Mechanization Of Fruit Harvesting

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Fruit production requires extensive hand labor. In recent years labor has become increasingly difficult to obtain. Future prospects indicate labor will become more expensive. If Idaho fruit farmers are to keep competitive, one of the adjustments they should make is to adapt mechanical methods of producing and harvesting their crops as rapidly as possible as efficient machines become available.

In recent times, the trend to mechanical fruit production has been continually on the increase. One report gave these statistics: 16 million pounds of cherries were harvested mechanically in Michigan during 1965; 75 percent of Michigan's blueberry crop was picked with batch-type mechanical equipment, replacing 5,000 workers; one-third of Oregon's raspberry and blackberry crops are being harvested mechanically; over 50 percent of California's tomato harvest is expected to be picked mechanically in 1966. With mechanical harvesting on the increase, farmers are hard pressed to keep up with new developments.

At present, two approaches are receiving attention in the race to mechanize fruit harvesting. First is the mass removal techniques, whereby the fruit is removed from the trees and transported to suitable containers entirely by mechanical means. The only labor involved is that needed to guide the machine and replace the containers. A second approach is to develop picking aids that reduce the worker's lost time.

This publication is primarily concerned with the current advances in the mass removal technique.

Cherries—At present, harvesting of sweet cherries for the fresh market must still be done by hand. Fortunately, price and labor still make this possible. The ultimate success or failure of a harvester for fresh-market cherries will hinge on its ability to pick the cherries with its stem intact.

Nearly all sour cherries are being harvested by shaking onto a light-weight picker frame. Catching frames are reportedly satisfactory, but limb attachment devices are causing some limb injury.

A cherry harvester is needed for the near future. One possibility, although as yet untested in Idaho Orchards, is a mechanical fruit picker invented by I. W. Richardson of Lady Lake, Florida. The fruit harvester reportedly combs the branches to strip fruit from the tree, simulating the snap twist action of hand picking. The picker head is raised and lowered through the tree on a tower which can be rotated 180 degrees and tilted as much as 30 inches to follow the contour of the tree.

Prunes—Prunes for processing are being shaken satisfactorily. Growers are looking toward shaking prunes for the fresh market. Some growers have reported there is very little loss in quality of the fruit as a result of shaking onto a catching frame. However, some bruising and splitting of the fruit does occur. The use of decelerator strips above the catching frame would probably reduce this damage to the fruit.

Pears and Peaches—No mass removal technique is available for either of these fruits at present. Extreme susceptibility to bruise injury eliminates tree shaking as a consideration. Growers should consider adapting picking aids to avoid labor shortages.

Apples—Apples bruise very easily; an apple dropped from a height of six inches will bruise. Apples have a reputation for being packed at a very high quality made possible by careful harvesting procedures. Apples are shaken for processing, but the bruise susceptibility of apples leaves little hope for successfully shaking apples for the fresh market.

However, growers are looking toward mechanical harvesting to offset picking labor. Difficulties that must be overcome before mechanical harvesting of apples becomes a reality are many. Limb props are in the way, and if removed before the fruit is picked, the limbs will break. Limbs and tree structure are such that apple trees are difficult to approach with a machine. There is danger of the spur being broken rather than separating from the stem. The variety of apple and the degree of maturity affect the ease of separation from the spur.

An apple shaken loose from the top of the tree hits many branches during its descent, causing bruises and the possible puncturing of the fruit. One machine designed recently by agricultural engineers at Cornell University, attempts to overcome the problems of harvesting bruise-free apples in an ingenious way. Still in the experimental stage, the machine has a massive bank of padded prongs which are inserted into the tree to shake the branches. Branches may be shaken either horizontally or vertically as desired. The loosened apples zigzag through the prongs onto a catching frame and then roll to a box filled with water. The main goal of the machine is to pick bruise-free apples suitable for fresh market.

Grapes—The conventional systems of training grapes such as the 2-cane and 4-cane Kniffin, Munsen system, fan system, etc., do not lend themselves to mechanical harvesting.

The Geneva Double Curtain system not only results in increased yields and better maturity and quality, but is adaptable to mechanical harvesting.

In this system vines are trained to a bilateral cordon and are short cane pruned. The elongated trunks are secured to a horizontal cordon wire located 5½ feet to 6 feet above the vineyard floor. There are two of these cordon supporting trellis wires, located four feet apart, for each row of grapes.

The Chisholm-Ryder Company of Niagara Falls, New York, has manufactured a harvesting machine developed to be used with the Geneva double curtain training system. Fruit is removed by shaking the wire at between 350 to 420 strokes per minute. The fruit is shaken off as whole berries or cluster fragments of two or three berries. The machine, as designed, has two picking heads and picks both sides of a single row.

Work with this harvester indicates that with the Geneva double curtain training system, grapes can be harvested mechanically and brought to the processing plants in excellent condition. Certain areas in southwestern Idaho have a climate and soil that will ripen Concord grapes to a desirable maturity for juice most years.

However because of competition for harvest labor and because the labor supply situation may actually decrease in the future, Idaho growers have not been interested in raising grapes. Harvesting mechanically may make Idaho grape production feasible.

Mechanical Shaking

The primary fruit harvesting equipment is still the tree shaker. Proper shaker selection, operation, and orchard management will make it more efficient and will produce fruit of a higher quality. It must be emphasized that at present shaking methods are acceptable only for fruit intended for processing within a short period of time following harvest.

Tree Shakers—Tree shakers generally consist of a power source, shaking boom and limb attachment device. The power source has either been a tractor at-

Figure 1. A small man-held shaker being demonstrated on hail damaged apples.

tachment to a hydraulically or manually controlled boom, or a boom constructed as an integral part of a self-propelled catching frame.

At present, a small limb shaker is under development by the Homelite Company, (Fig. 1). This machine consists of a light-weight gasoline powered reciprocator that drives a shaker boom. The thrust and cycle of the reciprocator are variable. The unit weighs 25 pounds and is supported by a body harness worn by the operator. Design is such that the operator feels very little effect from the shaking action. Commercial production of this machine is expected in the near future.

Limb Attachment—Limb attachment devices must be carefully designed and operated to avoid injury to the tree limb. The major causes of limb injury are:

1. Carelessness in clamping onto the limb.
2. Not centering on the limb.
3. Clamping too firmly.
4. Shaking force not applied directly at right angles to limb.

A number of different types of limb attachments have been used. Latest research findings indicate that permanent bolts or belt pads are the best clamp designs from the standpoint of limb injury.

1. **Permanent Bolts**—¾″ bolts permanently installed in the trunk of the tree were adequate to carry the shaking force when the force was applied in line with the bolt. Researchers placed a trailer hitch ball on the bolt for shaker attachment. Bolts were placed immediately beneath the crotch at a 45 degree angle to the tree row. Bolts were installed during early spring, and by harvest time a thin layer of callus had formed over the edge of many of the washers. This layer was not disturbed during shaking.
2. **Belt Pads**—This clamp consists of a flat belt located on two parallel rollers spaced a distance apart greater than the diameter of the limb. A portion of the flat surface of the belt contacts the tree and wraps partially around the limb as the clamp is closed. Centering on the limb is accomplished automatically by movement of the belts. Steel reinforcing is necessary in the belts to eliminate stretching on the limb during shaking and to provide sufficient strength. When tested the clamps used belts two inches wide and ¼ inch thick, containing 36 wraps of No. 250 steel cable. The belt had a rubber covering on one side and friction fabric on the other. This clamp proved successful providing the shaking angle did not exceed 30 degrees from right angles to the limb.

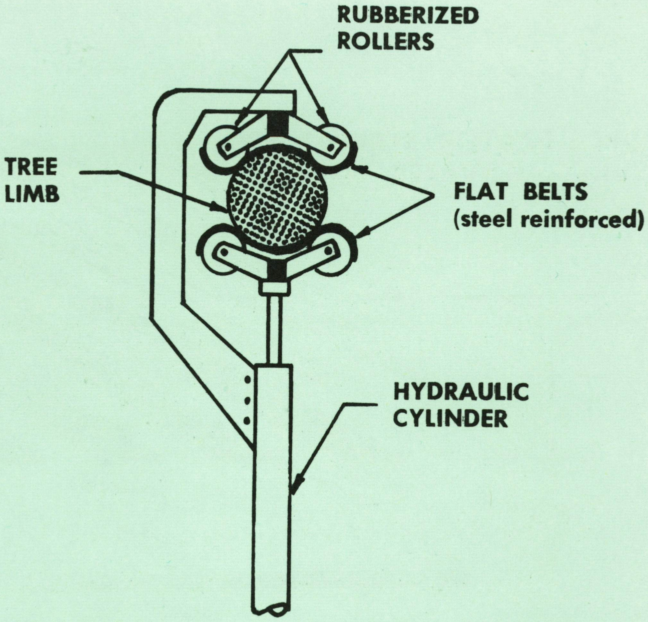

Figure 2. Belt-pad limb attachment device. The rubberized rollers pivot allowing the device to be self-centering on the limb. The belt pads are reinforced with steel cable.

Shaker Stroke and Frequencies—In harvesting Red Tart Cherries when the total movement of the claw exceeds 1800 inches per minute, regardless of stroke length or frequency, 95 percent of the fruit is removed from the tree. When the total movement is reduced to between 1400 and 1800 inchs per minute, the removal is not more than 90 percent. Short stroke and high frequency removes more fruit and has less tendency for bark damage on the limb than does a longer stroke and lower frequency. Under testing, one-inch stroke with a frequency of 900 cycles per minute was found to be best.

Catching Frames—Lightweight catching frames with vinyl coated nylon covering have proved successful for catching cherries and prunes. A new catching frame for harvesting apples for processing has been designed by the New York State Agricultural Experiment Station. It consists of a flat table with a movable belt for receiving the apples. The apples are slowed in their descent by decelerator strips placed above the table (see figure 3). The table is 27 feet long by 15 feet wide by 2 feet high with one unit required for each side of the tree. The apples drop through the decelerating strips, fall on cross conveyors which move them to a side conveyor and from there to a bulk box. The decelerator strips consist of three layers of nylon webbing strips offset so the apples hit the first, fall through to the second and then through the third layer and finally on to the cross conveyor below. Quality for processing is termed as excellent. Hopes are this machine design can be modified for harvesting fresh market apples.

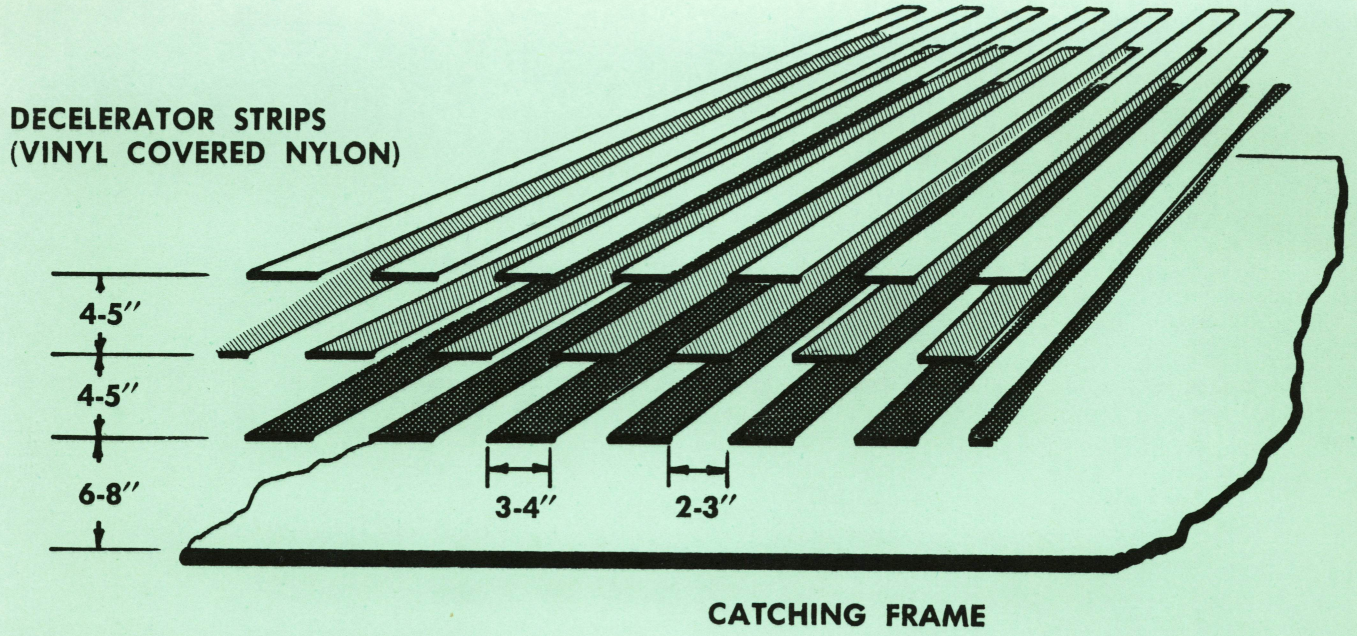

Figure 3. Perspective of a section of a catching frame equipped with decelerator strips. The decelerator strips placed above the catching frame slow the descent of the fruit before it contacts the catching frame, thus preventing bruising.

Orchard Management—The following orchard management practices will improve the rate and quality of harvest when using mechanical shakers:

1. Remove low branches that may obstruct catching frames.
2. Provide visibility to the point where the shaker attaches to the tree.
3. Keep the number of main scaffold limbs to a minimum (Three or four limbs would be dedesirable).
4. Provide a smooth orchard floor free of ruts, large stones, large weeds, and mounds around the trunk.
5. Harvest at proper stage of maturity.
6. Schedule harvest according to fertility levels.
7. Orient the branches to the same relative shaking direction in the row.

PICKER AIDS

One study has found that 22 percent of a picker's time is in unproductive motion. Theoretically, this would indicate that the picking force could be increased by almost ¼ if picking aids were supplied to reduce unproductive motion to a minimum. Many types and styles of devices are on the market or are being home-made to aid pickers. A complete discussion of these aids is beyond the scope of this article; however, every fruit grower should be on the alert for picker aids which will improve his field efficiency. Cost versus improvement in picking and reduction in labor requirements should always be carefully analyzed before adopting specific aids. Picker aids are only a stop gap measure between hand picking and full mechanical harvesting. Therefore, in figuring costs, the useful life of a picking aid should be short; in the range of 5 to 8 years.

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Information concerning picking aids will be made available when useful devices are observed in operation.

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