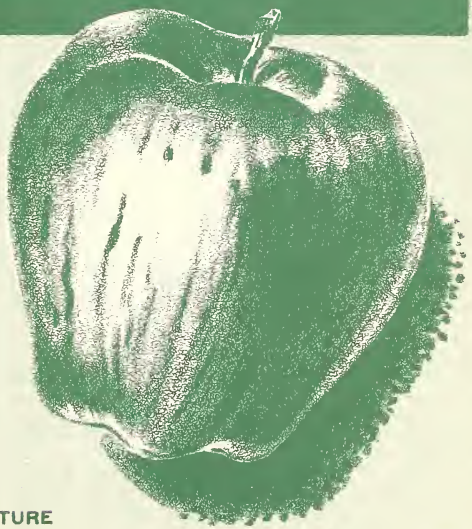
Methods and Costs of

LOADING APPLES IN THE ORCHARD IN THE PACIFIC NORTHWEST



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CONTENTS

METHODS AND COSTS OF LOADING APPLES IN THE ORCHARD IN THE PACIFIC NORTHWEST[1]

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Introduction

Handling methods from tree to warehouse have an important bearing on how quickly apples can be moved into cold storage after picking and how gently the fruit can be handled. Both of these factors influence the ultimate storage life of the fruit and its salability.

A research program in Washington State has accumulated considerable information on methods and costs of loading and moving apples from between the tree rows in the orchard to the storage and packing plants under the conditions found in that area. To make the comparisons of methods more exact, the orchard driving time and the preparation time at each stop in the orchard have been eliminated, because great variation was found in these operations that was not in any way related to the method being studied. An overall cost figure for moving apples from orchard to packing house would include the driving and preparatory operations; however, the comparison of two methods for a given orchard situation will be represented by the difference between the figures given here. The driving and preparatory operations would add the same amount to each method for a given instance (assuming the crew size remains the same). Evaluation of differences should be made only by comparing actual cost differences and should not be converted into percentages, because such a procedure involves the erroneous assumption that the operations that have not been included are nonexistent.

In this report several terms are used that have a specific or semitechnical meaning. The most important of these terms are defined as follows:

Standardized time.--Observed man-hours taken to perform various operations common to different methods, as found in the Washington State apple industry.

Preparation or setup time.--Time required previous to doing a given job. For example, walking from tractor to position beside stacks of boxes or taking off the ropes and end rack from a road truck before loading.

Wait time.--Time one member or members of a crew spend in waiting for another member or members during the work process.

Fatigue time.--Time allowance for resting after exertion required in doing a job.

Labor cost computations were based on the 1952 rate of $1.15 an hour.

The boxes used in the study are standard apple boxes used in the Northwest, having outside dimensions 19 1/2 inches long by 12 inches wide by 10 3/4 inches deep. When used as field lugs they will hold an average of 34 pounds of fruit, although this average may be subject to a variation of 3 pounds, depending on size and variety.

Machine costs that are charged against certain methods cover only the cost of special equipment required for that method and are figured on the basis of an annual

[1] This report summarizes parts of a study of apple handling costs and methods made by the Washington State Apple Commission, Research Department, working under contract No. A-1s-33006 for the U. S. Department of Agriculture. It covers a study in which certain phases were carried on under the Agricultural Marketing Act of 1946 (RMA Title II.)

charge of 15 percent of the initial cost to cover depreciation, insurance, taxes, and maintenance. The machine cost of trucks and trailers normally involved in the various methods has not been included in the evaluations, because the saving in machine time may or may not enable the grower to operate with less equipment, depending on the circumstance of an individual operation. The data presented on elapsed time, or machine time, for the various methods will enable a grower to investigate the possibility that an improved method may permit him to harvest his crop with less equipment.

General Orchard Equipment and Practices

Several methods of loading orchard trailers and road trucks are in current use in the industry. Some growers are trying new methods in an effort to find more efficient ways to move their fruit. No method is universally suitable, for conditions in some orchards will prevent the use of an otherwise desirable or economical method of loading.

Hauling from the orchard should follow picking as closely as possible, for each day the fruit is held at 70° F. is equivalent to losing 10 days of storage life.[2] With the late varieties, apples left in the orchard may be subject to freeze damage and to certain types of decay in the field and when they reach storage.[3] Serious losses may result if the fruit is left in the field during rainy weather. For those reasons it is important to have the hauling efficiently organized as well as to keep costs at a minimum.

The majority of Washington growers haul fruit from the orchard on flat-bed two-wheeled or tandem-wheeled trailers (one wheel slightly ahead of the other to ride gently over uneven orchard terrain) (fig. 1). Some of the older trailers have large wheel housings in the bed, while the newer ones all use smaller wheels and flat beds. The trailers are constructed with the beds relatively close to the ground so that the loaded trailer can move under the branches of the trees. The trailer is usually built with a bed approximately 7 feet wide, which will accommodate the length of four boxes or the width of seven boxes. Some growers prefer to load boxes crosswise to the trailer bed (fig. 2), because they believe the load rides more stably over orchard ditches and around turns. Others load the boxes lengthwise (fig. 3), because this arrangement is easier to load.

After the trailer has been loaded in the orchard it may be hauled directly to the cold storage plant or, more frequently, to the edge of the orchard. Trailers may be pulled by either a wheel- or crawler-type tractor or by a jeep. At the edge of the orchard the fruit is usually transferred to a platform or to a road truck or sometimes stacked on the ground; under most circumstances it is uneconomical to haul to the warehouse with tractor-trailer equipment.

The decision to haul fruit to the warehouse on trailers depends upon the distance, the transportation speed of hauling equipment, and the size of the load. A road truck generally hauls 288 boxes, whereas an average trailer hauls about half this load. A comparison of the time required per 1,000 boxes (including the time to transfer the boxes from the orchard trailer to the truck) shows that a highway truck traveling at 40 miles an hour will deliver more fruit to the warehouse than a trailer traveling 15 miles per hour when the distance to the warehouse is 4 1/2 miles. From an inspection of figure 4 a grower may determine whether it would be less costly to move fruit to the plant on trailers or on road trucks.

Loading Orchard Trailers

In these studies loading orchard trailers has been divided into three main operations: (1) Driving into, through, and out of the orchard; (2) preparing to pick up boxes after

[2] Fisher, D. F., and Smith, E. Handling Apples From Tree to Table. U.S. Dept. Agr. Cir. 659, 43 pp., illus. Revised 1951.

[3] Mostly anthracnose-type decay commonly called "bull's eye rot."

FIGURE 1. --Empty tandem-wheeled trailer.

FIGURE 2. --Loading boxes from tree row to orchard trailer--crosswise load (method A).

FIGURE 3. --Trailers with lengthwise loads.

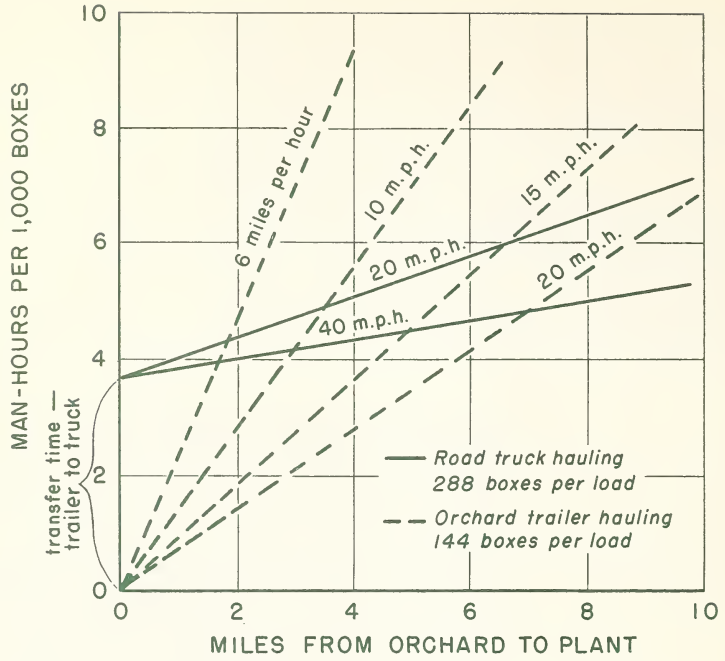

FIGURE 4. --Man-hours of work required to haul boxes of apples from an orchard to a storage plant by orchard trailer and by road truck when traveling at various speeds over various distances. The man-hours of work required when hauling by road truck includes 3.65 hours necessary to transfer the boxes from trailer to road truck.

stopping at the stacks beside the tree rows and preparing to move to the next stack of boxes in the tree rows; and (3) loading the boxes onto the trailer.

It is not possible to arrive at a uniform time spent in driving, because circumstances differ in each orchard and with each load. The distance to the unloading platform; changes in terrain, such as the presence of irrigation ditches and rills; and the distance between boxes in the tree rows affect the amount of time spent in driving. Similarly, a uniform time does not occur for preparing to pick up boxes. This time is affected by the number of stops required to fill the trailer, the yield of fruit, the instructions given to pickers on placing their boxes, as well as features of the terrain.

The variability of the foregoing factors is demonstrated by the data in table 1, which shows that the driving time to pick up loads in orchards ranged from 6.71 to 28.48 minutes per trailer load. The highest driving time was seven times the lowest, while the highest preparatory time was more than three times the lowest.

Since the great variability in time of driving and preparing to pick up boxes eliminates these from detailed study, the operation of actually loading the boxes is the main operation for analysis. A number of methods of loading boxes onto trailers has been compared.

TABLE 1.--Range in average time taken to drive through an orchard and in preparatory work for loading orchard trailers from tree-row stacks in 8 Washington State apple orchards[1]

Type of observation	Number of observations	Minutes per trailer load		
		Lowest	Highest	Average
Total driving time per trailer load:	--	6.71	28.48	14.02
Driving time with trailer unloaded and going into the orchard and with trailer loaded and coming out of orchard	10	5.67	22.88	11.50
Driving time through orchard with orchard trailer partly loaded	18	1.04	5.60	2.52
Preparatory time during the loading operation	18	.77	2.70	1.55

[1] Average trailer load 150 boxes.

Common Methods of Loading (Methods A and B)

The most common method of loading trailers in this area (method A, figs. 2 and 5) uses one worker on the ground to lift boxes from the tree-row stacks onto the edge of the trailer bed. This workman frequently carries the boxes several steps in this operation. Another worker standing on the trailer bed picks up the box from the edge and places it into hauling position. The amount of time required to do this is 3.04 man-hours per 1,000 boxes (table 2).

A variation of this common method is for the man on the trailer bed to stack the center rows on the trailer and then move to the ground, where he assists the ground worker in placing the remaining boxes along the edges of the trailer (fig. 6). This method (B) saved more than one-sixth of the work requirements per 1,000 boxes and reduced the time to load the trailer by approximately one-fourth of an hour per 1,000 boxes (table 2).

Improved Method of Loading (Method C)

In one orchard an improved trailer-loading method (C) eliminated the man standing on the trailer bed. This improvement was accomplished by placing skids across the trailer bed, enabling the worker to push the stack of boxes toward the center of the trailer after building a stack of the desired height on the edge of the trailer. Stacks can be pushed across the whole width of the trailer or to the middle of the trailer, permitting it to be loaded from either or both sides (figs. 7, 8, 9, and 10).

Improved method C saved 39 percent of the loading labor required by the common method A and reduced the elapsed time to load a trailer by nearly 40 percent.

Comparison of Common (A, B) and Improved (C) Methods of Loading

Method C effected a sizable savings in costs as a result of man-hours saved (table 2). Even more important, it may allow the use of a smaller crew; particularly, in smaller orchards where one man can do all of the loading and hauling of fruit to the warehouse. In a larger orchard the savings in total time may reduce the amount of hauling equipment needed. The difference in the capital cost of equipment for the two systems was negligible. The nominal cost of the hardwood strips may be offset by less wear on the trailer bed.

TABLE 2.--Labor and machine-hours and costs of loading 1,000 boxes of apples on orchard trailers by methods A to E, with a 2-man crew

[Labor costs based on $1.15 an hour]

Method	Type of loading on trailer	Figure reference (by No.)	Labor and machine-hours required to load apples				Labor and machine cost required to load apples		
			Labor	Waiting time	Elapsed time	Equipment time	Labor	Machine	Total
	Without pallets:		*Man-hours*	*Man-hours*	*Hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
A.....	By hand, one worker on ground, other stacking on trailer	2,5	3.04	0	1.52	0	3.50	0.00	3.50
B.....	By hand; worker on bed stacks center rows, then works from ground	6	2.52	0	1.26	0	2.90	0	2.90
C.....	By hand; both stack and slide boxes across hardwood strips on trailer	7 to 10	1.85	0	.92	0	2.13	0	2.13
	With pallets:[1]								
D.....	Same as A.....	11 to 13	3.24	0	1.62	0	3.73	0	3.73
E.....	Special trailer; workers on ground lift and stack	14 to 17	2.82	0	1.41	0	3.24	0	3.24

[1] When trailers using pallets are unloaded at the warehouse, 0.78 man-hour per 1,000 boxes is saved, representing a labor cost reduction of $0.90 per 1,000 boxes.

FIGURE 5. --Common method of loading orchard trailer: one man on the ground and one man on the trailer bed (method A).

FIGURE 6. --Method B: One worker lifts boxes to trailer bed and another stacks boxes in middle rows; both stack boxes in outside rows.

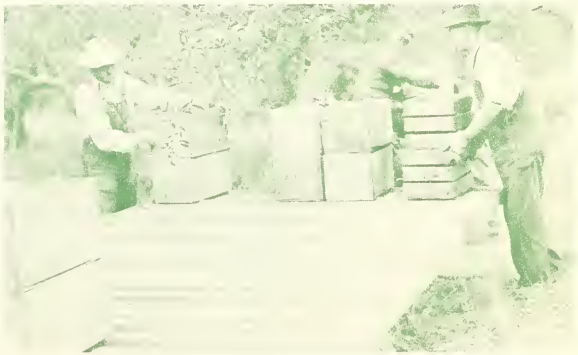

FIGURE 7. --Method C: Hardwood strips permit workers to slide stacks of boxes from edge of trailer to center.

FIGURE 8. --Closeup of hardwood strips on trailer bed (method C).

FIGURE 9. --Worker sliding tier of boxes across strips (method C).

FIGURE 10. --Worker completing one tier of the load (method C).

A disadvantage of method C is that it will not permit hand-clamp trucks to move over the trailer bed lengthwise for unloading the trailer. However, trailers usually are unloaded from the side.

Common Method of Loading When Using Pallets (Method D)

At industrial fork-lift truck plants in Washington, where fruit is hauled to the plant on trailers, a part of the trailer load may be hauled on pallets. Such a load is termed "a partially palletized" load and is illustrated in figure 11. The pallets are not stacked to a full unit load of 6-high, because a trailer load 2 or 3 boxes high is the maximum that can be maneuvered through the orchard beneath low-hanging limbs and over rather uneven terrain. After the trailer arrives at the warehouse the unit load must be built to full height by taking some of the boxes on the trailer that are not on pallets and stacking them on the partially loaded pallets.

Empty pallets are placed on the orchard trailer by the tractor driver and helper at the edge of the orchard (fig. 12) or at the warehouse where the trailer is unloaded. After the pallets are loaded the trailer is hauled to the orchard where the boxes are placed on the trailer in a manner essentially the same as previously described for the common trailer loading method (method A) (fig. 13).

The partially palletized load (method D) required 3-1/4 man-hours per 1,000 boxes of apples, 0.2 man-hour more than when pallets were not used, which was the time needed to handle the empty pallets. At the warehouse the partially palletized trailer method of hauling saved 0.78 man-hour per 1,000 field boxes.[4]

Loading Special Trailer Designed for Pallets (Method E)

One grower completely palletized his load to 5-high in the orchard by using a special trailer having minimum ground clearance, width to accommodate one pallet, and length to handle four pallets (figs. 14 and 15). The trailer was constructed so that the pallets were tied in place while in transit. The trailer was loaded by workmen standing on the ground and moving the boxes from the tree-row stacks to the pallet (fig. 16, method E).

With this specially built trailer 1,000 boxes were loaded with 2.82 man-hours of labor in an elapsed time of 1.41 hours. The decrease in stacking time (0.74 man-hour per 1,000 boxes) as compared to the common method was attributable to the fact that all boxes are stacked in hauling position with one handling. This improved method saves considerable time in stacking boxes on the trailer, but 43 percent of the savings is lost because the trailer load must be tied (fig. 17).

Comparison of Loading of the Common (D) and Special (E) Orchard Trailer When Using Pallets

Analysis of the data shows that method D of partially palletizing the load in the orchard is not so efficient as using the specially built trailer. The special trailer can be loaded in 13 minutes less time per 1,000 boxes than the partially palletized load (table 2). Labor is reduced by 13 percent.

There are obvious advantages of using the improved method, but it does have some shortcomings. Many orchards in this area are not planned or arranged to permit a 5-high load to be hauled from the orchard, although on this trailer a 5-high load is equal to only 4-high on a conventional trailer. Storage capacities in most pallet plants would be reduced if the pallet loads go into storage five boxes high instead of six, and the investment in pallets would be increased approximately one-sixth.

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[4] Carlsen, E. W., Hunter, D. L., Duerden, R. S., and Herrick, J. F. Apple Handling Methods and Equipment in Pacific Northwest Packing and Storage Houses. U. S. Dept. Agr. Market. Res. Rpt. 49, 302 pp., illus. 1953.

FIGURE 11. --Method D: Orchard trailer with partially palletized load.

FIGURE 12. --Pallets placed on bed of trailer in preparation of partially palletized load (method D).

FIGURE 13. --Loading partially palletized trailer (method D).

FIGURE 14. --Method E: Special palletized orchard trailer.

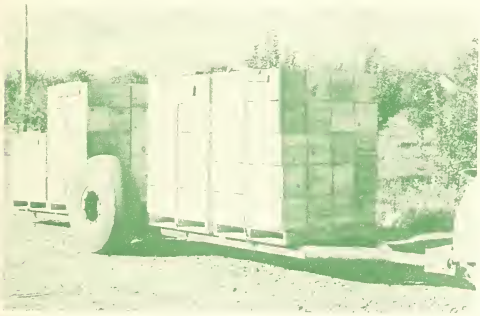

FIGURE 15. --Special palletized orchard trailer loaded (method E).

FIGURE 16. --Stacking boxes on special trailer (method E).

FIGURE 17. --Securing the pallet load to the special trailer (method E).

Loading Road Trucks at the Orchard

Fruit is sometimes hauled directly to the packing plant on trailers, but more often the apples are transferred from the trailer, either directly to the road truck at the edge of the orchard or to an assembly point at the edge of the orchard. When the fruit is accumulated, usually on a wooden platform, the boxes will be stacked 6-high on the trailer and hand-trucked onto the platform over a bridge plate. In other cases the boxes are moved from the trailer by hand and stacked onto the platform and occasionally onto the ground. Later the apples are hand-trucked from the platform to the road truck.

In loading road trucks it is necessary to arrange tie ropes to tie the boxes into place when the load is completed. The amount of time required to do this is referred to as set-up and cleanup time. Similar operations are involved in preparing to unload the trailer or to return to the orchard. The amount of time needed to do this is approximately 0.28 man-hour per 1,000 boxes. The setup time is not appreciably affected by the method of loading a road truck and for that reason is used as a standard allowance in the discussions that follow (table 3).

Loading Directly From a Trailer With a Roller Conveyor (Method F)

Roller conveyors are frequently used to load fruit directly to the road truck. By this method (F) the trailer is usually pulled in behind the road truck or the road truck is backed up to the trailer. An extension roller conveyor is placed on the bed of the truck, extending no more than a foot or two beyond the end of the truck bed. A worker standing on the edge of the trailer bed lifts the boxes and places them on the roller conveyor with a slight push so that the boxes roll to the end of the extension conveyor (fig. 18). A second worker on the truck bed picks up the boxes from the conveyor and places them in 6-high stacks. The roller conveyor is withdrawn as the truck is filled. The last few rows of boxes are stacked into place directly from the trailer.

Using the roller conveyor, two men can load a road truck in 4 man-hours per 1,000 boxes in an elapsed time of 2 hours. A truckload of 288 boxes will require 35 minutes to load. Sixteen percent of the man-hours for this operation was an allowance for fatigue.

Loading Directly From Trailer Without a Roller Conveyor (Method G)

A typical method (G) is to transfer apples from a trailer to a road truck without the use of a roller conveyor (figs. 19 and 20). After the truck and trailer are suitably positioned, one worker, standing on the trailer bed, lifts the boxes up, usually above shoulder height, and holds the box until it is grasped by another worker standing on the truck bed, who then stacks it.

Because this method of loading requires considerable effort, the man-hours allowed for fatigue amounted to 18 percent of the total work. Two workers can load a road truck by this method at the rate of 3.65 man-hours per 1,000 boxes in an elapsed time of 1.82 hours. Thus, it would require 31 minutes to load a 288-box truck.

While the time taken by method G is slightly less than that when a roller conveyor is used, it does require more strenuous effort on the part of the worker.

Improved Method of Loading Directly From Trailer (Method H)

An improved method of loading a road truck directly from an orchard trailer was found in use in one large orchard where fruit was hauled to a warehouse owned by the grower. Road trucks were equipped with wide bridge plates hinged similar to that for a tailgate. The truck, with bridge plate lowered onto the trailer bed, backs into an area

TABLE 3.--Labor and machine-hours and costs of methods F to K of transferring 1,000 boxes of apples from orchard trailers to road trucks with a 2-man crew

[Labor costs based on $1.15 an hour]

Method	Type of transfer	Figure reference (by No.)	Labor and machine-hours required to transfer apples							Labor and machine costs required to transfer apples		
			Labor						Equipment time			
			Total	Setup and clean-up	Productive time	Fatigue allowance	Waiting time	Elapsed time		Labor	Machine	Total
			Man-hours	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
	Direct from trailer to truck:											
F.....	By hand, with roller conveyor	18	4.00	0.28	3.10	0.62	0	2.00	1.86	4.60	[1] 0.05	4.65
G.....	By hand.....	19,20	3.65	.28	2.70	.67	0	1.82	0	4.20	0	4.20
H.....	By hand truck over bridge plate	21-23	2.60	.28	2.02	.30	0	1.30	1.16	2.99	.03	3.02
	Via assembly point at edge of orchard:											
I.....	Ground stack; by hand	24	6.26	.28	4.98	1.00	0	3.13	0	7.20	0	7.20
J.....	Stacked manually on platform; moved by hand truck to truck over bridge plate	25	5.36	.28	4.33	.75	0	2.68	1.32	6.16	.03	6.19
K.....	Hand-trucked from trailer to platform to truck over bridge plate	26,27	3.92	.28	3.20	.41	.03	1.96	2.48	4.51	.06	4.57

[1] Cost based on 10 feet of roller conveyor.

FIGURE 18. --Method F: Loading from trailer directly to road truck, using roller conveyor.

FIGURE 19. --Loaded orchard trailers parked beside road truck (method G).

FIGURE 20. --Method G: Worker on trailer handing boxes to man on the truck.

graded to adjust the beds of truck and trailer to the same level (fig. 21). Two workers build the 3-high stacks of boxes on the trailer to 6-high and then wheel the stacks into place on the road truck with hand trucks (fig. 22). When the road-truck load is completed, the hinged bridge plate is raised and the load is tied for transport to the warehouse (fig. 23).

By this method (H) of loading directly to the road truck 2.60 man-hours were used per 1,000 boxes, or 22 minutes of elapsed time per road truck (288 boxes). Twelve percent of the total time was fatigue allowance. The productive time was about evenly divided between the operation of building up the stacks on the trailer and the work of hand trucking them into hauling position.

Comparison of Common (F, G) and Improved (H) Methods of Loading Directly From Trailers

The advantage of method H is largely derived from the elimination of the more strenuous and time-consuming manual handling of individual boxes by moving the fruit in 6-high loads. The time required is reduced and, possibly more important, the boxes are handled more gently.

The disadvantage of the improved method is that hand trucks will be needed, and probably the method is not suitable for growers that do not own their hauling equipment or for small orchards in which only one trailer is needed.

Common methods F and G, loading boxes directly from trailers to road trucks, cost $4.65 and $4.20, respectively, to load 1,000 boxes (table 3). The less expensive of the two methods--loading without roller conveyors--required more strenuous effort on the part of the worker.

Improved method H, using a bridge plate and hand-clamp truck for unloading trailers, saved $1.18 per 1,000 boxes as compared with method G; this was a saving of 28 percent. Compared with the operation using roller conveyor (method F), the saving was 35 percent.

Transferring Manually From Trailer to Ground Stack to Truck (Method I)

In most orchards distantly located from a warehouse the trailers are unloaded to accumulate truckloads of apples near the orchard. The accumulated loads are placed on road trucks when the trucks are available, providing greater flexibility between road-truck and trailer operation schedules.

Many orchardists have not constructed orchard platforms nor do they have sheds at which they can accumulate their fruit, pending the arrival of road trucks to haul it to the warehouse. Some of these growers have their operations scattered and find it convenient to have apples stacked at several locations, which minimize hauling in the orchard. In these orchards field boxes of apples are stacked 6-high on the ground when unloaded from the trailer (method I). Later the boxes are loaded on a road truck.

The road truck is driven as near as possible to the boxes at the assembly area. One worker on the ground lifts the boxes to the side of the road truck, and another worker on the road truck places the boxes in hauling position, or 6-high stacks (fig. 24).

A total of 6.26 man-hours per 1,000 boxes was required to unload a trailer and load a road truck when the apples were stacked on the ground. A little more than one-third of this time was used to unload the trailer and stack the boxes. Fatigue allowance accounted for 16 percent of this time, because the work of unloading and especially loading was quite tiring. Elapsed time per 288-box truck load was 54 minutes.

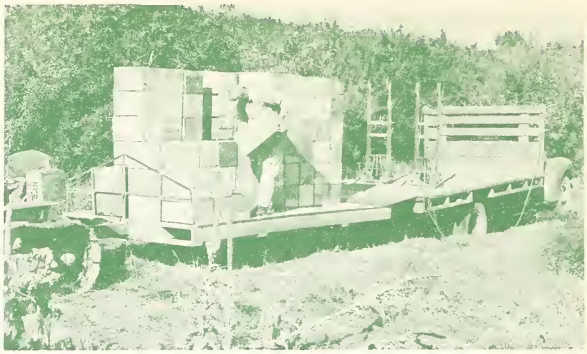

FIGURE 21. --Method H: Stacking boxes from 3 to 6 high on a trailer in preparation to loading truck over bridge plate.

FIGURE 22. --Hand trucking stacks from the trailer to the truck (method H).

FIGURE 23. --Loaded road truck with wide bridge plate used in method H.

Transferring Manually From Trailer to Platform and by Hand Truck to Truck (Method J)

Many orchardists have constructed platforms at the edge of the orchard or have sheds near the orchard where the fruit is accumulated between road-truck trips (fig. 25). The orchard trailers are driven close to the platform and one worker on the bed of the trailer lifts the boxes onto the platform while another worker builds the stacks 6-high (method J). Later the road truck is backed up to the platform and stacks on the platform are hand-trucked across a bridge plate and placed in hauling position on the truck.

The manual unloading of the trailer is usually necessary, as the orchard platform or storage shed is built to road-truck height, which does not permit stacks to be hand-trucked from the trailer to the platform.

By method J 1,000 boxes can be transferred with 5.36 man-hours of work and an elapsed time of 2.67 hours, or 46 minutes per truckload of 288 boxes (table 3). Seventy percent of the time was used in unloading the trailers.

Transferring By Hand Truck From Trailer to Platform and Then to Truck (Method K)

Many growers who have built platform areas or sheds in their orchards to assemble truckloads save time by hand trucking the fruit from the trailer to the assembly area. The trailers are pulled into place at one end or side of the platform where the ground has been graded up so that the trailer will be level with the dock. In method K stacks on the trailer are built to 6-high and then hand-trucked over a bridge plate to the platform (fig. 26). Later the road truck is backed up to the platform on the end graded to suit its bed and the fruit is hand-trucked across a bridge plate to the truck (fig. 27).

The total time to handle 1,000 boxes was reduced from 6.26 and 5.36 man-hours by the other methods (I, J) to 3.92 man-hours by method K. The elapsed time to unload and load also was considerably less. The worktime was rather equally divided into building the stacks of boxes from 3- to 6-high on the trailer, hand trucking the stacks from the trailer to the platform, and hand trucking from the platform to the road truck.

Comparison of Three Common Methods (I, J, K) of Loading Trucks From an Assembly Point in Orchard

It is apparent in this study that method K is the most desirable. However, there may not be enough space in some orchards for an orchard platform, and consequently the method cannot be used. In such cases, truckloads may be assembled in areas between trees after the props and the fruit have been removed and require no additional ground.

Common method I--transferring loads and stacking boxes on the ground--was entirely manual and had the highest cost, $7.20 per 1,000 boxes (table 3). Method J--manually unloading the trailer and using clamp-type hand trucks to load the boxes onto the road truck--was more efficient and resulted in a savings of $1.01 per 1,000 boxes. Method K--using the hand-clamp truck to unload the orchard trailer and to load the road truck--reduced the cost $1.62 from method J and handled the fruit more gently.

Loading Trucks, Using Conventional Pallet System (Methods L, M, and N)

In recent years in Washington State the use of pallets in storing and handling apples has increased. In most cases use of the pallets begins at the orchard where the fruit is placed on the pallets as the road truck is loaded. The method of handling the apples, i.e. unloading trailers and loading road trucks, may be the same as those already discussed.

Regardless of the method of unloading the trailer and loading the truck, handling the empty pallets was extra work. At the warehouse an additional 0.14 man-hour per 1,000

FIGURE 24. --Method I: Loading boxes from stacks on the ground onto a road truck.

FIGURE 25. --Method J: Boxes are lifted from trailer to orchard platform, where they are stacked 6-high.

FIGURE 26. --Method K: Hand trucking 6-high stacks from an orchard trailer to platform.

FIGURE 27. --Method K: Stacks being hand-trucked from platform to a road truck.

boxes handled was required, half of which was due to the road-truck driver waiting for the pallets to be loaded. After the road truck arrives at the orchard the pallets must be arranged on the road-truck bed, taking an additional 0.12 man-hour per 1,000 boxes.

Where the hand-clamp truck is used in placing the stacks upon the pallets on the road truck (method N), another extra work element is needed to make the stacks of boxes on the pallets butt together. The clamping arms of the hand truck will not permit placing boxes closely together; therefore, they are jacked into place with a box jack (fig. 28). The box-jacking operation required an extra 1.32 man-hours per 1,000 boxes, only 52 percent of which was productive time. Wait time and allowance for fatigue were larger.[5]

The use of pallets did not greatly change the costs of unloading trailers and loading road trucks. The additional labor of handling the pallets and jacking the boxes into place tended to favor a manual method of loading the road truck. However, the use of hand trucks to move the fruit from the trailer and the road truck was the least costly method, $6.55 per 1,000 boxes handled (table 4).

The extra work associated with the use of pallets added $0.46 to $1.98 per 1,000 boxes handled, depending upon the handling method. The extra cost of using the pallets in the orchard, however, is more than offset by the increased ease of handling at the warehouse. Not only is unloading time reduced at the warehouse but the road-truck driver has a reduced wait period, so that $2.23 per 1,000 boxes in labor cost may be saved at the warehouse. Furthermore, the fruit is moved more promptly into storage.

Labor and machine-hours and costs of loading road trucks by some of the methods tested, including the hours and costs of loading orchard trailers, are given in table 5.

Loading Trucks Fitted With Dunnage Strips, Using Stevedore-Type Two-Wheeled Hand Trucks

Part of the added cost in using pallets is associated with the necessity of jacking boxes into place when they are moved onto the pallet with a hand-clamp truck. This extra labor may tend to deter the loading of pallets at the orchard, which is the most logical place for this operation. For that reason some trials not representing current commercial practices were made.

A means of hauling the fruit to the warehouse without the use of pallets was explored. Two by fours were nailed across the truck, centered at 19-1/2 inches, so that the ends of the boxes rested on these dunnage strips (fig. 29). The addition of these strips necessitated loading the road truck from the side. Instead of using the conventional hand-clamp truck, which had clamping arms that would not ride above the dunnage strips, a stevedore-type truck was used. This truck was made by removing the clamping arms and adding a stevedore-type blade. The main advantage of the stevedore-type truck was that it could be used to set the 6-high stacks close together, as shown in figure 30, thereby eliminating the necessity of hand jacking the stacks into place.

After the truck was loaded, the stacks were secured for transit by tying with ropes. The method of tying was the same as that used by some growers who hand-truck onto pallets and required no extra time (fig. 31).

The use of a stevedore-type hand truck instead of the clamp-type hand truck saved 0.87 man-hour per 1,000 boxes in loading road trucks in the orchard. Elapsed time to load road trucks, however, was 0.60 hour greater, because only one man was used to load the truck. When the clamp-type two-wheeled hand truck was used to load pallets in conjunction with a box jack, 21 percent of the total time was wait time. This time was

[5] A different crew arrangement of two hand truckers and one box jacker would reduce wait time.

FIGURE 31. --Load on road-truck bed secured by the cables with corner plates.

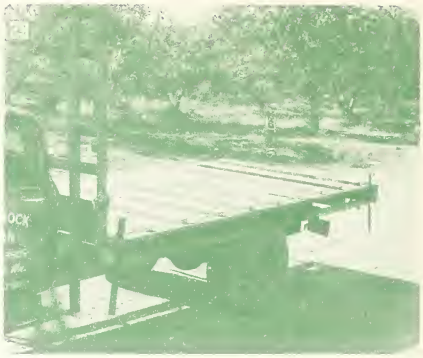

FIGURE 29. --Road-truck bed fitted with dunnage strips.

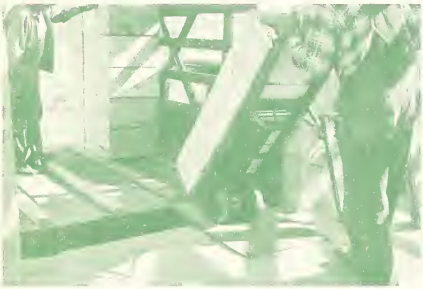

FIGURE 30. --Hand truck with stevedore plate used to load a road truck equipped with dunnage strips.

FIGURE 31. --Load on road-truck bed secured by tie cables with corner plates

TABLE 4.--Labor and machine-hours and cost of three common methods of transferring 1,000 boxes of apples from orchard trailers to road trucks, using pallets and a 2-man crew

[Labor costs based on $1.15 an hour]

Method	Type of transfer, with pallets used on trucks	Figure reference (by No.)	Labor and machine-hours required to transfer apples				Labor and machine costs required to transfer apples		
			Labor	Waiting time	Elapsed time	Equipment time	Labor	Machine[1]	Total[2]
			Man-hours	*Man-hours*	*Hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
L.....	Via assembly point at edge of orchard:								
	Ground stack, by hand (Method I).....	24	6.26	0	3.13	0	7.20	0.00	7.20
	Pallets loaded by hand.....	--	.26	.07	.13	.07	.30	.16	.46
	Total.....	--	6.52	.07	3.26	.07	7.50	.16	7.66
M.....	Stacked manually on platform; moved by hand truck to truck over bridge plate (Method J).....	25	5.36	0	2.67	1.32	6.16	.03	6.19
	Pallets loaded by hand truck; units tightened with box jack.....	--	1.58	.64	.80	.07	1.82	.16	1.98
	Total.....	--	6.94	.64	3.47	1.39	7.98	.19	8.17
N.....	Hand-trucked from trailer to platform to truck over bridge plate (Method K)...	26, 27	3.92	.03	1.94	2.48	4.51	.06	4.57
	Pallets loaded by hand truck; units tightened with box jack.....	28	1.58	.61	.80	.07	1.82	.16	1.98
	Total.....	--	5.50	.64	2.74	2.55	6.33	.22	6.55

[1] Machine costs based on a 4,000-pound electric fork-lift truck operating 0.07 hour in loading the pallets, plus any hand-truck cost needed.

[2] When trucks hauling boxes of apples are unloaded at the warehouse, the saving in direct labor is $2.23 per 1,000 boxes.

TABLE 5.--Labor and machine-hours and cost of loading 1,000 boxes of apples on orchard trailers and on road trucks by some of the methods tested, using a 2-man crew

[Labor costs based on $1.15 an hour]

Methods		Loading trailer and type of transfer from trailer to truck	Figure reference (by No.)	Labor and machine-hours required to load and transfer apples				Labor and machine costs required to load and transfer apples		
Trailer	Truck			Labor	Waiting time	Elapsed time	Equipment time	Labor	Machine	Total
				Man-hours	*Man-hours*	*Hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
		Without pallets:								
A.....	G....	Trailer loaded manually; direct transfer by hand	5, 20	6.69	0	3.34	0	7.70	0.00	7.70
A.....	H....	Trailer loaded manually; direct transfer by hand truck over bridge plate	5, 21, 22	5.64	0	2.82	1.16	6.49	.03	6.52
A.....	I....	Trailer loaded manually; ground stack and transfer to truck by hand	5, 24	9.30	0	4.65	0	10.70	0	10.70
C.....	K....	Trailer with hardwood strips loaded from edge; transfer to platform and to truck by hand truck	7-9, 10, 26, 27	5.77	.03	2.86	2.48	6.64	.06	6.70
		With pallets:[1]								
A.....	L....	Trailer loaded manually; ground stack and transfer to truck by hand	5	9.56	.07	4.78	.07	11.00	.16	11.16
C.....	N....	Trailer with hardwood strips loaded from edge; transfer to platform and to truck by hand truck; units tightened by box jack	7-9, 10, 28	7.35	.67	3.67	2.55	8.46	.22	8.68

[1] When trucks hauling boxes on pallets are unloaded at the warehouse, the saving in direct labor cost is $2.23 per 1,000 boxes.

TABLE 6.--Labor and machine hours and cost to load 1,000 boxes of apples on road trucks at orchard platform and to unload at warehouse with conventional pallet system as compared with the innovation using dunnage strips, stevedore truck, and broad-blade fork truck

[Labor costs based on $1.15 an hour]

Method of loading and unloading	Figure reference (by No.)	Crew size	Labor and machine-hours required to load and unload apples				Labor and machine costs required to load and unload apples		
			Labor	Waiting time	Elapsed time	Equipment time	Labor	Machine	Total
		Number	*Man-hours*	*Man-hours*	*Hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Pallets on truck loaded from platform with clamp-type hand truck; units tightened by box jack	28	2	2.95	0.63	1.48	1.54	3.40	0.25	3.65
Total time and cost of orchard loading and of unloading at warehouse by fork truck	--	3	4.51	1.41	2.26	3.10	5.31	1.52	6.83
Dunnage-stripped truck loaded from platform by stevedore-type 2-wheeled hand truck	29-31	1	2.08	0	2.08	2.08	2.39	.05	2.44
Total time and cost of orchard loading and of unloading on dunnage strips at warehouse with broad-blade fork-lift hand truck	--	2	4.32	.96	3.20	4.32	5.14	1.88	6.92

charged to the man who jacked the stacks into position, as he waited for the hand trucker to bring the fruit to the road truck (table 6).

With the stevedore-type two-wheeled hand truck 1,000 boxes can be loaded on road trucks in the orchard at a cost of $2.44. Of this total amount 98 percent was labor cost. With the clamp-type two-wheeled hand truck, box jack, and pallet combination of equipment used in loading trucks, loading cost $1.21 more. Labor accounted for 93 percent of the total cost for this common method.

Comparison of Unloading Methods at Warehouse From Trucks Using Conventional Pallet System and From Trucks Using Dunnage Strips and Stevedore-Type Trucks

When boxes of apples are loaded with the stevedore-type truck by placing the stacks on dunnage strips, the conventional-type industrial-fork truck cannot be used for unloading. It is possible that the boxes could be spaced on the road-truck bed into unit loads so that they might be removed with an industrial-clamp truck. In the trial that was made, however, the boxes were unloaded with the use of a broad-bladed fork-lift truck. The broad blades were inserted under the stacks of boxes in the space left by the dunnage strips. These boxes were set down on dunnage strips on the warehouse floor.

When the unloading operations, using the broad-bladed fork-lift truck at the warehouse, were added to the orchard operations and computed on a comparable basis with the regular fork-lift truck and pallet loading and unloading cycles of operation, it was found that the additional cost in the warehouse offset the savings in loading costs at the orchard. The overall cost was $6.92, as compared with the common method of unloading with fork-lift truck and pallets at $6.83 per 1,000 boxes. The broad-bladed fork-lift truck decreased the total labor time for both the orchard and the warehouse operation from 4.51 to 4.32 man-hours. However, all of this decrease in labor time occurred in the orchard, while at the warehouse the labor required to unload the road truck was increased. The additional time required to unload at the warehouse was reflected in increased machine cost of unloading.

Some Methods Used in Other Areas

J. H. Levin and H. P. Gaston,[6] working at Michigan State College, found that fork-lift trucks which operated on paved areas at the orchards, serving a similar purpose to the orchard platforms described in this report, offered substantial savings to many growers in that area. Some Pacific Northwest growers with storage or packing plants at their orchards have paved areas at the plants and are attaining the benefits described by Levin and Gaston.

L. L. Sammet,[7] working on orchard-to-plant handling problems in California, has developed some information regarding the use of tractors with fork-lift attachments in apple orchards. When used alone, this apparatus appears promising only for a very short haul from orchard to warehouse. In situations requiring transfer of fruit from orchard trailer to road truck, however, it does offer possible savings when used to bring loads from the tree rows to road trucks at the edge of the orchard. Thus the fork-lift attachment may prove advantageous in orchards where a fairly long haul to the packing plant precludes the economical use of hauling with trailers.

Summary

For a period of 2 years research in Washington State has accumulated considerable information on methods and costs of loading and moving apples from orchard to the

[6] Levin, J. H., and Gaston, H. P. Fruit Handling With Fork Lift Trucks. Mich. Agr. Expt. Sta. Spec. Bul. 379, 25 pp., illus. 1952.

[7] Sammet, L. L. Efficiency in Fruit Marketing--Orchard-to-Plant Transportation. Calif. Agr. Expt. Sta. Giannini Found. Agr. Econ. Rpt. 131. July 1952. [Processed.]

storage and packing plants. Usually this operation is a direct cost to the grower and approximately equals the cost of handling the fruit at the warehouse up to the time the fruit is packed. Several of the methods saved man-hours by using new techniques and thus saved costs as well as time in moving the fruit to storage under the conditions found in that area.

The improvements were usually a result of reducing the number of times the boxes are handled. The simplest way to move fruit from the tree rows to the warehouse was to haul it directly on the trailer after it had been loaded. However, this can be done efficiently only where transportation distances are short, for the trailers are not pulled at high speed and they usually carry only half the load hauled by a road truck. In most cases it is more economical to use road trucks to haul apples to the warehouse.

One improved method of loading is to attach hardwood skids across the bed of the orchard trailer. The boxes of fruit are stacked on the edge of the trailer and then pushed inward, thus eliminating one handling in loading the trailer.

An improved method of transferring the boxes to road trucks from orchard trailers consists of moving unit loads of 6-box-high stacks with a wheeled hand-clamp truck, rather than lifting the boxes one at a time. The boxes are moved from the trailer to a platform and from the platform to the road truck over a bridge plate. These preferred methods of moving apples not only resulted in less handling of the fruit but also reduced the cost.

A definite saving in time and cost can be made by loading a road truck directly from two trailers, but this method requires close timing of the arrival of the trailers and the truck at the loading area. In practice, this frequently necessitates waiting on the part of one trailer operator or the truck operator and, therefore, has not come into general use.

When pallets are used with road trucks or trailers and the fruit is loaded on pallets in the orchard, a slight amount of additional labor is needed to handle the empty pallets. This added labor is more than offset by reduced man-hour requirements when unloading at the warehouse; furthermore, one handling of the fruit is eliminated.

The costs of the comparable portions of different methods ranged from $2.13 per 1,000 boxes for loading orchard trailers to $11.16 for loading orchard trailers and transferring the loads to road trucks. These figures do not include driving time and preparation time in the orchard.

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