methods include a reduction in the number of workers to perform

the operations in the same or less elapsed time. Better personnel relations may be maintained when the back-breaking job is made easier, and more bananas can be handled by the worker when fatigue is reduced. Of significant importance is the possibility of reducing damage to the fruit by mechanical handling. It is possible that this may be of sufficient importance to individual dealers to justify certain types of equipment. This would be true where the savings in reduced damage are great enough to pay for the increased labor and equipment costs.

EFFECT OF VOLUMES OF BANANAS HANDLED ON LABOR AND EQUIPMENT REQUIREMENTS AND COSTS

Previous discussions have dealt with labor and equipment requirements and costs for various methods in plants handling an assumed annual volume of 300 carload equivalents of bananas. The purpose of this section is to show the effects of both larger and smaller volumes on labor and equipment requirements and on total costs.

As the annual volume handled increases up to the capacity of the equipment used, the equipment cost per carload decreases. Even when the annual volume handled is relatively small, a certain amount of equipment is necessary even though it may not be fully utilized. And equipment costs must be distributed over this volume. As the volume handled increases beyond the capacity of existing equipment, additional equipment must be acquired.

Some of the same considerations are involved in the use of labor, particularly for those methods that require crews of a fixed size. Therefore, both labor and equipment costs per unit of volume handled tend to decrease as the volume handled increases up to the point of need for additional equipment and labor.

Effect of Volume on Labor Requirements

In plants that handle 100 carloads annually or 2 carloads per week, 2 or 3 workers may make a reasonably well-balanced crew. Even with this volume the workers would need to devote only part of their time to banana handling. For instance, when using 4-wheel banana trucks, the labor required for a crew of 3 men to pack out 1 carload of fruit is roughly 18 man-hours or a total of 36 man-hours per week to pack out 2 carloads (table 43).

Table 43.--Utilization of the time of crew by specified sizes for handling specified volumes of bananas by 4-wheel banana trucks

Volume handled		Assigned labor		Labor distribution per week			
Annually	Weekly	Crew size	Available labor 1/	Packing	Receiving	Total productive work	Remainder available for other work
Cars	Cars	Number	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours
100	2	3	120	36	10	46	74
300	6	5	200	103	30	133	67
500	10	5	200	171	51	222	-22

1/ Based on 40-hour week.

If the workweek is 40 hours, the 3-man crew is employed a total of 120 man-hours, but only 36 man-hours, or 30 percent of the total, are required for packing out bananas. Therefore, this crew has ample time to receive the fruit without interfering with the packing out operation. Receiving fruit by 4-wheel banana trucks requires roughly 10 man-hours for 2 carload equivalents and brings the total labor requirement for both receiving and packing out to about 46 man-hours. This would leave about 74 man-hours per week, or 62 percent of the total time, for the other work.

In plants handling an annual volume of 300 carloads of bananas, additional workers are needed in the crew for both receiving and packing out fruit. Five workers using 4-wheel banana trucks can perform all banana handling operations with 133 man-hours of labor, leaving about one-third of their time available for other work.

However, if only 3 men were assigned to the crew, they could perform only the packing out operations, leaving receiving operations to be performed by other workers. The 3-man crew could perform all operations required in handling 300 carloads annually by working overtime, usually during the latter part of the week when sales are heavier. In some plants, therefore, it may be more economical to assign extra men to this work on days when workloads are heavy than to employ a 5-man crew full time.

In plants handling an annual volume of 500 carloads, an average of 2 cars must be packed out each day which requires a crew of 5 men. This crew will work 171 of the available 200 man-hours weekly packing out fruit. This leaves insufficient time during the regular working day for this crew to receive fruit. As banana receipts usually arrive twice each week, at times 4 to 5 cars would be on track to be unloaded during a single day. In such cases the fruit could not be received by the 5-man crew without interfering with packing out operations. Thus, receiving operations normally should be performed by a separate crew.

In most produce warehouses, banana handling operations are part of the overall warehousing operations, and labor can be shifted to this work as needed. This is particularly true in houses handling small volumes of bananas. In the larger volume plants a regular crew is usually assigned full time, and other workers are added when needed during periods of peak requirements. In plants handling bananas only such integration is not possible, and there is a problem in minimizing nonproductive labor.

Effect of Volume on Equipment Requirements

To handle even a small volume of bananas a minimum amount of equipment will be needed. Depending on methods used, this may include a packing table, cutting stand, scales, and transportation equipment for moving packed boxes to storage. In all except the manual method, additional items of equipment are needed to transport bunches to the ripening rooms and later to the packing area. Some types of transportation equipment also are used to hold bunches for cutting. The needed equipment of each type is determined by the volume handled and methods used for receiving and packing out fruit. The equipment requirements shown are based on an 8-hour day at the lowest labor input. The manual method of receiving requires no equipment.

In plants that handle 100 carloads of bananas annually, packing out requires at least 1 stationary cutting stand, 1 self-taring scale, 1 rotary table, and 1 warehouse-type 2-wheel hand truck. To handle an annual volume of 500 carload equivalents, 2 items of each

of these types of equipment, except the rotary table, are required. Therefore, an increase of 500 percent in the annual volume handled can be accomplished without an additional rotary table and by increasing other items of equipment 100 percent.

By the 2-wheel bunch truck and hydraulic bunch-lift truck method, the annual volume handled can be increased from 100 to 500 carloads by adding the 1 hydraulic bunch-lift truck, 2 self-taring scales, and 30 semilive skids with necessary jacks.

In plants where the continuous powered monorail conveyor is used for receiving and 4-wheel banana trucks are used for packing out, the annual volume handled can be increased from 100 to 500 carloads by adding only 1 self-taring scale, 1 warehouse-type 2-wheel hand truck, and by extending the conveyor line to the additional rooms needed to ripen the increased volume.

By the manual monorail conveyor system an increase in volume from 100 to 500 carloads annually can be accomplished by adding 2 self-taring scales and 30 semilive skids with necessary jacks. However, the conveyor line must be extended to the 7 additional rooms necessary for the increased volume. Trackage must be installed in the aisles across the front of the rooms and in the aisles the full depth of each room. A switch must also be installed outside each door.

As 4-wheel banana trucks are used both for receiving and packing out, 3 trucks are necessary for handling an annual volume of 100 carloads. When more than 400 carloads are handled annually, separate trucks must be provided for receiving and packing. One hundred carloads can be packed out annually with 1 cutting table, 2 self-taring scales, and 2 warehouse-type 2-wheel hand trucks. The annual volume can be increased to 500 carloads by the addition of only 1 self-taring scale and 1 warehouse-type 2-wheel hand truck.

To increase the annual volume of bananas from 100 to 500 carloads when the manual monorail *ripen-on-carrier* conveyor system is used, 2 extra self-taring scales and 30 semilive skids with necessary jacks must be provided. Additional ripening rooms also are necessary, and each of these rooms requires a set of tracks and switches.

Up to a volume of about 400 carloads annually, 1 forklift truck can perform both the receiving and packing operations. Above this volume 1 forklift truck is required on a full-time basis in the packing operation, and another must be employed to receive fruit. When the annual volume is increased from 100 to 500 carloads, the following items of equipment must be added: 1 forklift truck, 40 pallets, 1 self-taring scale, 1 position conveyor, and 364 6-bunch carriers. If the second forklift truck is used for other handling operations, ownership costs are spread over a wider base, and the cost per carload for handling bananas is reduced.

Labor and Equipment Costs

If unproductive time resulting from changing jobs, crew regulated wait time, and avoidable delays, is not included, labor costs for each carload equivalent of bananas handled changes only slightly as the annual volume changes. For example, when the annual volume handled is 100 carloads the cost of labor required to receive and pack out 1 carload of fruit by the manual method is $34.71 (table 44). When the annual volume is increased to 500 carloads, the labor cost per carload by this method is $33.84 (table 45), or only $0.87 less. By the forklift truck method these costs are $30.68 and $29.93, respectively,

Table 44.--Comparative labor and equipment costs for receiving and packing out 100 carload equivalents of bananas annually by specified methods and types of equipment 1/

Method and type of equipment	Crew size	Elapsed time	Labor and equipment costs		
			Labor	Equipment 2/	Total
	Number	Hours	Dollars	Dollars	Dollars
Manual handling					
Receiving	4	1.83	9.16	0.00	9.16
Packing	2	10.22	25.55	2.81	28.36
All operations			34.71	3/ 2.81	37.52
2-wheel bunch truck and hydraulic bunch-lift truck					
Receiving	5	1.20	7.50	1.11	8.61
Packing	2	9.22	23.05	7.28	30.33
All operations			30.55	4/ 8.39	38.94
4-wheel banana truck					
Receiving	3	1.69	6.33	.10	6.43
Packing	3	5.93	22.24	4.04	26.28
All operations			28.57	5/ 4.14	32.71
Continuous powered monorail conveyor and 4-wheel banana truck					
Receiving	4	1.23	6.15	7.06	13.21
Packing	3	5.93	22.24	4.14	26.38
All operations			28.39	6/ 11.20	39.59
Manual monorail conveyor system					
Receiving	4	1.33	6.68	.79	7.47
Packing	2	7.97	19.94	10.55	30.49
All operations			26.62	7/ 11.34	37.96
Manual monorail "ripen on carrier" conveyor system					
Receiving	5	1.10	6.86	3.28	10.14
Packing	2	7.97	19.94	28.69	48.63
All operations			26.80	8/ 31.97	58.77
Forklift truck					
Receiving	4	1.27	6.67	2.45	9.12
Packing	3	6.00	24.01	15.65	39.66
All operations			30.68	9/ 18.10	48.78

1/ Transportation distances standardized as follows: Receiving operations 100 feet, packing operations 60 feet.

2/ Based on equipment cost shown in table 51 of the Appendix.

3/ Cost of 1 stationary cutting stand, 1 rotary table, 1 self-taring scale, and 1 warehouse-type 2-wheel hand truck.

4/ Cost of three 2-wheel bunch trucks, 1 hydraulic bunch-lift truck, three 4-wheel banana trucks, 1 rotary table, 1 self-taring scale, and 30 semilive skids with jacks.

5/ Cost of three 4-wheel banana trucks, 1 rotary table, 2 self-taring scales, and 2 warehouse-type 2-wheel hand trucks.

6/ Cost of 1 continuous powered monorail conveyor system, three 4-wheel banana trucks, 1 rotary table, 2 self-taring scales, and 2 warehouse-type 2-wheel hand trucks.

7/ Cost of 1 manual monorail conveyor system, 1 rotary table, 1 self-taring scale, and 30 semilive skids with jacks.

8/ Cost of 1 manual monorail "ripen on carrier" conveyor, two 3-bunch banana trucks, 1 rotary table, 1 self-taring scale, and 30 semilive skids with jacks.

9/ Cost of 1 forklift truck with attachment, 1 lowerator, 156 6-bunch carriers, 1 position conveyor, 1 rotary table, 2 self-taring scales, and 40 pallets.

which is a difference of only $0.75 per carload, even though 400 additional carloads are handled each year. These figures indicate that the annual volumes handled have but little effect on labor costs for the same method. As volume is increased the labor force must be increased proportionately. This increase tends to hold labor costs per carload constant.

Variations in costs resulting from changes in volumes handled are due almost entirely to changes in equipment costs. The widest range in costs between methods occurs at the lower volumes. As the number of carloads handled increases but does not exceed

Table 45.--Comparative labor and equipment costs for receiving and packing out 500 carload equivalents of bananas annually by specified methods and types of equipment 1/

Method and type of equipment	Crew size	Elapsed time	Labor and equipment costs		
			Labor	Equipment 2/	Total
	Number	Hours	Dollars	Dollars	Dollars
Manual handling					
Receiving	4	1.83	9.16	0.00	9.16
Packing	5	3.95	24.68	.83	25.51
All operations			33.84	3/ 0.83	34.67
2-wheel bunch truck and hydraulic bunch-lift truck					
Receiving	5	1.20	7.50	.65	8.11
Packing	6	3.07	23.05	2.93	25.98
All operations			30.55	4/ 3.58	34.13
4-wheel banana truck					
Receiving	3	1.62	6.33	.13	6.46
Packing	5	3.42	21.38	1.16	22.54
All operations			27.71	5/ 1.29	29.00
Continuous powered monorail conveyor and 4-wheel banana truck					
Receiving	4	1.23	6.15	1.74	7.89
Packing	5	3.42	21.38	1.16	22.54
All operations			27.53	6/ 2.90	30.43
Manual monorail conveyor system					
Receiving	4	1.33	6.68	.98	7.66
Packing	5	3.29	20.59	4.85	25.44
All operations			27.27	7/ 5.83	33.10
Manual monorail "ripen on carrier" conveyor system					
Receiving	5	1.10	6.86	3.22	10.08
Packing	5	3.07	19.20	11.48	30.68
All operations			26.06	8/ 14.70	40.76
Forklift truck					
Receiving	4	1.27	6.67	2.74	9.41
Packing	6	3.00	23.26	5.79	29.05
All operations			29.93	9/ 8.53	38.46

1/ Transportation distances standardized as follows: Receiving operations 100 feet, packing operations 60 feet.
2/ Based on equipment cost shown in table 52 of the Appendix.
3/ Cost of 2 stationary cutting stands, 1 rotary table, 2 self-taring scales, and 2 warehouse-type 2-wheel hand trucks.
4/ Cost of three 2-wheel bunch trucks, 2 hydraulic bunch-lift trucks, three 4-wheel banana trucks, 1 rotary table, 2 self-taring scales, and 60 semilive skids with jacks.
5/ Cost of six 4-wheel banana trucks, 1 rotary table, 3 self-taring scales, and 3 warehouse-type 2-wheel hand trucks.
6/ Cost of 1 continuous powered monorail conveyor, three 4-wheel banana trucks, 1 rotary table, 3 self-taring scales, and 3 warehouse-type 2-wheel hand trucks.
7/ Cost of 1 manual monorail conveyor, 1 rotary table, 3 self-taring scales, and 60 semilive skids with jacks.
8/ Cost of 1 manual monorail "ripen on carrier" conveyor, two 3-bunch banana trucks, 1 rotary table, 3 self-taring scales, and 60 semilive skids with jacks.
9/ Cost of 2 forklift trucks with attachments, 1 lowerator, 520 6-bunch carriers, 2 position conveyors, 1 rotary table, 3 self-taring scales, and 80 pallets.

the capacity of the minimum amount of equipment, the cost per carload decreases. The greater the number of carloads over which the fixed costs of the equipment can be spread, the lower the cost per carload. With increasing volumes, additional items of equipment frequently must be added. However, the cost of these additional items usually will be a small percentage of the initial investment in equipment, and will have only a minor effect on the cost per unit.

Table 46 shows the comparative costs of receiving and packing bananas by use of 4-wheel banana trucks when specified annual volumes are handled. Labor costs for receiving remain constant at $6.33 per carload within the range of 100 to 500 carloads. To pack out

fruit, the crew is increased to increase production per day but the cost per carload is reduced only slightly. Labor savings amount to only $0.86 per car. However, equipment costs range from $4.14 per carload at 100 cars annually to $1.29 per carload at 500 carloads annually. In this method three 4-wheel banana trucks are required for volumes up to 300 carloads annually, and 6 trucks for 500 cars annually. This additional equipment requires only a small investment, and the cost per carload actually is reduced from $1.81 at an annual volume of 300 carloads to $1.29 at an annual volume of 500 carloads.

Table 46.--Comparative labor and equipment costs per carload equivalent for receiving and packing out specified volumes of bananas annually by use of 4-wheel banana truck

Operations by indicated volume	Crew size	Elapsed time	Labor and equipment costs		
			Labor	Equipment	Total
	Number	Hours	Dollars	Dollars	Dollars
100 cars annually					
Receiving	3	1.69	6.33	0.10	6.43
Packing	3	5.93	22.24	4.04	26.28
All operations			28.57	4.14	32.71
300 cars annually					
Receiving	3	1.69	6.33	.07	6.40
Packing	5	3.42	21.38	1.74	23.12
All operations			27.71	1.81	29.52
500 cars annually					
Receiving	3	1.69	6.33	.13	6.46
Packing	5	3.42	21.38	1.16	22.54
All operations			27.71	1.29	29.00

Total labor and equipment costs per carload by the 4-wheel banana truck method are reduced from $32.71 at a volume of 100 carloads to $29.00 per carload at a volume of 500 carloads. This represents an 11 percent reduction even though the amount of transportation equipment is doubled. Further increases in volume would decrease proportionately equipment costs per carload.

These equipment costs are based on the assumption that all materials-handling equipment is used solely for and are chargeable to banana operations. Most banana handling equipment studied, such as the manual monorail conveyor systems, packing tables, and scales, etc., is of special design not adapted to other operations in produce houses. However, some of this equipment can be used for other operations. Such use should permit reduction of the cost allocated to banana handling. Such equipment includes warehouse-type 2-wheel hand trucks, 4-wheel banana trucks with the superstructure removed, semilive skids and jacks, battery powered pallet transporters, and forklift trucks.

This equipment can be used part-time in other warehouse operations. A volume of 100 carloads annually requires that some of this equipment be used for banana handling

only about one-fourth of the time. By sharing this equipment with other warehouse operations, equipment costs for banana handling can be reduced. However, the relative advantage of 1 type of equipment over another remains about the same, as each type of equipment, with the exception of forklift trucks, usually performs only banana-handling operations.

In produce houses where the forklift truck can be productively utilized for other operations, equipment costs chargeable to banana handling operations can be reduced (table 47). In a plant where the forklift truck and attachments are used for handling only 100 carloads annually equipment costs will approximate $10 per carload. Where it also is used for other warehouse operations the cost per carload for banana operations may be reduced to $4.69. To handle 300 carloads annually, the forklift truck usually can be utilized full time for banana operations, and its cost is not shared by other operations.

Table 47.--Comparative equipment ownership and operation costs per carload equivalent for handling specified annual volumes of bananas by forklift trucks, pallets, and other needed equipment

Annual volume	Ownership and operation costs per carload equivalent for forklift trucks charged to banana handling	
	Forklift truck used only for banana handling	Forklift truck used for banana handling and other warehouse operations
Carloads	Dollars	Dollars
100	10.00	1/ 4.69
300	4.30	4.30
500	2/ 5.14	3/ 2.66

1/ It is assumed that the forklift truck was used 727 hours for handling bananas and 1,273 hours for other operations.

2/ Includes use of 2 forklift trucks plus attachments and 1 battery charger. One forklift truck used for packing line, and 1 truck used for receiving operations.

3/ Includes use of 1 forklift truck plus attachments 1,500 machine-hours at $0.645 in banana operations plus 635 machine-hours for second forklift truck and attachments without additional battery charger at $0.57 per hour in receiving operations.

One forklift truck cannot handle 500 carloads annually during a 40-hour week. Therefore, to handle this volume 2 forklift trucks are necessary--1 for use in packing out, the other for receiving. When the full cost of 2 trucks and attachments are charged to the banana handling, these costs approximate $5.14 per carload, even though 1 forklift truck is used 1,500 hours and the second one is operated only 635 hours annually. Although it appears desirable to use a single forklift truck overtime, or on a 2-shift basis, the work of receiving 500 carloads of bananas annually cannot always be scheduled to fit into a single forklift truck operation.

The cost of 2 forklift trucks can be reduced to $2.66 per carload of bananas if the idle time of the equipment is utilized for other operations. However, this situation does

not significantly change the relative position of this method in terms of total labor and equipment costs. For instance, at an annual volume of 100 carloads, total labor and equipment costs (when used solely for banana operations) for the forklift truck method is $48.78 per carload (table 44), in comparison with $32.71 per carload for the 4-wheel banana truck method which is $16.07 greater per carload. With the exception of the manual monorail *ripen-on-carrier* conveyor system, the forklift truck method is more costly to operate than any other method analyzed. However, the cost of the forklift truck method can be reduced to $43.47 per carload if it is used for other warehouse operations.

These relationships exist in plants handling volumes up to 500 cars annually. The cost of the forklift truck method can be reduced $2.48 per carload by using the equipment for handling other products. However, this cost reduction in terms of total cost of labor and equipment is not sufficient to change the relative position of the forklift truck method in comparison with other methods analyzed.

Figure 43 shows graphically the comparative labor and equipment costs for specified methods when specified volumes of bananas are handled. The 4-wheel banana truck method shows the lowest total cost at all volumes up to at least 500 cars. For all volumes included, both the forklift truck method and the manual monorail *ripen-on-carrier* conveyor method are more costly than the manual method.

In summary, there are only slight differences in labor costs for receiving and packing out bananas by different methods. Labor cost relationships remain nearly constant at all volumes up to 500 carloads annually. There are wide differences in equipment costs, particularly for handling small volumes. As volumes increase these differences narrow. However, even at 500 carloads annually (about 10 carloads per week) the combined labor and equipment costs of the forklift truck or manual monorail *ripen-on-carrier* conveyor methods are considerably greater than those obtained with the 4-wheel banana truck, manual monorail conveyor, or 2-wheel bunch truck with hydraulic bunch lift truck methods.

However, the more expensive methods should not be completely discounted in selecting equipment. Mechanical equipment reduces the physical exertion in banana handling, and at the higher volumes this factor assumes greater importance in terms of labor cost relationships. Moreover, these cost differences may be narrowed through reduced shrinkage and damage resulting from more mechanized handling.

One method which combines both low equipment costs and the advantages of mechanized handling associated with more expensive types of equipment is the 2-wheel bunch truck and hydraulic bunch-lift truck. The rate of production by this method is essentially the same as for the more expensive types of equipment at all volumes.

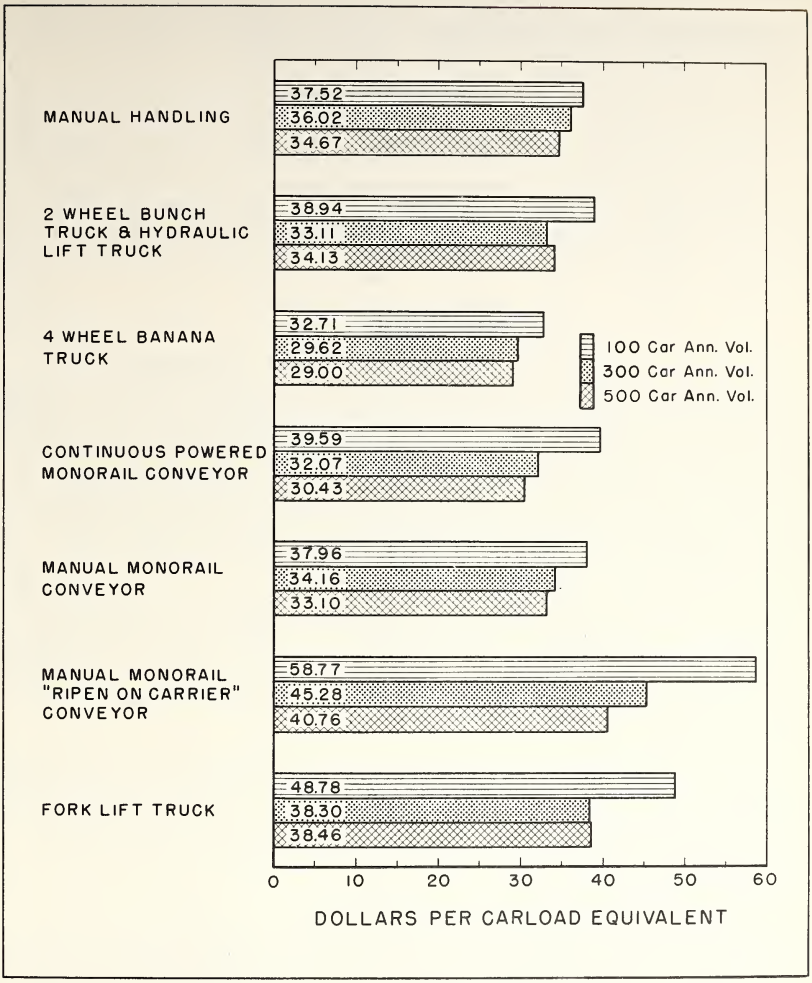


Figure 43.--Comparative labor and equipment costs per carload equivalent for receiving and packing bananas for varying volumes by selected methods and types of equipment.

EFFECT OF HANDLING ON DAMAGE AND SHRINKAGE OF BANANAS

Labor and equipment are not the only costs incurred in handling bananas. Because bananas are highly perishable and delicate, the equipment and methods for handling them affect the percentage of salable fruit in each lot handled. Therefore, this section discusses the effect of handling methods on types and amounts of damage to fruit.

In the trade *shrinkage* is that part of the billed weight of the fruit not packed out in banana boxes. In addition to damaged fruit, shrinkage includes stems, moisture losses during transit and ripening, and overweight packed in boxes. These items are a complete loss. Shrinkage also includes the hands and fingers of bananas that are sufficiently diseased, malformed, undersize, or injured to make them lower than first-quality fruit. However, such fruit is not a complete loss as most dealers have an outlet for these bananas. They usually are collected in jumble-packed crates and sold at a discount to hucksters or to retail grocers in low-income neighborhoods who take out and sell the edible fruit.

Causes of Injuries

To determine the causes of injuries and damage to fruit, tests were made in the laboratory and in wholesale stores. It was found that the principal causes of fruit damage and shrinkage from handling were pressure on the fruit and rubbing or striking of fingers against each other or against a rough object. Table 48 shows the results of the tests. Green fruit withstood concentrated pressures (applied by a 1-inch diameter plunger) up to 20 pounds, and broad pressures (applied to approximately 3 square inches of surface) up to 75 pounds, without noticeable damage to either the peel or pulp. These pressures are considered the maximum that would be applied to fruit during receiving operations, even by the manual method. Therefore, bananas unloaded or handled while green should suffer little or no damage from this type of injury.

However, 20 pounds of concentrated pressure applied to turning fruit caused peel indentation and pulp bruising (fig. 44). When bananas are received in the *turning stage* of ripeness, considerable damage usually will have occurred during transit and additional damage will be caused by handling during unloading. At the green-tip stage, 5 to 10 pounds of concentrated pressure caused indentations and bruising, but at 15-20 pounds pressure the fingers were crushed.

Bananas at the turning stage were not affected by broad pressures of up to 30 pounds but this same amount of pressure crushed green-tip fruit. Most bananas are cut and packed at the green-tip stage. It is at this stage of ripeness, when they are most susceptible to bruising, that bananas are handled most frequently in wholesale stores. This susceptibility to injury at that stage suggests some merit to the practice of cutting fruit at a slightly earlier stage of ripeness.

The peel of green fruit was scarred by both sharp strikes and abrasions against a rough wooden surface, but in both cases the pulp showed little injury (fig. 45). However, turning and green-tip fruit subjected to the same tests was injured; the peel was scarred, and the pulp was bruised (fig. 46). Scratching the peel caused scarring at all stages of ripeness and with turning and green-tip fruit the peel split, exposing the pulp. Puncturing the peel of fruits in all stages of ripeness caused the immediate area of the damage to blacken in all cases but the pulp was uninjured except for slight superficial scarring.

Table 48.--Effect of different mechanical injuries on the skin and pulp of bananas at 3 specified stages of ripeness and the amount of damage caused by such when fruit ripened to color stages 6 to 7 (full yellow stage) 1/

Type of injury applied to fruit 2/	Green fruit 3/		Turning fruit 4/		Green-tip fruit 5/	
	Peel damage	Pulp damage	Peel damage	Pulp damage	Peel Damage	Pulp damage
Concentrated pressure (10 pounds)	None	None	Indented	None	Indented	Bruised
Concentrated pressure (20 pounds)	None	None	Indented	Bruised	Crushed	Crushed
Broad pressure (30 pounds)	None	None	None	None	Crushed	Crushed
Broad pressure (75 pounds)	None	None	Crushed	Crushed	Crushed	Crushed
Striking	Scarred	None	Scarred	Bruised	Scarred	Bruised
Abrasions	Scarred	None	Scarred	Bruised	Scarred	Bruised
Skin scratches	Scarred	None	Scarred	None	Scarred	None
Skin punctures	Scarred	None	Scarred	Slightly scarred	Scarred	Slightly scarred

1/ Color stages taken from chart in *Banana Ripening Manual*, Fruit Dispatch Company Cir. 14, 3rd rev. p. 6, New York, N. Y., 1949. The effect of the applied injuries was determined when the fruit reached the full yellow (No. 6 to 7) ripening stage. The scars were black areas on the peel, and bruised pulp was soft, brown, and mushy.

2/ Concentrated pressure bruises simulate the damage that might be expected from finger pressure when fruit is grasped. Broad pressure bruises were made by pressing the fruit with the heel of the hand. This test was designed to show the effect of pressure applied over a large area of the fruit. Striking injury was caused by tapping the fruit sharply against the side of a box. Abrasions result from rubbing the fruit against a rough surface such as a car floor. For the test, a piece of unfinished lumber was used. Skin scratches were applied by removing a small amount of surface peel with a fingernail. Skin punctures were made with a small sharp stick.

3/ Color stages No. 1 to 2.

4/ Color stage No. 3.

5/ Color stages No. 4 to 5.

Although these tests were made under controlled conditions in the laboratory, they illustrate the types of damage that occur under operating conditions. They also provide a good indication of susceptibility to various types of injuries of fruit at different degrees of ripeness.

Normally green bananas should not be damaged by the usual pressures that are applied when a bunch is lifted from the floor or carried on a worker's shoulder. However, as shown in figure 47, the peels will be scarred from the abrasive effect of dragging bunches of green fruit across the floor of a carrier. All methods that require manual lifting of bunches while unloading carriers are equally responsible for this type of injury. By these methods bunches must be manually broken out from their position in the carrier and transferred to the handling equipment which often is done by dragging the bunch across the floor to the point where it is placed on the transportation equipment. By the 2-wheel bunch truck methods, bunches are loaded directly onto the equipment from their position in the railroad car with no manual lifting which eliminates much of the possibility of damage from dragging and abrasion.

Figure 44.--Damage caused by 20 pounds of concentrated pressure applied to turning fruit, shown after 5 days at 70 degrees when the fruit reached full yellow stage.

Figure 46.--Damage caused by striking turning fruit against rough wooden surface, shown after 5 days at 70 degrees when the fruit reached full yellow stage.

Figure 45.--Damage caused by striking green fruit against rough wooden surface, shown after 5 days at 70 degrees when the fruit reached full yellow stage.

As previously pointed out, bananas are highly susceptible to all forms of injury at the normal cutting stage. Pushing green-tip bunches along a conveyor undoubtedly causes some damage to the fruit. The relatively small amount of thumb pressure cutters apply to fruit during the cutting operations may be sufficient to bruise the pulp. Packers also subject fruit to injury when they drop hands into a box, rather than placing them individually. A common practice is to shove the packed hands together to make room for the last hand and the padding, which applies pressure to the fingers at each point where they come in contact. This type of damage

does not appear immediately but often is evident when the bananas are put on display in the retail store.

Figure 47.--Damage caused by green fruit rubbing against wooden surface, shown after ripening to full yellow stage.

Damage and Shrinkage in Banana Warehouses

Tests were made in 5 wholesalers' warehouses where different methods of handling were used to evaluate further the causes of injuries and shrinkage. In these tests with 10 carloads of bananas, the waste fruit from representative samples of each carload was examined, and damaged fingers were classified as to the type of damage. Bananas falling into each type of waste then were weighed and converted to a percentage of the billed weight.

Averaged data covering the 10 loads studied are shown in table 49. Although these data do not show the damage caused by specific methods of handling, they do indicate the relative importance of each type of damage to which the fruit is subjected. Fourteen causes of shrinkage were noted. Frequently, discarded fingers had been damaged in more than one way. Such fingers were classified according to the most likely cause of discard. Malformed and undersize fingers were classified as such without consideration of any injuries that may have been present.

Three causes of shrinkage which are not related to handling are: (1) Stems, (2) undersize fruit, and (3) malformed fruit. The percentage of stems to billed weight usually is constant among loads. Of the 10 loads studied, stems averaged 8.76 percent of the billed weight. Stems have no commercial value, and their disposal is often an extra expense. Undersize and malformed fruit are developmental defects and occur in about the same ratio in most loads. Of the loads studied, undersize fingers, generally considered less than 5 to 6 inches long, comprised 1.12 percent and malformed fruit (twins, horseshoes, etc.) 0.13 percent of the billed weight. These fingers have the same eating qualities of undamaged fruit, but are rejected because they possess lower customer appeal. In the 10 loads, stems, undersize, and malformed fruit accounted for an average of 10.01 percent of the billed weight.

Diseased fruit made up another 1.43 percent of the weight. Nearly all the fruit discarded for this reason was infected with neck rot (probably Thielaviopsis) (fig. 48). The degree of infestation was not consistent among loads and appeared to vary widely between varieties of banana and different seasons of the year. The method of handling bunches in the warehouse had little, if any, effect on the amount of fruit discarded because of disease. There is some evidence, however, that rough handling weakens the necks of the fingers, and this weakening may provide an entrance for the fungus organism.

Table 49.--Types and amounts of banana damage and shrinkage expressed as percentage of billed weight 1/

Types of damage and shrinkage	Average waste	
	Billed weight	Total waste
	Percent	Percent
1. Stems	8.76	47.56
2. Undersize fruit	1.12	6.08
3. Malformed fruit	.13	.71
4. Neck rot	1.43	7.76
5. Green drops (unloading and hanging)	.67	3.64
6. Ripe drops (ripening and transporting)	.24	1.30
7. Crushed or broken fruit	.70	3.80
8. Old scars and bruises	2.82	15.31
9. New scars and bruises	.34	1.85
10. Split fingers	.24	1.30
11. Fingers with torn peel	.26	1.41
12. Fingers with knife cuts	.05	.27
13. Good fruit discarded	.21	1.14
14. Moisture loss (shrinkage and excess weight in boxes)	1.45	7.87
Total waste (including stems)	18.42	100.00
Total waste (excluding stems)	9.66	52.44
Waste attributable largely to handling (5, 6, 7, 8, 9, 10, 11, 12, and 13)	5.53	30.02
Waste attributable largely to handling at ripening room--wholesale level (9, 10, 11, 12, and 13)	1.10	5.97

1/ Based on studies of 10 loads of bananas at 5 different facilities employing different types of handling equipment.

The category *moisture loss* represents that portion of the billed weight that could not be specifically accounted for by other causes. It consists of both loss of moisture during ripening and overweight packed into boxes. Moisture loss accounted for 1.45 percent of the billed weight. It is known that ripening conditions affect the amount of moisture given off during ripening. This loss can be minimized by maintaining the proper high humidity in the ripening room. Frequent checks of scales and packers to minimize overweight in packed boxes also will reduce these losses.

Four causes of shrinkage which originate in the warehouse but which are not directly attributable to the handling method are: (1) Split fingers, (2) torn peel (fig. 49), (3) knife cuts, and (4) discarding salable fruit. These causes account for 0.76 percent of the billed weight. The splitting of banana peels appears to occur as a result of both the ripening process and excessive pressure on the fingers. Proper temperature and humidity

Figure 48.--Fruit damaged by disease (neck rot). Shown at full yellow stage.

Figure 49.--Fruit with torn peel. Shown at full yellow stage.

while the fruit is ripening will help reduce this type of shrinkage. Torn peels and knife cuts occur mainly during the cutting and packing operations. Discarding good fruit can be reduced by instructing workers in the care of the fruit and providing adequate supervision.

Crushed or broken fruit (fig. 50) accounted for 0.70 percent of the billed weight. Because of the condition of the fruit it was difficult to determine where or when the damage was incurred. Most of the crushing probably happened in transit with the fingers on the bottom hands receiving the greatest damage. However, some fruit was crushed during receiving when strings broke and the bunches fell to the floor.

Although it was impossible to determine the exact cause of fingers dropping from bunches, both rough handling and neck rot contributed. Some fingers dropped off while the fruit was in transit; others dropped off while being removed from the car. Green fingers dropping in the car, in transit to the ripening room, or during hanging, represented 0.67 percent of the billed weight. Drops that occur in the ripening room or in transit to the cutting area may result from injuries to the necks of the fingers during transit or unloading, or from a natural weakening of the neck during ripening.

Green *drops* are collected in baskets and placed in the ripening room to ripen. When the fruit in the room is cut out, these fingers are sorted and some are discarded because of injury or improper ripening. Bananas that fall off after ripening are nearly always damaged, and very few of these fingers are salvaged in the regular pack-out.

Bananas rejected because of old scars and bruises equalled 2.82 percent of the billed weight (fig. 51). These scars were hard and black and in some instances the pulp underneath was corky, indicating that the damage was probably done before the fruit reached the warehouse and before the fruit was ripened. Most of these black scars become more noticeable as the fruit ripens. It is possible that some of this scarring occurred during the receiving operation, but the majority probably took place somewhere in transit between the banana plantation and the receiver's warehouse.

Figure 50.--Crushed and broken fruit after ripening to full yellow stage. The damage occurred when the fruit was green.

Figure 51.--Fruit showing old scars and bruises, an important cause of shrinkage.

New scars and bruises represented 0.34 percent of the billed weight of the loads studied. These injuries largely are the result of the handling of bunches through the packing-out operations.

Summary of Factors Affecting Damage and Shrinkage in Banana Handling

Laboratory tests of banana handling were conducted to determine how well bananas withstand various mechanical injuries at different stages of ripeness. These tests indicate that green bananas are not easily injured by the application of normal handling pressures. Carrying green bananas manually will cause little bruising or crushing unless the bunches are dropped or broken by abusive handling.

None of the laboratory treatments were severe enough to bruise the pulp of green fruit. However, green fruit is highly susceptible to scarring and scuffing. When bananas were bruised or rubbed against any rough surface scars developed. It was observed that merely scraping the wax from the surface of a banana with the fingernail without breaking the skin caused a dark scar to develop. All such scars disfigure bananas and reduce marketability even though the pulp or edible part may be undamaged.

Ripe fruit is highly susceptible to all types of bruising. Manual lifting and carrying of bunches of ripe fruit causes much bruising and crushing. Ripe bananas (green-tip stage) are injured by the application of only 5 pounds of thumb pressure, as evidenced

by bruised tissue to the center of the pulp. All treatments which applied pressure to ripe bananas caused severe internal bruising. The bruised areas became brown, watery, and very soft soon after injury.

Fruit which is intermediate between green and ripe fruit also is *intermediate* in its ability to withstand pressure without apparent injury. At this stage fruit is also susceptible to abrasions, scarring, and scuffing.

It appears that the average banana wholesaler can increase his pack-out of fruit a maximum of about 1 to 2 percent of the gross weight. For banana dealers who ripen fruit at improper temperatures or humidities, the possibilities for improvement are even greater. These tests also indicate the desirability of cutting and packing fruit not later than the green-tip stage of ripeness.

Ways of Reducing Damage and Shrinkage

These studies suggest certain ways by which the amount of damage and shrinkage resulting from handling bananas can be reduced:

1. Green fruit can withstand the normal pressures that are applied during receiving, but is susceptible to abrasive actions. Therefore, bunches should be lifted from their position in the railroad car or truck and carried--not dragged--to the transporting equipment.

2. After bananas have *turned* they become highly susceptible to all types of injuries, and greater care must be taken when they are handled. In bringing out fruit on a conveyor, it is common practice to move the bunches by pushing on the last bunch in the train. This practice applies damaging pressure to the fingers, particularly when the carrier wheels *hang up* on a switch or rail joint. To reduce damage caused in this way it is suggested that the train be pulled with a long rod attached to the last carrier. This arrangement will remove the pushing force from the bunches and place it on the carriers.

3. If bananas are packed when they first start to turn, they are less likely to be damaged by handling. After bananas are packed into boxes they should be returned to the ripening room to complete the ripening process. This method is being used in some plants with good results.

4. Cutters and packers should be instructed to use extra care in handling fruit. Cutters should place the hands on the table rather than drop them, and the packers should set each hand or partial hand in the box. Packers should also avoid pulling the hands together in the box to make room for the last hand. Injuries caused during cutting and packing are not readily visible at that time but show up when fruit is placed on display at the retail store.

LOCATION AND LAYOUT OF BANANA RECEIVING, RIPENING, AND PACKING FACILITIES

The layout and location of a banana facility in a wholesale store or warehouse should incorporate the following objectives: (1) To perform banana-handling operations at the lowest costs for labor and equipment, (2) to minimize shrinkage and maintain high quality of fruit, (3) to provide for possible future expansion, and (4) to safeguard against undue interference from other warehouse operations. How nearly management can approach these objectives is determined largely by the bounds imposed by other warehouse conditions and requirements.

Facility Requirements

Banana receiving, ripening, and packing facilities in wholesale stores should include: (1) A receiving platform for unloading railroad cars and motortrucks; (2) an adequate number of properly equipped and designed rooms for ripening the fruit; and (3) an area adjacent to the ripening rooms for cutting, packing, temporarily storing packed boxes, and for storing empty boxes, and other packaging material.

Receiving Platform

The platform at which bananas are unloaded should serve both railroad cars and motortrucks. Although separate platforms can be provided for each type of carrier, this would spread banana-receiving operations over a wider area of the warehouse and increase facility costs. It is desirable that bananas be received in a single area.

For all methods of receiving the platform should be at least 12 feet deep. Platforms should be level with the floor racks in refrigerator cars or about 54 inches above the top of the rails. Sufficient clearance should be provided between the car and platform dock to permit opening the car doors. The centerline of the tracks should be 8 feet from the edge of the platform. Motortrucks can be unloaded at platforms of this height by providing ramps on which the rear truck or trailer wheels can be backed to raise the truckbed level with the platform. These ramps can be located along the length or at one end of the platform. When trucks are unloaded at the end of the platform, they are clear of the railroad tracks, and do not interfere with the moving of railroad cars.

The forklift truck and manual monorail *ripen-on-carrier* conveyor methods of receiving require that a lowerator be installed on the platform. In most stores using these methods, lowerators are permanently installed and carriers must be spotted in its immediate vicinity to facilitate unloading. When receiving is by overhead conveyors, the conveyor track is suspended about 7 feet above the platform in the unloading area. The hooks hang down an additional 6 inches. Such an installation leaves insufficient clearance for the masts of forklift trucks which could obstruct the use of this equipment and create a hazard to workers. Therefore, banana operations should be separated from other warehouse activities insofar as possible.

Ripening Rooms

To ripen bananas they must be stored from 4 to 7 days in a ripening room which should be insulated to make it as nearly airtight as possible, in order that temperature and humidity can be closely controlled. Overhead steampipe lines and waterpipe lines, with spray nozzles at regular intervals, should be installed along each side of the room to control humidity. An overhead blower-type heater of adequate capacity should be installed at one end of the room to provide necessary heat and air circulation for ripening. Gages should be located outside the rooms so that temperature and humidity conditions can be checked without opening the doors. Floor drains are necessary for the removal of excess moisture. These drains also are needed for removing water when the rooms are cleaned. Specifications for these items should be determined by individual firms.

Individual rooms vary in size, but the average room used in the trade holds 1 carload of from 250 to 300 bunches weighing approximately 22,500 pounds. The shape and size of each room often is determined by the layout of the building and the type of equipment used for handling bananas. The construction and design of banana rooms is similar to that for cold-storage rooms, the principal difference being that bananas are suspended from the ceiling during ripening instead of resting on the floor.

Rooms should be insulated with not less than 3 inches of corkboard and should be of tight construction. Since ethylene gas occasionally is used for ripening fruit, these rooms should have as few leaks as possible. If ethylene gas is to be used, extreme care must be exercised to avoid injury to personnel. Standard cold storage doors are used.

Bananas are hung in 2 tiers to make economical use of ripening space. The recommended ceiling height is 7 feet 8 inches to 8 feet 2 inches, preferably 8 feet. Hooks are spaced 7 inches by 14 inches or 8 inches by 16 inches. The floor space required for 2-tier hanging is approximately 1 square foot per hook if an open aisle space is left in the room for inspection of the fruit (fig. 52).

The capacity or size of ripening rooms should be determined largely by the anticipated volume of bananas handled. Dealers who receive about 1 carload weekly should consider the construction of ½-car capacity rooms. By dividing a carload between 2 rooms and by applying different temperature and humidity controls, the fruit can be brought to cutting stage on different days. This will permit the culling and packing of 1 carload of bananas to be spread out over a period of 1 week.

For annual volumes of from 100 to 300 carloads, rooms of 1-carload capacity are preferable. Within this volume range, a dealer frequently cuts and packs out an entire carload in 1 day and there is no particular advantage in dividing a carload into 2 parts. Moreover, the cost of constructing 1-car rooms is considerably less than the cost of an equivalent capacity in ½-carload rooms.

For volumes above 300 cars annually, or from 1 to 2 carloads a day, 2-carload capacity ripening rooms might be considered. Such rooms are less costly to build per unit than those with smaller capacities. However, banana-handling operations are less flexible in rooms of this size than in 1-car rooms. Where 2-carload capacity rooms are used, there are fewer rooms around which to schedule receiving and ripening. Transportation distances also may be increased.

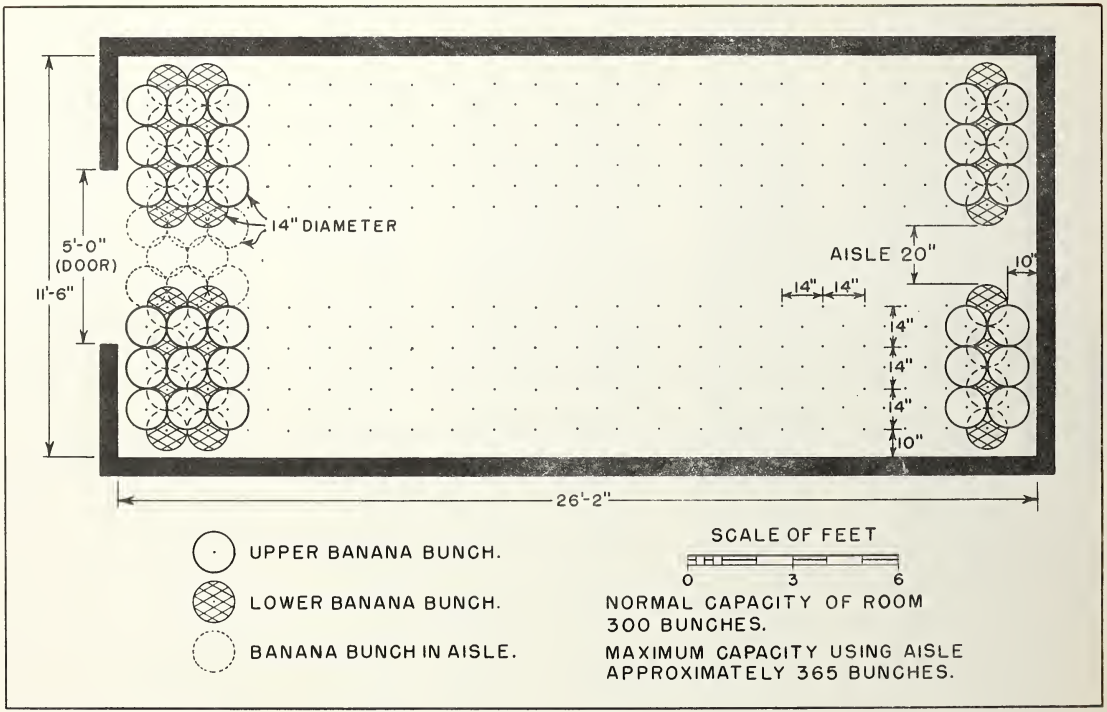


Figure 52.--Layout of a 1-carload capacity ripening room.

To fully utilize a 2-car capacity room 2 carloads must be received at the same time. If only 1 carload is received on a given day, it will occupy the space in a 2-car room. After a load has been hung in a room and the ripening process has been started, no additional bananas should be placed in that room until it is empty. Unless it is the practice for a firm to receive 2 cars at a time, double rooms should not be used. A further disadvantage of 2-car rooms is that different temperature and humidity treatments cannot be applied to the 2 carloads, and the optimum treatment for one may be detrimental to the other.

The inside dimensions of the single-car room shown in figure 52 are 11 feet 6 inches wide by 26 feet 2 inches deep. The overhead cross beams are spaced at 7-inch intervals, and the hooks and eyes on the beams are on 14-inch centers. The beams should be high enough so that the low-hanging bunches clear the floor, but low enough so that the top bunches can be easily removed. This height varies somewhat with the equipment used but is from 7 to 8½ feet. With a 20-inch aisle down the center of the room, its capacity is 300 bunches. However, by utilizing the aisle for hanging bunches, this room will hold up to 365 bunches. By varying the length of the room, its capacity can be changed from ½ to 2 cars.

Ripening rooms for forklift truck operations are 30 feet deep and 11 feet 6 inches wide. No cross beams are used. Four steel beams, 2 in the center and 1 on each side running the depth of the room support the carriers from which bunches are hung during the ripening process. Double doors also are necessary at each end to permit the forklift truck to enter either side of the room.

Ripening rooms in which the *ripen-on-carrier* system is used should be varied in width and depth, depending on the specific type of equipment used. Under no condition should the inside tracks be spaced closer than 20 inches on center. This is necessary to allow freedom in switching in the room and for easy movement of fruit on one track when bypassing fruit on an adjacent track.

Information on factors that control the ripening process, ripening treatments to apply under different conditions, and equipment for ripening bananas is available in published reports. 4/

Cutting and Packing Area

In addition to the space needed for cutting and packing bananas, sufficient space should be provided in this area for storing empty boxes, packing supplies, packed boxes of fruit, and handling equipment. An aisle at least 10 feet wide should run directly in front of the ripening rooms through the length of the cutting and packing area. There should be free access to all work stations, and this area should not be crowded or congested.

4/ *Banana Ripening Manual*, Fruit Dispatch Company, Pier 3, North River, New York; *General Requirements for Banana Ripening Plants*, Equipment Department Circular No. 24 (Revised), Fruit Dispatch Company; and *Bananas*, Chemistry, Physiology, Technology, Harry W. Von Loesecke, Interscience Publishers, Inc., New York, 1950. Information on ripening room construction is also available from manufacturers of refrigeration equipment.

Floor space in the cutting and packing area, including aisles, should be approximately equal to the area occupied by ripening rooms. As considerable transportation is necessary during the cutting and packing operations, aisles and passageways must be sufficiently wide to permit the free movement of handling equipment.

Location in Warehouse

Unless banana operations occupy the entire store or warehouse, plant managers must consider these operations as only a part of their warehouse operations. Where bananas are handled in warehouses that carry a complete line of fruits and vegetables, plant managers should determine the relative importance of bananas and what priority they will receive in the assignment of space. They also should anticipate future business, and locate the banana facilities so that additional ripening rooms and cutting and packing space can be added as needed. Expansion of the banana facilities should be possible without loss of efficiency.

A separate crew usually is employed for banana operations and spends full time receiving, cutting, packing, and storing fruit. It is not normally called on to do other work in the warehouse. Therefore, work in the banana area has little relationship to other warehouse operations, and the banana facilities should, as nearly as possible, be out of the way of other operations. Members of the banana crew can more nearly establish a balanced work pattern, when they are free of interference from other plant workers.

The importance of transportation distances between the receiving platform and the ripening rooms varies with the type equipment used. The manual and 2-wheel bunch truck methods of receiving show up favorably at shorter distances. Although it is desirable to locate the banana area adjacent to the receiving platform, if the handling equipment can transport unit loads this consideration becomes less important. This distance also affects the time fruit is exposed to the elements. In extremely cold areas this may require that the ripening rooms be located near the receiving dock.

Determining Space Requirements

Ripening rooms usually should account for about half the floor space required in a warehouse for handling bananas. The number and size of rooms needed will depend on the volume of bananas handled and the receiving and ripening schedules. Even the smaller-volume dealer will need a minimum of 3 rooms even though he may receive only 1 carload of fruit per week. One room will generally contain ripe fruit, 1 room turning fruit, and the third room green fruit. For larger dealers, the number of additional rooms, if any, needed should be determined by how many days each week bananas are received, and the length of time a carload will occupy a room. Frequent receipts, plus a fast ripening schedule, mean that fewer rooms should be necessary for a given volume.

For an annual volume of 100 carloads or an equivalent of 2 cars each week, 3 ripening rooms should be adequate if receipts are evenly spaced throughout the year. However, this volume would place heavy demands on the capacity of the rooms during the peak banana season.

A dealer who handles 300 carloads annually should have a minimum of 6 ripening rooms. This annual volume is the equivalent of about 1 carload daily. Because of seasonal

variations in volumes handled and the dealer's inability to control completely the receiving schedule, as many as 3 carloads may arrive on 1 day. Moreover, slow sales of fruit may cause heavy losses if sufficient rooms are not available.

For an annual volume of 500 carloads or more at least 10 single-car capacity ripening rooms are necessary. Although 10 single-car rooms are more costly to construct than 5 double-car rooms, they would permit greater flexibility in banana operations. Most dealers prefer single-car rooms to the 2-car capacity rooms.

Expansion of Facilities

Generally, expansion of existing facilities can be made by: (1) Increasing the size of the present ripening rooms, (2) constructing additional rooms in a line with present rooms, and (3) constructing additional ripening rooms opposite and facing the present rooms with the packing area in between this double row. An expansion of ripening rooms should include provision for enlarging the packing area.

Expansion by converting single-car capacity rooms into double-car capacity rooms generally is not desirable, as each car of fruit can be handled best in individual ripening rooms under optimum heat and humidity conditions. A preferable method of expansion is to extend a line of single-car capacity ripening rooms. However, when such expansion reaches a point where the transportation distances are overly extended, alternate methods of expansion should be considered. Larger dealers should consider expansion by constructing additional ripening rooms opposite the packing area so that the 2 rows of rooms face each other with the packing area in the center.

Layout of Ripening and Packing Area

Banana facilities should be arranged so that fruit moves directly from 1 operation to the next with no out-of-line or back hauls. By locating the cutting table in front of the center room, the mean distance from ripening rooms to the cutting table is minimized. This arrangement also permits a direct flow of empty boxes and packing materials from one side of the room to the cutting table and a direct flow of packed boxes from that point to the opposite side of the room. Work stations around the packing table should contain sufficient space so that each worker can perform his job with maximum efficiency and with a minimum amount of interference with the other workers.

Packers, who are stationed opposite the cutter, should have adequate aisle space between the table and the storage areas to replenish stocks of empty boxes and packing supplies. Packers should not have to detour around other packers or cross the route over which fruit is brought up to the cutter. By the same token, packers should have easy access to the storage area for packed boxes. Sufficient storage space should be provided for storage of both empty and packed boxes. Aisles should be at least 10-feet wide.

The layouts shown in the sections that follow are suggested for a 300-car annual volume. Different layouts are shown for different types of materials-handling equipment. Figure 53 shows a suggested layout when fruit is received either manually, by 2-wheel bunch trucks, or by 4-wheel banana trucks. By these methods shorter-than-usual transportation distances are preferable. To unload bananas into facilities with this layout, workers leave the carrier, cross the 12-foot platform, and enter the ripening rooms--an

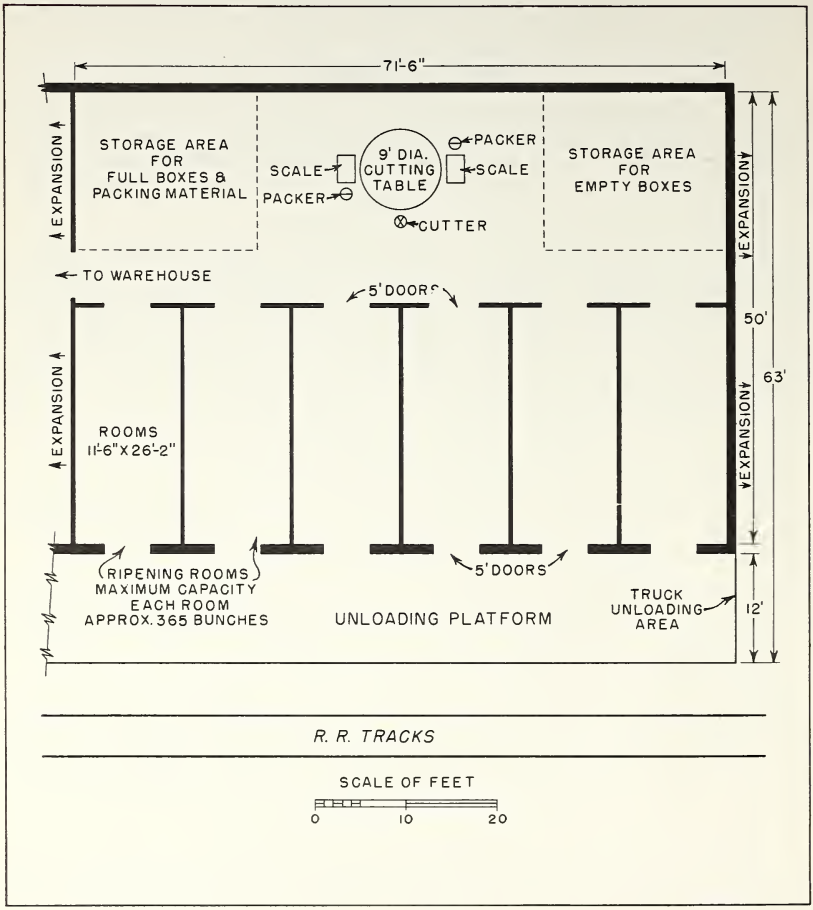


Figure 53.--Suggested layout of a banana facility when receiving by manual, by 2-wheel bunch truck, or by 4-wheel banana truck methods.

average transportation distance of 25 feet. If carriers are properly spotted, this distance is the average for the 6 rooms shown.

Bunches are moved through the door at the opposite end of the rooms enroute to the cutter. By placing the cutting table in front of the center room the average distance is minimized. At one end of the packing area sufficient storage space is provided for supplies. At the opposite end, which is nearer other warehouse operations, ample storage area is provided for packed boxes of fruit.

Figure 54 shows a suggested layout when fruit is received by continuous powered monorail conveyor. Conveyor tracks are installed along the front of the ripening rooms and extend out to the edge of the platform to the railroad siding. Extensions of the conveyor tracks can be constructed along the outer edge of the platform so that more than 1 railroad car can be unloaded simultaneously and so that the end of the receiving platform can be used for receiving truck shipments. By this method, bunches are manually hung on the conveyor track at the car and are lifted from the conveyor track outside the ripening rooms and carried into the room. Ripe fruit usually is moved from the ripening rooms to the packing table by another method.

Figure 55 shows a similar layout for use when fruit is received by manual monorail conveyor on which bunches of bananas are moved directly into each ripening room. In the room, bunches are manually lifted from the conveyor and hung on hooks or ropes. At the receiving platform, circular trackage extends along the platform so that several cars can be unloaded concurrently and directly onto the conveyor. Truck receipts can be received at the lower end of the platform directly onto the conveyor system.

Ripe fruit can be moved from the ripening rooms to the packing table by the conveyor system. In the ripening room, bunches are manually lifted from the hooks and hung on the conveyor carriers. When several bunches have been placed on the carriers, they are pushed as a train along the track to the packing table. Fruit is cut from the stems, while the bunches are suspended from the carriers on the overhead track.

Packed boxes of fruit can be moved out of the packing area, directly through the warehouse to the delivery truck loading area. Empty boxes can be moved through the warehouse directly from the truck receiving platform to the storage area in the packing room.

A layout for handling bananas by forklift truck is shown in figure 56. The layout of the ripening rooms and the packing area is similar to that suggested for monorail conveyor plants. However, more space is required in the packing area to permit free movement of the forklift truck around the packing table and the position conveyor. Fruit can be received from the rail siding or from motortrucks at the receiving platform. In either case the maximum transportation distance will be under 100 feet. A lowerator must be installed on the receiving platform to make up unit loads.

Ripening rooms in this layout are of standard width and depth, but ceiling heights must be sufficient to permit the forklift truck to operate. Each room is constructed in 2 sections, both with permanent beams on which unit load carriers are spaced. Special doors should be provided for each room so that forklift trucks can enter either side of the room. These doors must be of sufficient width and height to clear the loaded forklift truck, or about 5 feet wide and 9 feet high.

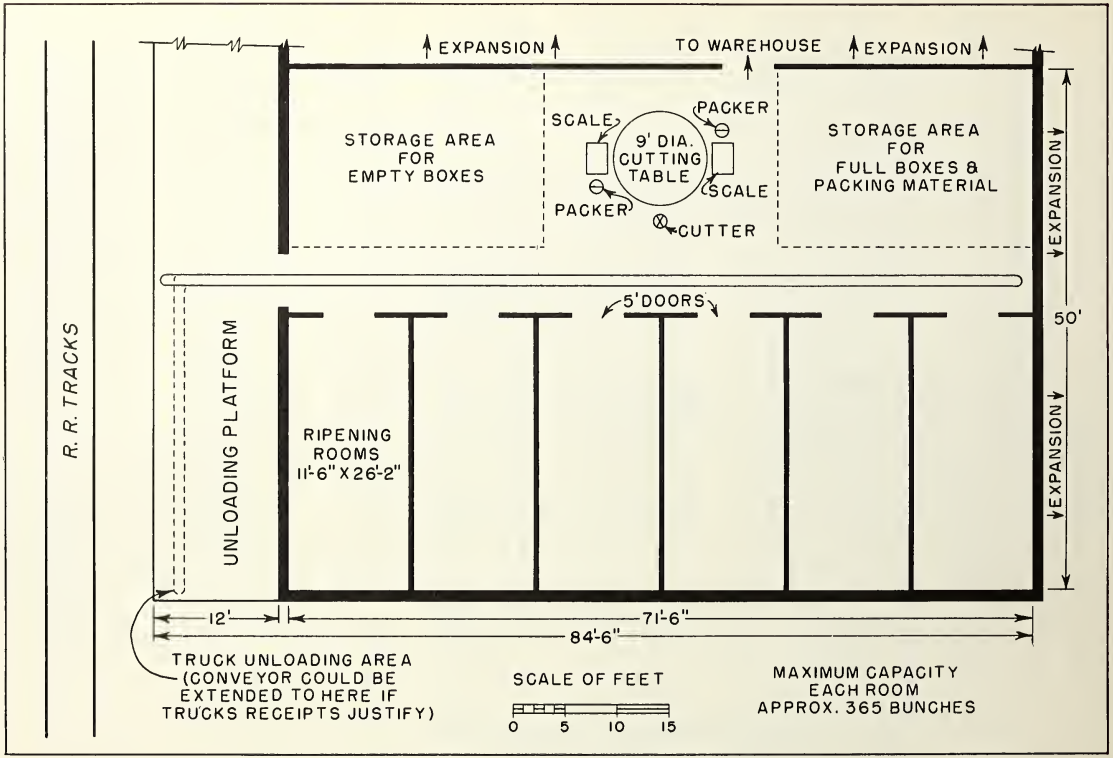


Figure 54.--Suggested layout of a banana facility when receiving is performed by use of continuous powered monorail conveyor.

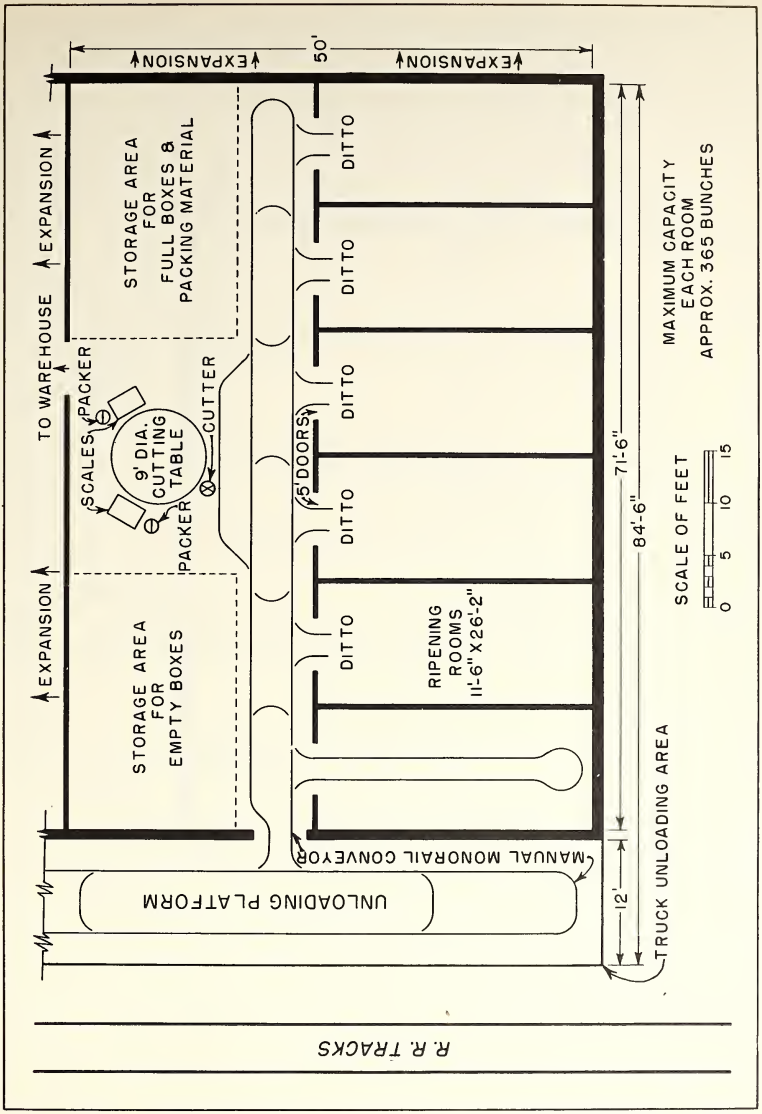


Figure 55.--Suggested layout of a banana facility when receiving is performed by use of manual monorail conveyor.

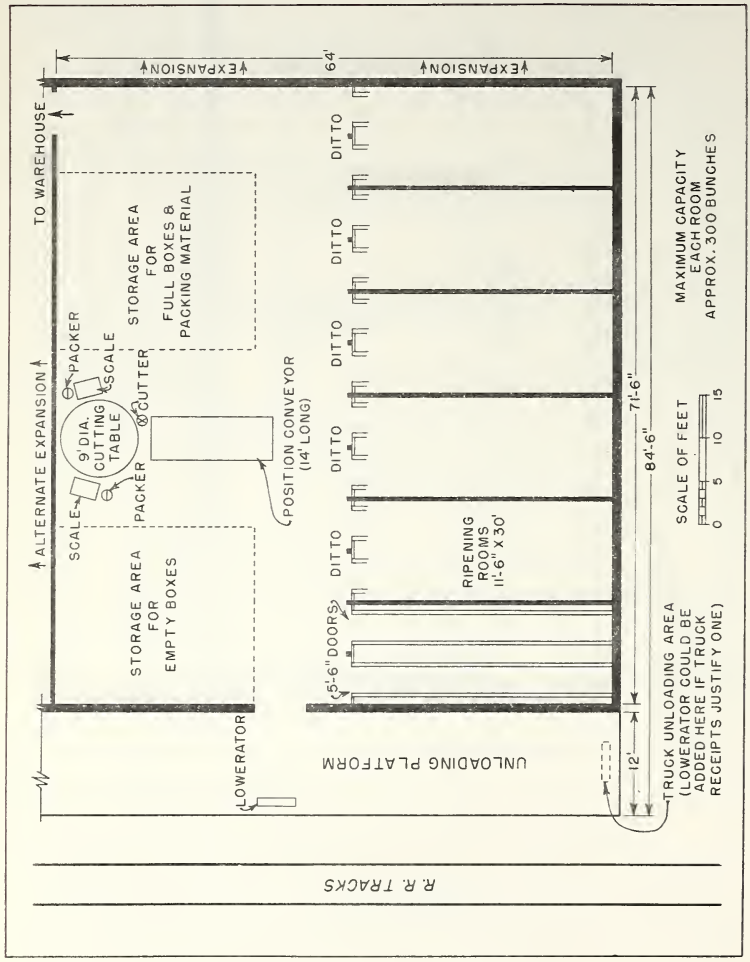


Figure 56.--Suggested layout of a banana facility when receiving is performed by use of forklift truck.

The position conveyor is a permanent fixture at the packing table. It should be located so as to head directly into the packing table which will station the cutter in the best position to operate. The floor area required for storage of packed boxes of fruit is smaller by this method because the forklift truck can tier pallet loads 2 to 3 pallets high. The area in which packed boxes are stored should be located so that the forklift truck can operate without hinderance in and out of the position conveyor and around the packing table. This layout can be expanded by extending the line of ripening rooms or by constructing additional rooms opposite the packing area, when space is available in the warehouse. Thus the 2 rows of rooms face each other with the packing area in the center. Obviously, the packing area would need to be enlarged to make room for an increased volume.

Figure 57 shows a suggested layout when bananas are handled by a manual monorail *ripen-on-carrier* system. By this equipment, bananas are unloaded to a lowerator on the platform which can be used for receiving both rail and truck shipments. The same lowerator can be utilized for receiving both rail and truck shipments. Maximum transportation distance from the receiving platform into the ripening room is about 125 feet. Average transportation distance is about 80 feet.

A series of overhead tracks in each ripening room make it possible to store the loaded carriers in the room during the ripening process and to move them out when the fruit is ripe. Six tracks in each room carry a maximum of 42 carriers with 6 bunches on each, or a total of 252 bunches. An extra track down the center aisle will increase the capacity of each room by 7 additional carriers, or 42 bunches, which will give extra capacity for car receipts up to about 300 bunches.

A loop track through the packing area permits the loaded carriers to move from the ripening rooms to the packing table. A lowerator on the track adjacent to the packing table permits the bunches to be positioned on the track so that the cutting operation can be performed without removing the individual bunches of fruit from the carrier.

Storage space for the empty boxes and packing materials is provided at one end of the packing area, and adequate space to store packed boxes is provided at the opposite end. In loading-out operations, the packed boxes move directly from this temporary storage area to the truck loading area in the warehouse.

This facility can be expanded by extending the line of ripening rooms to include the monorail system. However, for a facility requiring more than 8 to 10 ripening rooms, 2-car capacity rooms may be preferable. Such expansion might be made by extending the ends of present rooms 30 feet.

The layouts shown are intended as illustrations of factors that should be considered in laying out facilities in individual plants and are not offered as recommendations for particular plants.

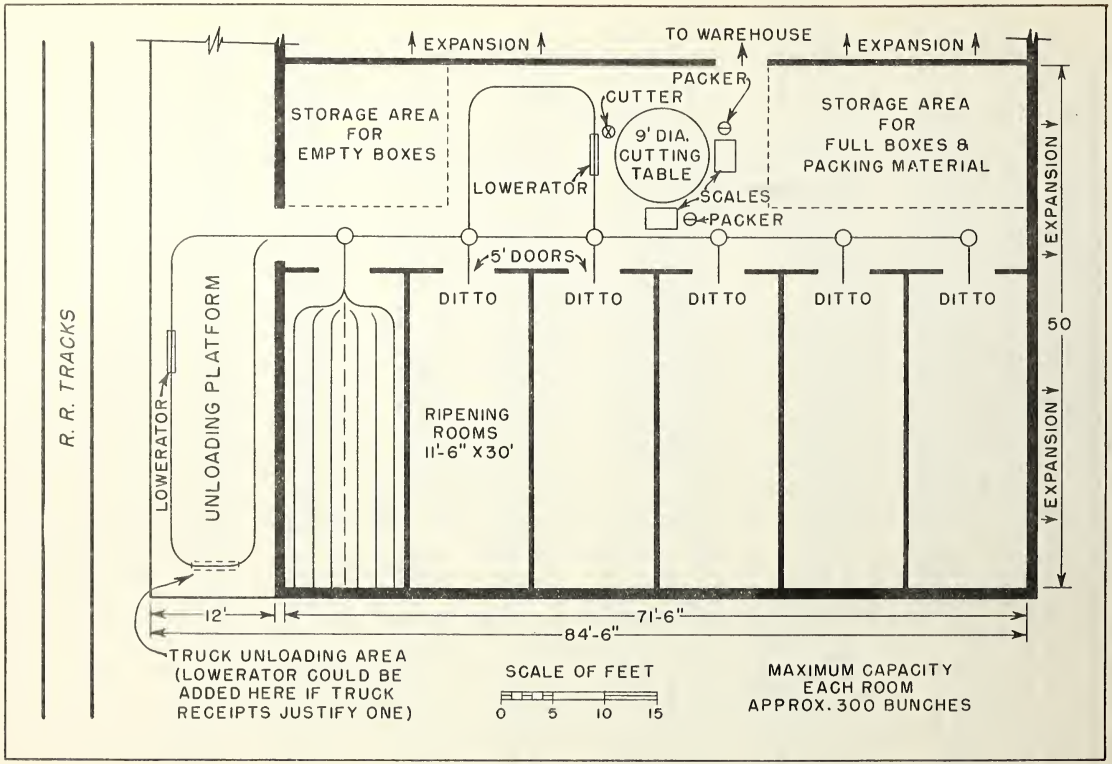


Figure 57.--Suggested layout of a banana facility when receiving is performed by use of manual monorail "ripen-on-carrier" conveyor.

APPENDIX

Equipment Costs

In order to make comparisons between different types of the equipment for performing the receiving and packing operations, it was necessary to determine cost figures for each of the types of equipment included in the study. Costs per carload for each type of equipment based on different annual volumes were determined. For those types of equipment used in more than one operation the cost per carload was allocated between the separate operations in proportion to the percentage of time the equipment was used in each operation. Tables 50, 51, and 52 show the basis for the development of the annual cost for each type of equipment and the cost per carload at various volumes.

Comparative Labor Requirements per Carload Equivalent for Setup and Cleanup Operations by Use of Various Types of Equipment in Receiving Operations

	Labor required per carload equivalent Man-hours
Setup: Begins when order is received to start unloading. Consists of assembling crew, opening car door, placing bridgeplate, removing bracing, installing weather guard, placing extension light in car, assembling the strings, cleaning obstructions from transportation route, and assembling transportation equipment. Setup ends when transporter lifts bunch from railroad car floor or motortruck bed.	0.40
Cleanup: Begins when last bunch has been stored in ripening room. Consists of picking up loose fingers in railroad car and along transportation route, removing bridgeplate, removing extension light, removing weather guard, closing car door, placing baskets of loose bananas in ripening room, closing ripening room, turning off light, recording data on shipment, and replacing transportation equipment in storage when necessary.	0.28

Comparative Labor Requirements per Carload Equivalent for Setup and Cleanup Operations by Various Types of Equipment in Packing Operations

	Labor required per man per working day Man-hours
Setup: Begins when workers start to assemble in the packing area at the beginning of work day. Consists of cleaning the work area, assembling necessary transportation equipment and packing supplies, sharpening knives, starting rotary table, assembling waste baskets, and opening the room door. Setup ends when workers start to perform packing operation.	0.18

	Labor required per man per working day Man-hours
Cleanup: Begins when last box has been packed and placed in storage. Consists of turning off rotary table, placing loose fingers in baskets and placing in storage, brushing off table, replacing transportation equipment, sweeping floor, removing cull bananas and stems, closing ripening room door, and recording production data. Cleanup ends when workers are ready to leave packing area.	0.32

Setup and cleanup usually takes place only once during the working day regardless of the number of cars that may be packed out. Therefore, to determine the man-hour requirements per car, setup and cleanup time for the entire day must be divided by the number of cars packed out. It is assumed that each crew member spends half an hour of elapsed time each day in setup and cleanup in the packing operation. For instance, if a 3-man crew packs 2 carloads daily, each carload is then charged 0.75 man-hour for setup and cleanup. This figure will vary with different crew sizes and daily production rates. For instance, a 4-man packing crew will require a total of 2.00 man-hours in setup and cleanup per work day.

Table 50.--Ownership and operation cost for banana-handling equipment based on 300 cars annual volume

Equipment	Amount of equipment	Initial cost 1/	Expected life	Ownership cost				Operating cost			Total annual cost	Cost per carload equivalent 4/
				Depreciation	Interest 2/	Insurance and taxes 2/	Total	Power	Maintenance	Total 3/		
		Dollars	Years	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Hydraulic bunch-lift truck 5/	1	800.00	10	80.00	20.00	32.00	132.00	10.00	25.00	35.00	167.00	0.5567
2-wheel bunch truck	1	225.00	10	22.50	5.62	9.00	37.12	-	3.00	3.00	40.12	.1337
2-wheel 3-bunch banana truck 6/	1	40.00	10	4.00	1.00	1.60	6.60	-	3.00	3.00	9.60	.0320
Warehouse-type 2-wheel hand truck	1	30.00	10	3.00	.75	1.20	4.95	-	3.00	3.00	7.95	.0265
4-wheel banana truck	1	75.00	10	7.50	1.88	3.00	12.38	-	7.50	7.50	19.88	.0663
Continuous powered monorail conveyor	To supply 6 ripening rooms	5,500.00	15	367.00	137.50	220.00	725.50	10.00	55.00	65.00	789.50	2.6317
Manual monorail conveyor	To supply 6 ripening rooms	7,500.00	15	500.00	186.50	300.00	986.50	-	75.00	75.00	1,061.51	3.5383
Manual monorail "ripen on carrier" conveyor	To supply 6 ripening rooms	35,768.41	15	2,384.56	891.21	1,430.74	4,709.51	-	150.00	150.00	4,859.51	16.1984
Forklift truck and attachment 7/	1	6,000.00	10	600.00	150.00	240.00	990.00	100.00	200.00	300.00	1,290.00	4.3000
Lowerator for forklift truck	1	400.00	15	26.67	10.00	16.00	52.67	10.00	5.00	15.00	67.67	.2256
6-bunch carriers	312	936.00	10	93.60	23.40	37.44	154.44	-	15.00	15.00	169.44	.5648
Position conveyor 8/	1	1,500.00	15	100.00	37.50	60.00	197.50	10.00	75.00	85.00	282.50	.9417
Semilive skids and jacks 9/	30	1,313.00	10	131.30	32.83	52.52	216.65	-	150.00	150.00	366.65	1.2222
Low-lift battery pallet transporter	1	3,500.00	10	350.00	87.50	140.00	577.50	40.00	80.00	120.00	697.50	2.3250
Stationary cutting stand	1	50.00	20	2.50	1.25	2.00	5.75	-	-	-	5.75	.0192
Stationary flattop packing table	1	100.00	15	6.67	2.50	4.00	13.17	-	10.00	10.00	23.17	.0772
Rotary packing table	1	1,250.00	15	83.33	31.25	50.00	164.58	12.50	15.00	27.50	192.08	.6403
Platform scales and weigh trays	1 scale											
	3 trays	150.50	15	10.03	3.76	6.02	19.81	-	6.00	6.00	25.81	.0860
Self-taring scale	1	600.00	15	40.00	15.00	24.00	79.00	-	10.00	10.00	89.00	.2967
Pallets (36- by 40-inch)	40	140.00	3	46.67	5.60	3.50	55.77	-	50.00	50.00	105.77	.3526

1/ Based on f. o. b. factory costs.
2/ Interest at 5 percent of average investment. Insurance and taxes at 4 percent of initial investment.
3/ Based on average costs in the industry.
4/ Includes cost of one item of equipment as indicated. To compute total cost for any one method of operation, multiply this cost by number of items of equipment used.
5/ This is a special bunch-lift truck with battery powered hydraulic feature for transferring bunches of bananas between hooks or ropes and transporting equipment in ripening room.
6/ Special 2-wheel hand truck designed to carry 3 bunches of bananas in an upright position.
7/ One-thousand pound capacity electric forklift truck with battery charger and special attachment for transporting 6-bunch carrier loads of bananas.
8/ Includes combination conveyor and lift hoist for handling 6-bunch carrier loads of bananas.
9/ Includes 1 jack for every 10 semilive skids.

Table 51.--Ownership and operation cost for banana-handling equipment based on 100 cars annual volume

Equipment	Amount of equipment	Initial cost 1/	Expected life	Ownership cost				Operating cost			Total annual cost	Cost per carload equivalent 4/
				Depreciation	Interest 2/	Insurance and taxes 2/	Total	Power	Maintenance	Total 3/		
		Dollars	Years	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Hydraulic bunch-lift truck 5/	1	800.00	15	53.33	20.00	32.00	105.33	7.00	20.00	27.00	132.33	1.3233
2-wheel bunch truck	1	225.00	15	15.00	5.62	9.00	29.62	-	2.00	2.00	31.62	.3162
2-wheel 3-bunch banana truck 6/	1	40.00	15	2.67	1.00	1.60	5.27	-	2.00	2.00	7.27	.0727
Warehouse-type 2-wheel hand truck	1	30.00	10	3.00	.75	1.20	4.95	-	2.00	2.00	6.95	.0695
4-wheel banana truck	1	75.00	15	5.00	1.88	3.00	9.88	-	5.00	5.00	14.88	.1488
Continuous powered monorail conveyor	To supply 3 ripening rooms	5,000.00	15	333.33	125.00	200.00	658.33	8.00	40.00	48.00	706.33	7.0633
Manual monorail conveyor	To supply 3 ripening rooms	4,000.00	15	266.67	100.00	150.00	516.67	-	50.00	50.00	566.67	5.6667
Manual monorail "ripen on carrier" conveyor	To supply 3 ripening rooms	19,109.33	15	1,273.95	477.73	764.37	2,516.05	10.00	90.00	100.00	2,616.05	26.1605
Forklift truck and attachment 7/	1	6,000.00	15	400.00	150.00	240.00	790.00	60.00	150.00	210.00	1,000.00	10.0000
Lowerator for forklift truck	1	400.00	20	20.00	10.00	16.00	46.00	6.00	3.00	9.00	55.00	.5500
6-bunch carriers	156	468.00	10	46.80	11.70	18.72	77.22	-	10.00	10.00	87.22	.8722
Position conveyor 8/	1	1,500.00	20	75.00	37.50	60.00	172.50	6.00	50.00	56.00	288.50	2.2850
Semilive skids and jacks 9/	30	1,313.00	15	87.53	32.83	52.52	172.88	-	125.00	125.00	297.88	2.9788
Low-lift battery pallet traneporter	1	3,500.00	15	233.33	87.50	140.00	460.83	25.00	50.00	75.00	535.83	5.3583
Stationary cutting stand	1	50.00	20	2.50	1.25	2.00	5.75	-	-	-	5.75	.0575
Stationary flattop packing table	1	100.00	15	6.67	2.50	4.00	13.17	-	7.00	7.00	20.17	.2017
Rotary packing table	1	1,250.00	15	83.33	31.25	50.00	164.58	8.00	10.00	18.00	182.58	1.8258
Platform scale and weigh trays	1 scale											
	3 trays	150.50	15	10.03	3.76	6.02	19.81	-	4.00	4.00	23.81	.2381
Self-taring scale	1	600.00	15	40.00	15.00	24.00	79.00	-	7.00	7.00	86.00	.8600
Pallets (36- by 40-inch)	40	140.00	3	46.67	5.60	3.50	55.77	-	30.00	30.00	85.77	.8577

1/ Based on f. o. b. factory costs.

2/ Interest at 5 percent of average investment. Insurance and taxes at 4 percent of initial investment.

3/ Based on average costs in the industry.

4/ Includes cost of one item of equipment as indicated. To compute total cost for any one method of operation multiply this cost by number of items of equipment used.

5/ This is a special bunch-lift truck with battery powered hydraulic feature for transferring bunches of bananas between hooks or ropes and transportation equipment in ripening room.

6/ Special 2-wheel hand truck designed to carry 3 bunches of bananas in an upright position.

7/ One-thousand pound capacity electric forklift truck with battery charger and special attachment for transporting 6-bunch carrier loads of bananas.

8/ Includes combination conveyor and lift hoist for handling 6-bunch carrier loads of bananas.

9/ Includes 1 jack for every 10 semilive skids.

Table 52.--Ownership and operation cost for banana-handling equipment based on 500 carc annual volume

Equipment	Amount of equipment	Initial cost 1/	Expected life	Ownership cost				Operating cost			Total annual cost	Cost per carload equivalent 4/
				Depreciation	Interest 2/	Insurance and taxes 2/	Total	Power	Maintenance	Total 3/		
		Dollars	Years	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Hydraulic bunch-lift truck 5/	1	800.00	10	80.00	20.00	32.00	132.00	12.00	30.00	42.00	174.00	0.3480
2-wheel bunch truck	1	225.00	8	28.12	5.62	9.00	42.74	-	4.00	4.00	46.74	.0935
2-wheel 3-bunch banana truck 6/	1	40.00	8	5.00	1.00	1.60	7.60	-	4.00	4.00	11.60	.0232
Warehouse-type 2-wheel hand truck	1	30.00	10	3.00	.75	1.20	4.95	-	4.00	4.00	8.95	.0179
4-wheel banana truck	1	75.00	10	7.50	1.88	3.00	12.38	-	10.00	10.00	22.38	.0448
Continuous powered monorail conveyor	To supply 10 ripening rooms	6,000.00	15	400.00	150.00	240.00	790.00	15.00	65.00	80.00	870.00	1.7400
Manual monorail conveyor	To supply 10 ripening rooms	12,100.00	15	806.66	302.50	484.00	1,593.16	-	100.00	100.00	1,693.16	3.3863
Manual monorail "ripen on carrier" conveyor	To supply 10 ripening rooms	44,848.62	15	2,989.90	1,121.22	1,793.94	5,905.06	15.00	185.00	200.00	6,105.06	12.2101
Forklift truck and attachment 7/	1	6,000.00	10	600.00	150.00	240.00	990.00	130.00	250.00	380.00	1,370.00	2.7400
Lowerator for forklift truck	1	400.00	10	40.00	10.00	16.00	66.00	13.00	7.00	20.00	86.00	.1720
6-bunch carriers	520	1,560.00	10	156.00	39.00	62.40	257.40	-	25.00	25.00	282.40	.5648
Position conveyor 8/	1	1,500.00	15	100.00	37.50	60.00	197.50	15.00	100.00	115.00	312.50	.6250
Semilive skids and jacks 9/	60	2,626.00	10	262.60	65.65	105.04	433.29	-	300.00	300.00	733.29	1.4666
Low-lift battery pallet transporter	1	3,500.00	10	350.00	87.50	140.00	577.50	50.00	100.00	150.00	727.50	1.4550
Stationary cutting stand	1	50.00	20	2.50	1.25	2.00	5.75	-	-	-	5.75	.0115
Stationary flattop packing table	1	100.00	15	6.67	2.50	4.00	13.17	-	20.00	20.00	33.17	.0663
Rotary packing table	1	1,250.00	15	83.33	31.25	50.00	164.50	16.00	25.00	41.00	205.50	.4110
Platform scale and weigh trays	1 scale											
	3 trays	150.50	15	10.03	3.76	6.02	19.81	-	10.00	10.00	29.81	.0596
Self-taring scale	1	600.00	15	40.00	15.00	24.00	79.00	-	15.00	15.00	94.00	.1880
Pallets (36- by 40-inch)	80	280.00	3	93.33	11.20	7.00	111.53	-	100.00	100.00	211.53	.4231

1/ Based on f. o. b. factory costs.
2/ Interest at 5 percent of average investment. Insurance and taxes at 4 percent of initial investment.
3/ Based on average costs in the industry.
4/ Includes cost for one item of equipment as indicated. To compute a total cost for any one method of operation multiply this cost by number of items of equipment used.
5/ This is a special bunch-lift truck with battery powered hydraulic feature for transferring bunches of bananas between hooks or ropes and transportation equipment in ripening room.
6/ Special 2-wheel hand truck designed to carry 3 bunches of bananas in an upright position.
7/ One-thousand pound capacity electric forklift truck with battery charger and special attachment for transporting 6-bunch carrier loads of bananas.
8/ Includes combination conveyor and lift hoist for handling 6-bunch carrier loads of bananas.
9/ Includes 1 jack for every 10 semilive skids.

Productive Data

Fatigue and personal allowances for performing various handling operations in banana wholesale houses

Time item	Allowances		
	Fatigue Percent	Personal Percent	Total Percent
Manually lift bunches from car or truck to shoulder height, carry to threshold of car or tailgate of truck, and return	25	5	30
Manually lift bunches from car or truck to shoulder height with assistance of another worker, carry to threshold of car or tailgate of truck, and return	20	5	25
Manually lift bunches from car or truck floor to shoulder height, carry to threshold of car or truck tailgate, and hang on monorail conveyor	25	5	30
Manually lift bunches from car or truck to shoulder height, carry to threshold of car or truck tailgate, and hang on 6-bunch carrier at lowerator	25	5	30
Transport bunches manually	20	5	25
Manually hang bunches in ripening room	20	5	25
Manually hang bunches on cutting stand	20	5	25
Manually hang bunches in ripening room with assistance of another worker	15	5	20
Manually unhook bunches in ripening room and hang on 4-wheel banana truck	20	5	25
Use 2-wheel bunch truck to pick up bunches in car or truck with assistance of another worker, and hang bunches in ripening room	10	5	15
2 workers in car or truck load 3 bunches on 2-wheel banana truck, 1 worker transports to dock outside car, and hangs bunches on monorail carrier at lowerator	10	5	15
Manually lift bunches from car or truck floor to shoulder height, carry to threshold of car or truck tailgate, and hang on manual monorail conveyor	25	5	30
Lift bunches from car or truck floor level and hang on 4-wheel banana truck	25	5	30
Lift bunches from 4-wheel banana truck and hang in ripening room	20	5	25
Transport with 4-wheel banana truck	10	5	15
Transport with 2-wheel bunch truck	10	5	15
Transport on manual monorail conveyor system	10	5	15
Transport on manual monorail *ripen-on-carrier* conveyor system	10	5	15
Pick up, transport, and store with forklift truck	5	5	10
Lift bunches from continuous powered monorail conveyor, carry into ripening room, and hang them	20	5	25
Lift bunches from manual monorail conveyor in ripening room and hang them	20	5	25
Operate hydraulic bunch lift truck	10	5	15
Unhook bunches in ripening room and hang on manual monorail conveyor	20	5	25
Manually unhook bunches in ripening room and position for manual transportation	20	5	25
Cut, inspect, and grade banana hands; place on table and remove stems	15	5	20
Weigh and pack bananas in 40-pound boxes using self-taring scales, and stack full boxes	10	5	15
Weigh bananas in 40-pound lots using platform scale and weigh trays	10	5	15
Pack bananas in 40-pound boxes using weigh trays and stack full boxes	10	5	15
Transport full boxes to storage and bring up supplies using warehouse-type 2-wheel hand trucks, semilive skids and jacks, and battery pallet transporter and pallets	10	5	15
Transport full boxes to storage and bring up supplies using forklift truck and pallets	5	5	10
Break banana hands into consumer-size sections	10	5	15
Band consumer-size sections of bananas	10	5	15

Comparative labor requirements per carload equivalent for performing the cutting operation by selected methods and types of equipment

Time item	Base time	Fatigue and personal allowances	Productive time
	Man-hours	Man-hours	Man-hours
Use of stationary cutting stand	3.92	0.78	4.70
Use of 4-wheel banana truck	4.08	.82	4.90
Use of manual monorail convevor system	3.42	.68	4.10
Use of manual monorail *ripen-on-carrier* conveyor system	4.12	.82	4.94
Use of position conveyor in forklift truck system	4.71	.94	5.65

Comparative labor requirements per carload equivalent for performing weighing and packing operations by different methods and types of equipment

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
Weigh 40-pound lots of full hands using platform scale and weighing trays and push full trays across stationary packing table to packer	4.35	0.65	5.00
Pack 40-pound boxes of full hands from weighing trays and push empty trays across stationary packing table to weigher	4.82	.72	5.54
Weigh and pack 40-pound boxes of full hands by self-taring scale and rotary table	5.93	.89	6.82
Weigh and pack 40-pound boxes of consumer-size sections of bananas by self-taring scale and rotary table	6.89	1.03	7.92
Inspect, grade, and weigh 40-pound boxes of full hands of bananas using self-taring scale and rotary table	7.11	1.07	8.18
Break full hands of bananas into consumer-size sections on rotary packing table	6.25	.94	7.19
Inspect, grade, break into consumer-size sections, and weigh 40-pound lots of bananas by platform scale and weigh tray on a stationary packing table	9.37	1.41	10.78
Cut, inspect, grade, and break bananas into consumer-size sections by 4-wheel banana truck and rotary packing table	8.17	1.23	9.40
Band consumer-size sections with gummed labels by banding machine at rotary packing table	10.87	1.63	12.50
Weigh and pack full hands of bananas in 40-pound boxes by self-taring scales and rotary table, winter cover boxes with shredded paper on top of fruit and cover boxes with box lid	8.09	1.21	9.30
Weigh and pack full hands of bananas in 40-pound boxes by self-taring scales and rotary table and winter cover the boxes with shredded paper and a sheet of newsprint or brown kraft paper	9.23	1.38	10.61
Remove 40-pound boxes of bananas from packing stand and stack--			
4-high on 4-wheel platform truck (16 boxes)	.58	.09	.67
4-high on pallet (12 boxes)	.47	.07	.54
4-high on skid (16 boxes)	.60	.09	.69
5-high on pallet (15 boxes)	.52	.08	.60
5-high on floor for warehouse-type 2-wheel hand truck	.53	.08	.61

Comparative labor requirements per carload equivalent to manually perform various handling operations

Time item	Base time	Fatigue and personal allowances	Productive time
	Man-hours	Man-hours	Man-hours
Transporter lifts bunch to shoulder position and moves to threshold of car	1.38	0.41	1.79
Transporter lifts bunch to shoulder with assistant and moves to threshold of car:			
Assistant loader	.71	.18	.89
Transporter	1.46	.37	1.83
Total load time	2.17	.55	2.72
Transporter unhooks bunches in ripening room and positions on shoulder	.46	.11	.57
Transport to storage point and return: 1/			
Distance in feet:			
20	.78	.19	.97
40	1.46	.36	1.82
60	2.15	.54	2.69
80	2.83	.71	3.54
100	3.52	.88	4.40
150	5.23	1.31	6.54
200	6.94	1.73	8.67
Transporter hangs bunch in ripening room	.37	.09	.46
Transporter hangs bunch with assistant in ripening room:			
Assistant hanger	.33	.07	.40
Transporter	.33	.07	.40
Total hang time	.66	.14	.80
Transporter hangs bunch on cutting stand	.33	.08	.41

1/ Based on 250 trips with 1 bunch each. For transport times at additional distances use formula $t = 0.0342d + 0.096$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

Comparative labor requirements per carload equivalent to perform various handling operations by use of 2-wheel bunch truck and hydraulic bunch lift truck

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
2 workers load 2 bunches on 2-wheel bunch truck and transporter moves it to threshold of car:			
Assistant loader	0.60	0.09	0.69
Transporter	.79	.12	.91
Total load time	1.39	.21	1.60
Transport to storage point and return: 1/			
Distance in feet:			
20	.72	.11	.83
40	.89	.13	1.02
60	1.07	.16	1.23
80	1.24	.19	1.43
100	1.42	.21	1.63
150	1.85	.28	2.13
200	2.29	.34	2.63
2 workers hang bunches in ripening room:			
Hydraulic bunch lift operator	.67	.10	.77
Transporter	.48	.07	.55
Total hang time	1.15	.17	1.32

1/ Based on 125 trips with 2 bunches each. For transport times at additional distances use formula $t = 0.00875d + 0.5415$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

Comparative labor requirements per carload equivalent to perform various handling operations by use of warehouse-type 2-wheel hand truck

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
1 worker loads stacks of 5 full boxes on hand truck at packing line	0.29	0.04	0.33
1 worker loads stacks of 10 empty boxes on hand truck in storage area	.14	.02	.16
Transport packed boxes to temporary storage and return: 1/			
Distance in feet:			
20	.52	.08	.60
40	.64	.10	.74
60	.76	.11	.87
80	.90	.13	1.03
100	1.02	.15	1.17
150	1.34	.20	1.54
200	1.65	.25	1.90
Transport empty boxes to packing line and return: 2/			
Distance in feet:			
20	.26	.04	.30
40	.32	.05	.37
60	.38	.06	.44
80	.45	.07	.52
100	.51	.08	.59
150	.67	.10	.77
200	.82	.12	.94
1 worker sets down stacks of 5 full boxes in storage	.23	.03	.26
1 worker sets down stacks of 10 empty boxes at packing line	.11	.02	.13

1/ Based on 90 trips of 5 boxes each. For transport times at additional distances use formula $t = 0.0063d + 0.39$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

2/ Based on 45 trips of 10 empty boxes each. For transport times at additional distances use formula $t = 0.00315d + 0.195$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

Comparative labor requirements per carload equivalent to perform various handling operations by 4-wheel banana truck

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
1 worker positions truck in car, loads 8 bunches, and pushes truck onto platform	1.12	0.34	1.46
2 workers position truck in car, load 8 bunches, and push loaded truck onto platform	1.50	.45	1.95
1 worker positions truck in ripening room and loads 8 bunches	.88	.22	1.10
1 worker positions truck in ripening room and loads 8 bunches with hydraulic bunch lift truck	1.67	.25	1.92
Transporter releases empty truck and picks up loaded truck on platform	.04	.01	.05
Transport loaded truck to storage and return: 1/ Distance in feet:			
20	.17	.03	.20
40	.26	.04	.30
60	.34	.05	.39
80	.43	.06	.49
100	.51	.08	.59
150	.72	.11	.83
200	.94	.14	1.08
Transporter releases loaded truck in ripening or cutting area and picks up adjacent empty truck	.04	.01	.05
1 worker removes bunches from truck and hangs them in room	1.00	.25	1.25
2 workers remove bunches from truck and hang them in room	1.41	.35	1.76

1/ Based on 31 trips of 8 bunches each. For transport times at additional distances use formula $t = 0.00424d + 0.0887$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

Comparative labor requirements per carload equivalent to perform various handling operations by continuous powered monorail conveyor

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
Enter car, pick up bunches from floor, carry to platform outside car (about 5 feet), and hang on carrier of conveyor	1.63	0.49	2.12
Transport to storage point and return	-	-	-
Unhook bunches from conveyor outside room door (about 5 feet), carry into room, and hang	1.50	.38	1.88

Comparative labor requirements per carload equivalent to perform various handling operations by the manual monorail conveyor system

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
Pick up bunches in car, manually carry to receiving platform, and hang on monorail carrier	1.79	0.54	2.33
Manually unhook bunches in ripening room and hang on monorail carrier	1.13	.28	1.41
Unhook bunches in ripening room and hang on monorail carrier by use of hydraulic bunch lift truck	1.79	.27	2.06
Deposit empty and pick up loaded carriers	.10	.01	.11
Transport loaded carriers to ripening room or packing line and return: 1/			
Distance in feet:			
20	.17	.03	.20
40	.28	.04	.32
60	.38	.06	.44
80	.49	.07	.56
100	.60	.09	.69
150	.86	.13	.99
200	1.13	.17	1.30
Deposit loaded and pick up empty carriers	.12	.02	.14
Unhook bunches from carriers and hang them in ripening room	.92	.23	1.15

1/ Based on 25 trips of 10 bunches each. For transport times at additional distances use formula $t = 0.00534d + 0.0625$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty and transport loaded.

Comparative labor requirements per carload equivalent to perform various handling operations with manual monorail *ripen-on-carrier* conveyor system

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
Load monorail 6-bunch carrier by 3-bunch 2-wheel banana truck and lowerator:			
1 worker in car assists in loading banana trucks	0.56	0.08	0.64
Truckers load banana trucks with assistant, move to lowerator, and hang bunches	1.61	.24	1.85
1 worker operates lowerator and assists in hanging bunches	.44	.07	.51
Total load time	2.61	.39	3.00
Transport loaded carriers to ripening room or packing line and return: 1/			
Distance in feet:			
20	.30	.05	.35
40	.42	.06	.48
60	.54	.08	.62
80	.66	.10	.76
100	.77	.12	.89
150	1.07	.16	1.23
200	1.36	.20	1.56
Deposit loaded carriers in ripening room or at packing line and assemble empty carriers	.04	.01	.05

1/ Based on 21 trips with 2 carriers (12 bunches) each. For transport times at additional distances use formula $t = 0.00588d + 0.1855$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport loaded plus transport empty.

Comparative labor requirements per carload equivalent to perform various handling operations by forklift truck

Time item	Base time	Fatigue and personal allowances	Productive time
	Man-hours	Man-hours	Man-hours
3 workers manually unload from car and hang bunches on 6-bunch carriers using lowerator on platform	2.54	0.76	3.30
Change forks of forklift truck to special attachment for handling 6-bunch carriers	.17	.02	.19
Pick up and maneuver 6-bunch carrier from lowerator by forklift truck	.08	.01	.09
Pick up 6-bunch carrier from rack in ripening room by forklift truck	.13	.01	.14
Transport 6-bunch carrier to storage point by forklift truck and return: 1/			
Distance in feet:			
20	.44	.04	.48
40	.50	.05	.55
60	.57	.06	.63
80	.63	.06	.69
100	.69	.07	.76
150	.86	.09	.95
200	1.02	.10	1.12
Set down 6-bunch carriers on rack in ripening room	.06	.01	.07
Maneuver into position conveyor and set down 6-bunch carriers	.30	.03	.33
Pick up pallet loads of 12 packed boxes at packing line by forklift truck	.12	.01	.13
Transport 12 packed boxes to storage point by forklift truck and return: 2/			
Distance in feet:			
20	.40	.04	.44
40	.45	.05	.50
60	.51	.05	.56
80	.57	.06	.63
100	.63	.06	.69
150	.78	.08	.86
200	.82	.08	.90
Set down pallet load of 12 packed boxes in storage (2 tiers)	.15	.02	.17
Pick up pallet loads of 30 empty boxes in storage area	.05	.01	.06
Transport 30 empty boxes to storage point by forklift truck and return: 3/			
Distance in feet:			
20	.16	.02	.18
40	.18	.02	.20
60	.20	.02	.22
80	.23	.02	.25
100	.25	.03	.28
150	.31	.03	.34
200	.36	.04	.40
Release pallet load of 30 empty boxes at packing line	.04	.01	.05

1/ Based on 42 trips of 6 bunches each. For transport times at additional distances use formula $t = 0.00322d + 0.3731$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

2/ Based on 38 trips of 12 boxes each. For transport times at additional distances use formula $t = 0.00292d + 0.3376$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

3/ Based on 15 trips of 30 boxes each. For transport times at additional distances use formula $t = 0.00115d + 0.133$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport empty plus transport loaded.

Comparative labor requirements per carload equivalent to perform various handling operations with semilive skids and jack

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
Pick up skid load of 16 packed boxes	0.08	0.01	0.09
Transport 16 packed boxes to storage point and return: 1/			
Distance in feet:			
20	.38	.06	.44
40	.47	.07	.54
60	.57	.09	.66
80	.66	.10	.76
100	.76	.11	.87
150	1.00	.15	1.15
200	1.24	.19	1.43
Set down semilive skid load of 16 packed boxes in storage	.07	.01	.08
Pick up skid load of 40 empty boxes in storage area	.03	-	.03
Transport 40 empty boxes to storage point and return: 2/			
Distance in feet:			
20	.16	.02	.18
40	.20	.03	.23
60	.24	.04	.28
80	.28	.04	.32
100	.33	.05	.38
150	.43	.07	.50
200	.53	.08	.61
Set down semilive skid load of 40 empty boxes at packing line	.03	-	.03

1/ Based on 28 trips of 16-box skid loads each. For transport times at additional distances use formula $t = 0.00476d + 0.284$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport loaded plus transport empty.

2/ Based on 12 trips of 40 empty boxes per skid load. For transport times at additional distances use formula $t = 0.00204d + 0.122$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport loaded plus transport empty.

Comparative labor requirements per carload equivalent to perform various handling operations by use of electric low-lift pallet transporter and pallets

Time item	Base time Man-hours	Fatigue and personal allowances Man-hours	Productive time Man-hours
Pick up pallet load of 15 packed boxes by pallet transporter and replace empty pallet	0.19	0.02	0.21
Pick up pallet load of 30 empty boxes in storage area by pallet transporter	.06	.01	.07
Transport 15 packed boxes to storage by pallet transporter and return: 1/			
Distance in feet:			
20	.34	.05	.39
40	.42	.06	.48
60	.52	.08	.60
80	.60	.09	.69
100	.68	.10	.78
150	.90	.14	1.04
200	1.13	.17	1.30
Transport 30 empty boxes to packing area by pallet transporter and return: 2/			
Distance in feet:			
20	.17	.03	.20
40	.21	.03	.24
60	.26	.04	.30
80	.30	.05	.35
100	.34	.05	.39
150	.45	.07	.52
200	.56	.09	.65
Set down pallet load of 15 packed boxes in storage by pallet transporter	.17	.03	.20
Set down pallet load of 30 empty boxes at packing area by pallet transporter	.07	.01	.08

1/ Based on 30 trips with pallet load of 15 boxes each. For transport times at additional distances use formula $t = 0.0044d + 0.246$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport loaded plus transport empty.

2/ Based on 15 trips of 30 boxes each. For transport times at additional distances use formula $t = 0.0022d + 0.123$ when d = distance between points in feet and t = base time in man-hours per carload equivalent to include transport loaded plus transport empty.

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