HARVESTING PEARS MECHANICALLY
. . . a new approach to fruit collection

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Mechanical harvesting of Bartlett pears appears practical, and economically feasible, with the collector-decelerator system showing the greatest potential, according to these tests. As with any harvest operation, yield, fruit losses, fruit quality and harvest rate are extremely important. Acceptable fruit quality has been achieved with this experimental equipment, and it is believed that commercial machines could be produced to equal or exceed this performance.

RESEARCHERS AT the University of California, Davis, have demonstrated the feasibility of harvesting pears mechanically. Although the experimental approach employs shake and catch operations, it differs greatly from the shake-catch harvesters that have become commonplace on several stone fruits, such as prunes, cherries, and cling peaches, when the harvest is intended for processing. Pears are damaged too severely by hitting limbs within the tree. Tree training can minimize the problem, but using current technology, tree training alone is insufficient for satisfactory harvest of pears.

The research reported here attempted to develop an improved means of fruit collection. Three basic approaches to reducing fruit damage caused by impact of fruits on limbs were considered: (1) limb padding to reduce bruising; (2) filling the air space within the tree (space-fill) with a material which would retard the fall of the fruits and thereby reduce bruising; and (3) directing the fruits on shorter paths out of the tree to reduce the number of potential impacts with large limbs.

The use of limb padding was tested by spraying a polyurethane foam on the major limbs of the trees (photo). Drop tests with apples and peaches indicated that the polyurethane padding greatly reduced impact damage. However, the amount of fruit hitting treatable limbs was found to be low, making the net benefit of the padding marginal. Also, special equipment is required for application of the material, and since equipment currently available is intended for spraying insulation on flat surfaces, application to trees presents unique problems. The idea may have merit for the future, perhaps combined with other systems.

The space-fill approach was tested next, using two methods. The first procedure, conceived by Joe Perrelli of El Cerrito, California, involved enclosing a tree in a large canvas bag, filling the bag with plastic balls three inches in diameter, like ping-pong balls (photo) and shaking the tree with a trunk shaker. The fruits were held in a fluid-like suspension and could be readily separated from the balls as they were removed from the bag. Fruit damage was quite low: only about 11% of the fruits were bruised. However, the balls dampened the shaking action, restricting motion and causing reduced fruit removal (only 40 to 50% of the pears were removed). This concept is reported to be under development by a Danish firm and is also being researched by the USDA in Washington State and by the Agricultural Engineering Institute of Israel.

The second space-fill approach involved the use of decelerator tines or arms of several designs, including various diameters of padded metal tines, telescopic metal tines with air bag padding, and inflated tines.

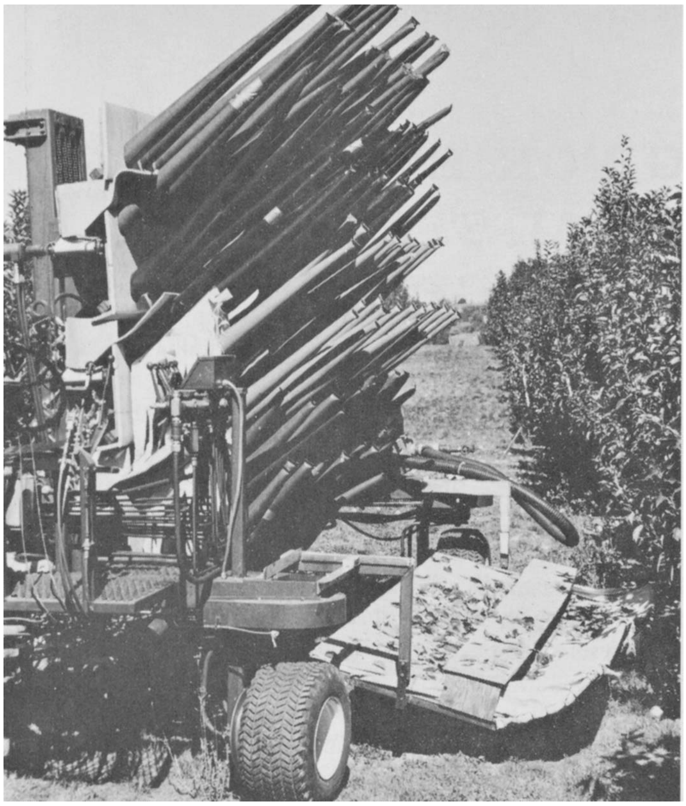
A unique aspect in the application of the second space-fill concept involved combining the decelerating arms with the third approach (directing the fruit out of the tree). To this end, the tines were cantilever-mounted and inclined to deflect fruits toward the periphery of the tree. Preliminary results indicated damage could be reduced by use of such a collector-decelerator.

Based upon experience gained over several seasons of trials, a decision was made to build one side (one-half) of a prototype collector-decelerator (photo). The test panel was 10 ft in length and about 8.5 ft high, with 8 levels of tines, and 4 levels of fruit-receiving conveyors, with a padded plywood collector below the panel. The tines were made from rubber covered nylon, approximately 1/64-inch thick ("Rub-R-Lite") welded into tapered tubes of three sizes, having the small end closed. Tine diameter was increased from top to bottom to make collection more positive near the bottom. The bottom two rows had a 6-inch diameter base, 2-inch diameter tip, and were 48 inches long. The third and fourth levels had a 5-inch diameter base, 1½-inch diameter tip, and were 60 inches long. The top four levels had a 4-inch diameter base, 1½-inch diameter tip, and were 60 inches long. Vertical clearance between all levels was 8 inches, with the tines on 8-inch centers horizontally, and offset 4 inches between levels. Inflation of the tines to 3 to 5 psi air pressure was sufficient to hold them at the desired 40° slope.

The design is intended for use on a hedged or semi-hedged tree row having a thickness of not more than 8 ft. As envisioned, a complete harvester would consist of two matching units that approach the tree row from opposite sides. When used in high density plantings, each unit would likely have a trunk shaker. The collector would be 2 to 3 times as long as the test unit with about the same height. The resultant machine would be about the size of existing harvesters for other soft fruits. By having a trunk shaker on each half, 2 trees could be harvested at once to achieve a high harvest rate (estimated to have a potential of 50 cycles per hour, or 100 trees per hour) even though the trees are close planted.

Major tests of the experimental col-

Limb padding by spraying polyurethane foam on major limbs of the tree reduced impact damage of pears hitting limbs during harvesting.



View of collector-decelerator for harvesting pears showing shock-absorbing, inflated pneumatic tubing.

Space-fill approach to minimizing harvest damage from fruit drop involved use of canvas bag enclosing the tree and filled with small plastic balls to absorb impact of falling fruit.

lector were conducted in two hedgerow-trained Bartlett pear orchards, and one close planted Golden Delicious apple orchard. The two pear orchards were substantially different with respect to the thickness of the trees and the shape and stiffness of the fruit-bearing branches. The first orchard was less desirable, having both thick trees and some long willowy fruiting branches (caused by high vigor), which resulted in an average removal of only 78% of the fruit. The shake was dampened in part by some hanger-type branches, and in part by the vertical wall of the collector pressing against branches which extended too far into the aisle. Both conditions are easily correctable by minor pruning. The trees in the second orchard were less vigorous, 6 ft thick, very upright, with branches and limb stiffness very suitable for shaking. Average fruit removal in this orchard was 93%.

Penetration of the tree by the flexible, inflated tines and alignment of the tines was nearly always excellent, with not more than a few tines severely buckled or deflected on any tree. The damping effect of the pneumatic tubes did not prevent good fruit removal. Fruit maturity was less advanced, and the pears were smaller in the first orchard, which could have influenced ease of fruit removal. Abscission-delaying sprays had been applied in all instances.

Trunk height was generally adequate (12 to 18 inches to first scaffold) for attachment of the large limb shaker (previously developed for olives), which was used as a trunk shaker.

To determine fruit quality, representative samples were carefully collected, transported to Davis and stored at 0°C until evaluated. It was assumed that no significant bruising occurred in transit. After peeling, the fruit halves were classified as: acceptable for choice grade, or damaged sufficiently to downgrade the half. Damaged areas less than ¼-inch diameter were not considered as downgrading, since such an injury is usually shallow. If more than one damaged area occured on a half, or if the area was more than ¼-inch, the half was downgraded.

The condition of Bartlett pears collected by the pneumatic tubes (collector-decelerator) was in our opinion commercially acceptable. These fruits yielded approximately 90% choice halves, compared with 61% for fruits caught on a conventional catch frame, and 70% choice halves for the padded plywood catcher below the tine panel. Combining the fruits from the collector-decelerator with the fruits from the padded plywood catcher results in a yield of 80% choice halves. These results are comparable with good machine harvesting of cling peaches. Hand harvest data was not obtained. However, in other studies, good hand picking yielded 12% bruised halves and rough hand picking, more than 30% bruised halves.

Examination of the kinds of bruises occurring indicated some fruit-on-fruit damage on the padded plywood catcher in spite of an elevated padded strip 1 ft wide, intended to protect fruit already at rest. Also, some bruising occurring on the collector may be correctable. The problem was especially obvious with the sensitive Golden Delicious apple.

Evaluation of the economic merit of the collector-decelerator for harvesting pears can only be a rough estimate, since, as tested, the unit was far from being representative of commercial successors. However, we believe the estimates used, in comparison with conventional shake-catch, offer a realistic approach, since shake-catch is virtually the only alternative should available hand harvest labor be inadequate. The test results indicate harvest costs might be as low as $20 per ton for the collector-decelerator, as compared with $25 per ton for conventional shake-catch, using conservative inputs. These costs, when compared with $17 to $20 per ton hand harvest costs, show how close the collector-decelerator is to being competitive with hand harvesting.

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