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Bulk Bins on Winter Pear Damage

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INFLUENCE OF BULK BINS ON WINTER PEAR DAMAGE

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Problem and Study Objectives

Pear growers and packers are showing increasing interest in possible methods of moving pears from orchard to packing house in bulk bins rather than field boxes.

Bulk handling is by no means a recent innovation, for it has been applied by numerous industries for many years as a means of reducing handling costs. In recent years there has been an increasing use of pallet bins in the apple industry. Need for adoption of some new type of field container for apples has become increasingly important with the growing replacement of shook boxes by shipping cartons. The apple industry in the Northwest has commonly applied a dual function to the wood box by using it as a field and storage container as well as a shipping box when fruit is graded and packed.

Relative product damage and total handling costs are the principal factors governing consideration of new methods of moving fruit. Though there are differences in handling techniques applied to apples and pears, it is possible that efficiencies derived from bulk handling of apples could be applied to movement of pears. An example of a major departure in practices applicable to the two commodities is illustrated by the fact that a multipurpose container is not adaptable to pears, for it is the practice to pack them in shipping containers immediately following harvest. For this reason, movement of pears has always required a sizeable investment to maintain a permanent inventory of field boxes used only for

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orchard-to-plant transportation. This and other variations between the handling practices for pears and apples warrant independent studies of handling pears by different methods. These studies may be divided into investigations of fruit damage and cost of operation. The primary purpose of the work reported here is to determine influence of bulk handling upon fruit quality. Current research is being designed to establish costs of bulk handling as compared to conventional methods.

Pear Handling Procedures

Orchard and transportation facilities designed to handle palletized field boxes can accommodate bulk bins equally well. Weight of filled bins makes mechanical handling essential at all stages of orchard-to-plant movement. However, less labor is required for bin handling. Hand stacking boxes on pallets or vehicles is not required and the need for tying down loads is eliminated or simplified. Distribution of empty bins also requires fewer units and, hence, less labor.

Notable differences between bin- and box-handling methods occurs in the fruit dumping procedure. Field boxes may be dumped by hand or with a mechanical dumper. Since filled bin boxes may weigh more than half a ton, they must be emptied with mechanical assistance. Machines of several different designs are used for bin dumping, but they are essentially of two types: 1) those that tilt the bin, and 2) those that empty the bin by completely inverting it. The tilt-type arrangement shown in Figure 2 raises the back of the bin so the fruit can slide out the gated end. Another type of tilt dumper not available for this study tilts the bin about 110° from the horizontal, thereby eliminating need for gates in the bulk containers. Inversion dumpers (Figure 7) hold the bin securely between slat conveyors while it is rotated 180°. After rotation, the slat conveyors slowly move the bin forward, allowing the fruit to flow by gravity on to a carry-off belt.

Bin Design

Each packing firm in which pear-damage studies were made had a bulk bin of different design and size characteristics. In all cases, the pallet was an integral part of the bin structure. Dimensions, capacity, and frame location of each bin are shown in Table 1.

A field-box volume of 1.1 cubic feet was used for determining the approximate number of boxes that would be displaced by each of the different bins. The equivalent capacities may not be representative in all cases, for there is variation not only in size of field lugs used by different districts, but also in the degree to which they are filled.

Positioning of the bin framework relative to the sideboards can make considerable difference in the useful space available in the container. Bins with interior framing, such as the one shown in Figure 4, were used in damage studies at Plant C. A bin with the same over-all measurements, but with the frame outside of the sideboards, would have its capacity diminished by about two field boxes.

Definition of Handling Damage

Most handling damage observations were applied to Anjou pears. This variety was selected because it constitutes 70 percent of winter pear

Table 1. Dimensions of Bulk Bins Used in Pear Handling Damage Studies

	Dimensions in Inches							/1	/1
	Outside			Inside			Frame	Cap. in	Equivalent
Plant	Length	Width	Height	Length	Width	Depth	Location	cu. ft.	Field Boxes
A - Bin 1	42 1/2	47 1/2	29	41 1/4	46 1/4	24	Exterior	25.1	22.8
A - Bin 2	42	27	29	40 3/4	25 3/4	24	"	14.0	12.7
B	42	48	34	40 1/2	46 1/2	29	Interior	30.1	27.4
C	46 1/2	48	29	44 3/4	46 1/2	24 3/4	"	29.6	26.9
D	48	48	27	43 3/8	43 3/8	21 1/2	Exterior	22.3	20.3

/1 Capacity is at a depth of one inch less than bin depth to allow for top clearance and settling of pears.

production in Oregon. In addition, experience has shown that stem structure of Anjou pears is inclined to cause more punctures in the fruit as a result of handling movement than occurs with other varieties.

Members of the packing industry and staff of the Department of Horticulture at Oregon State College agreed that stem punctures and skin breaks would provide the best comparative measure of damage introduced to pears handled in field lugs and bin boxes. Size of the defect was not a factor in identifying stem punctures. Skin breaks included any break, crease, or abrasion that penetrated to the flesh of the fruit. If a puncture and break occurred on the same pear, the defect was counted as only a puncture. However, incidence of combined damage proved to be very infrequent. Other grade defects were not considered. Hence, a cull pear without a stem puncture or skin break would be considered free of damage incurred in handling.

The frequency with which stem punctures and skin breaks occur within a sample of pears may be influenced by localized growing conditions, handling practices of individual pickers, and methods used in moving fruit to the packing house. Where it was possible to control picking of the test fruit, an effort was made to minimize these variables by obtaining pears in both field lugs and bulk bins that had been handled by the same pickers and had come from trees within the same area of an orchard. If such control of test fruit was not possible, pears then were selected which had been handled by a number of different pickers in several locations. This practice was followed to balance out and minimize variations in fruit damage that might have been caused by picking and environmental conditions. If a significant difference in damage results still remained, it might reasonably reflect injury that could be associated with the type of container.

Layout circumstances in each plant governed the point in the process at which test fruit for inspection could be obtained without unduly interfering with any of the operating crew. In two plants it was possible to take samples of field-run fruit before they reached the sorting table. Stem punctures and skin breaks then could be specified as a proportion, either by weight or count, of the total fruit in the samples. Facilities in the other two cooperating packing houses made it necessary to accumulate all the cull fruit, and in one case unclassified fruit, from the dumping of a known number of field lugs or bins. After careful inspection of this fruit, the proportion of each damage classification could be related to the known weight of fruit dumped. However, a definite proportion by count could not be obtained since number of pears dumped was not known.

Observations and Results

Summary of results in Table 2, comparing bin and field box handling, indicate no significant difference in total damage where bins are emptied by inversion. Some disadvantage is shown for bins that are tilt dumped.

Table 2. Summary of Stem Puncture and Skin Break Damage Incurred by Anjou Pears Handled in Field Boxes and Pallet Bins.

Plant	Type Bin Dump	Container: Pallet Bin	Container: Box
		Damage in % by weight	
A	Tilt, wet--(Large bin)	10.3	7.8
A	Tilt, wet--(Small bin)	8.7	7.3
B	Tilt, dry	22.0	19.2
C	Inversion	4.0	4.3
D	Inversion	17.6	17.4

Variations in input quality of test fruit and differences in handling practices previously noted would tend to make comparisons of results between plants unreliable. However, relative damage incurred in bins and lugs within a plant should be meaningful. In order to maintain this perspective results for each cooperator are discussed separately.

Plant A

All test fruit at Plant A was picked by the same family of three pickers. Fruit in lugs was hauled to the packing house by truck and bins were brought in on a stone boat. The orchard was adjacent to the plant so pears were moved only a few hundred feet. Fruit in lugs was hand-dumped into a water filled receiving tank. A pad was placed over the top of the field box to reduce tumbling pears as the box was tilted. Bulk-bin fruit was dumped by opening an end gate hinged at the top of the bin. As the fork-lift truck tilted the bin from the back, fruit slid into a receiving tank. The bin tilting operation is shown in Figure 1.

Dimensions of the two sizes of bins used are shown in Table 1. Both bins were constructed of plywood and had hard-board liners to provide a smooth surface for the fruit.

A linked-rod conveyor carried the pears out of the tank, through a spray rinse and on to the sorting belt. All culls and unclassified fruit coming from the sorting table was accumulated for each test bin or equivalent quantity of field lugs. This fruit was then carefully inspected to determine quantity of stem punctures and skin breaks.

At this operation pears moved so rapidly from trees through dumping that it was not possible to distinguish by color of the damaged area between old punctures inflicted by handling up to dumping and new punctures acquired when the fruit was dumped.

Inspection results in Table 3 indicate that total damage is greater for bin-handled fruit than for field-lug fruit. This differential is true for both small and large bins. For all types of handling about 85 percent of the damage is assignable to stem punctures. Damage of this type is several percent greater for the pears handled in bins. Range of damage to inspected bin fruit reveals considerable more variation than existed for field-lug fruit.

Skin break damage is only slightly greater for bin fruit. The differential over lug fruit probably is not significant.

Observations of the dumping operation suggested puncture damage may have been reduced by increasing depth of water in the receiving tank to prevent pears from piling up on the submerged conveyor rods. Advantage would also be gained if the gate end of the bin could be immersed in water so pears would flow directly into the tank and thus avoid a drop of several inches to the water and other fruit. Though skin break damage was relatively low, it might be further reduced by controlling fruit

Table 3. Comparative Damage to Anjou Pears at Plant A Incurred in Field Box and Pallet Bin Handling Between Orchard and Packing House. Field boxes are hand dumped and bins are tilt dumped into water.

Type Damage	Container: Method:	Damage in percent by weight: Bin (22 box) Tilt dump		Field box Hand dump	
		Range	Avg.	Range	Avg.
Stem punctures		5.1 - 16.8	8.7	3.8 - 10.1	6.7
Skin breaks		0.7 - 3.0	1.6	0.8 - 1.5	1.1
Total damage		6.3 - 19.8	10.3	5.3 - 11.0	7.8
Pounds of pears inspected		970		940	
	Container:	Bin (13 box)		Field box	
		Range	Avg.	Range	Avg.
Stem punctures		3.6 - 14.3	7.6	4.1 - 9.8	6.5
Skin breaks		0.4 - 1.9	1.1	0.5 - 1.3	0.8
Total damage		4.7 - 16.3	8.7	4.7 -11.1	7.3
Pounds of pears inspected		550		440	

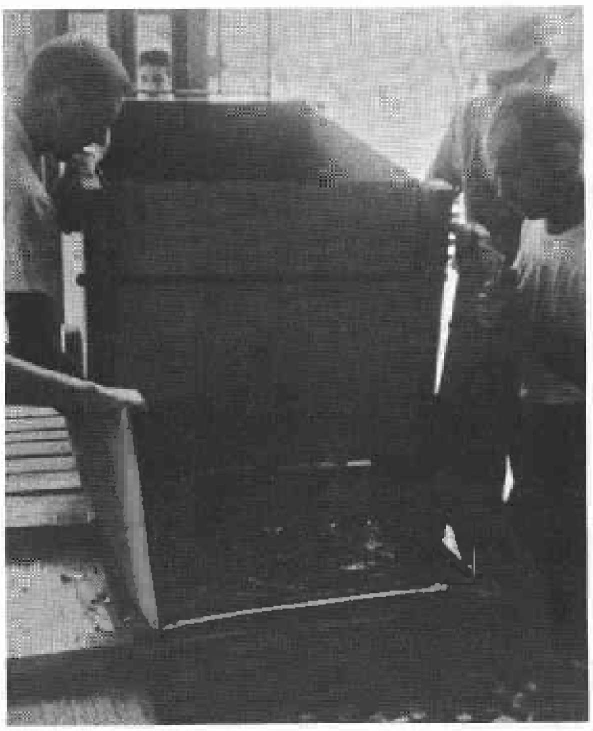

Figure 1. Dumping pears from end gated bin into water filled receiving tank.

discharge rate with a tilt mechanism or by using a gate, hinged at the botton of the bin, which could be swung up to regulate flow. The present gate which must be swung into the fruit to retard flow probably inflicts pressure cuts on some pears.

Plant B

Practically all pears packed by Plant B were handled in bins. All fruit used for damage studies was picked by the same group of pickers. It was obtained in an orchard adjacent to the plant and required a haul of about one-fourth of a mile. Transportation was provided by a tractor equipped with a fork-lift attachment. After arrival at the plant, pears were temporarily stored for several hours or more before being moved by fork truck to the dumping station. This delay made it possible to distinguish between old punctures which occurred before storage and new punctures added to the fruit during dumping.

A hydraulic mechanism tilted bins so the fruit would flow out the lower end as shown in Figure 2. The end opening in the bin was obtained by vertically lifting a sliding gate that moved in channels cut in the interior framework. A belt conveyor carried pears to the washer. Field lugs, as shown in Figure 3, were dumped directly onto this belt.

Fruit was inspected immediately after dumping. At this time new punctures were moist and flesh was a normal light color, whereas the area about an old puncture showed evidence of shrivel and was darkened by oxidation.

Five inspection boxes of fruit were taken for each bin box for duration of the test. Random fruit was carefully removed from the washer conveyor as it approached the sorting table. Percent of each type defect was related by weight to the total sample of fruit.

Comparisons in Table 4 of old and new punctures for both bins and lugs reveals that punctures occurring before dumping accounts for over two-thirds of this type of damage. Skin breaks and the two classes of punctures are higher for pears handled in bins. Relatively high fruit damage for all the conditions is undoubtedly related to the large amount of sunburn softened fruit that was present in inspection samples. Wide spaces between side and end boards of bins and pulling the end gate up between its slides may, in part, have caused skin breaks to be greater in bin fruit.

Plant C

Pears of excellent quality were obtained from the same orchard area by the same picking team for bin and lug box handling comparisons. Bins were brought to a truck reload station by a tractor with a lift attachment. Lugs were hand stacked on an orchard trailer for movement to the reload area. Both types of containers were reloaded on flatbed trucks and hauled about three miles to the packing house. Lift trucks moved the fruit into storage and a few hours later brought it out to start the packing process.

Tests involved one hundred field lugs of fruit and about an equivalent volume of bulk fruit in four bins of the type shown in Figure 4. All interior wood surfaces of bins were finished, but no lining material was used. Lug fruit was hand loaded to a roller conveyor that carried it to an automatic dumper. Bin pears flowed onto a carry-off conveyor from an inversion dumper as shown in Figure 5.

Only U. S. Number 1 pears were being packed so all culls and other fruit for the experimental run were accumulated from the sorting table for damage

Table 4. Comparative Damage to Anjou Pears at Plant B Incurred in Field Box and Pallet Bin Handling Between Orchard and Packing House. Field boxes are hand dumped and bins are tilt dumped onto a belt.

Type Damage	Container: Method:	Damage in percent by weight: Bin (27 box) Tilt dump		Field box Hand dump	
		Range	Avg.	Range	Avg.
Old stem punctures		8.4 - 21.0	14.2	9.1 - 17.4	13.7
New stem punctures		3.1 - 20.1	6.6	1.2 - 10.2	4.8
Total stem punctures		12.9 - 35.4	20.8	14.0 - 22.7	18.5
Skin breaks		0.6 - 3.5	1.2	0 - 2.0	0.6
Total damage		13.5 - 35.4	22.0	15.9 - 23.2	19.1
Pounds of pears inspected		1080		630	

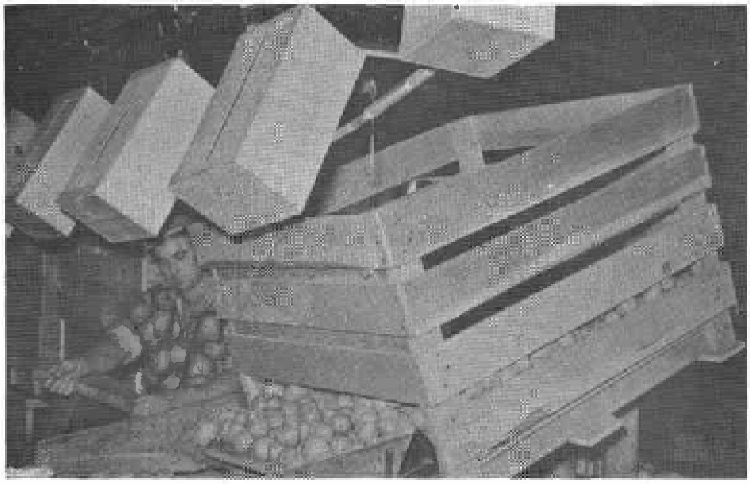

Figure 2. Hydraulic tilting device for discharging pears from a bin with an interior end gate that slides up.

Figure 3. Hand dumping pears from field lug onto belt.

inspection. Circumstances did not permit segregation of old and new punctures or inspection by sub-samples. Table 5 reveals total damage from stem punctures and skin breaks amounts to only about four percent for both types of containers. The low damage reflects good equipment utilization and well supervised handling of good quality fruit.

Plant D

Pallet bin fruit was moved by tractor from orchard to a reload station and then by straddle trailer for a mile and a quarter to the plant. Lift trucks placed bins in cold storage where they were held for about two weeks before being packed. Field lug pears were handled in a similar manner except that techniques used in the orchard varied with the four growers whose fruit was used in damage studies.

Bin used for the bulk fruit is shown in Figure 6. Corrugated fiberboard from dismantled shipping boxes was employed as bottom lining material for bins.

Palletized lugs and bulk bins were brought out of storage by lift trucks. Individual stacks of lugs were hand-trucked to the destacker conveyor chain preceding the automatic dumper. Lift trucks positioned bin boxes on an elevated conveyor leading to the inversion dumper (Figure 7). All fruit samples were taken at random from a transfer belt ahead of the washer at the rate of about five boxes for each bin or 20 lugs dumped.

Total damage to pears in both type containers is shown in Table 6 to be practically indentical. However, there is variation in specific types of damage. Ability to separate old and new punctures provides evidence for the conclusion that bin handling causes fewer punctures than lug handling

Table 5. Comparative Damage to Anjou Pears at Plant C Incurred in Field Box and Pallet Bin Handling Between the Orchard and Packing House. Field box and bins are emptied by an automatic dumper and an inversion dumper respectively. Fruit from both containers flows onto a belt.

Type Damage	Container: Method:	Damage in percent by weight Bin (27 box) Inversion dump	 Field box Hand loaded, auto. dump
		Avg.	Avg.
Stem punctures		3.7	3.9
Skin breaks		0.3	0.4
Total damage		4.0	4.3
Pounds of pears inspected		330	340

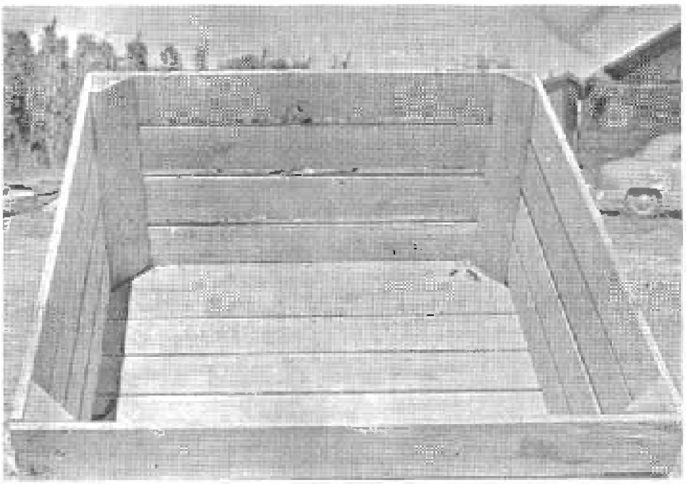

Figure 4. Bin design used at Plant C with internal diagonal post framework.

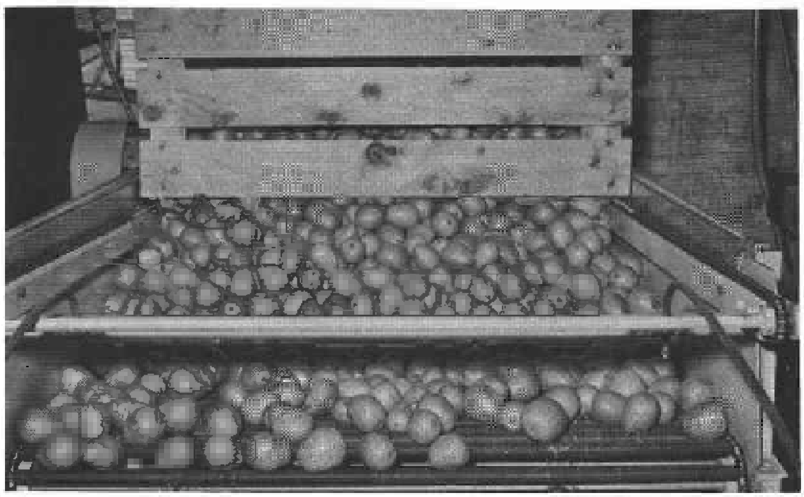

Figure 5. Pears moving from an inverted bin onto a distribution conveyor.

Table 6. Comparative Damage to Anjou Pears at Plant D Incurred in Field Box and Pallet Bin Handling Between Orchard and Packing House. Field boxes and the bins are emptied by an automatic dumper and an inversion dumper respectively. Fruit from both containers flows onto a belt.

Type Damage	Container: Method:	Damage in percent by weight: Bin (20 box) Inversion dump		Field box Auto. destack and dump	
		Range	Avg.	Range	Avg.
Old stem punctures		9.5 - 13.8	11.1	11.2 - 16.7	13.2
New stem punctures		4.0 - 6.9	5.4	1.7 - 1.9	1.8
Total stem punctures		13.9 - 20.7	16.5	13.0 - 18.4	15.0
Skin breaks		0.5 - 2.0	1.1	2.1 - 3.0	2.4
Total damage		14.7 - 21.2	17.6	16.0 - 20.1	17.4
Pounds of pears inspected		840		790	

Figure 6. Bin type used at Plant D with external frame.

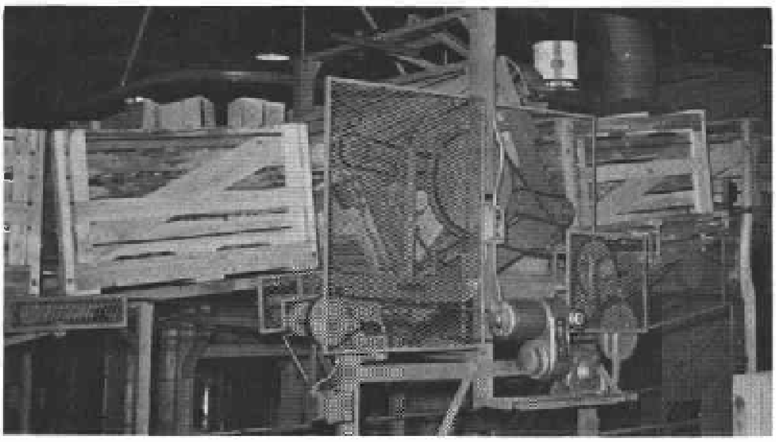

Figure 7. Bins approaching and leaving an inversion type dumper.

between orchard and cold-storage. Skin breaks for bulk fruit are also lower, being about one-half as numerous as those reported for lug fruit. These advantages are neutralized by the larger number of new skin punctures obtained in the bin dumping operations.

Conclusions

Results have shown that stem punctures and skin break damage was no greater for Anjou pears moved from orchard to packing house in pallet bins and put into process on the two available inversion dumpers than it was for conventionally handled fruit. Even the added differential of damage for tilt-dumped bins was not so great as to suggest that further consideration of bulk handling be dismissed. On the contrary, since no major quality disadvantage to bin handling has been revealed thus far, need for further information exists in at least two areas:

1. The relatively high incidence of damage associated with all handling conditions in three of the four plants justifies the need for knowledge of quantity and type of fruit damage accumulated at various stages of different handling methods. Further benefits might accrue from studies of latent damage not apparent until after storage or ripening. Such basic information would provide a point of departure for improvement and evaluation of containers, handling equipment, worker methods, training and supervisory control.
2. Information is needed concerning marketing process costs of equipment and labor required for various lug box and bulk handling methods so growers and processors can select optimum technique adaptable to their operating conditions.

Bibliography

Those who are considering decisions regarding bulk-handling of pears may find the publications listed below of interest. Additional information may also be obtained from manufacturers of containers and material handling equipment. Though the items cited are primarily concerned with bulk handling of apples, many factors discussed would be directly applicable to bulk movement of pears.

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