Mechanized Harvest Systems for Cherries
Michigan State University
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Farm Science Series
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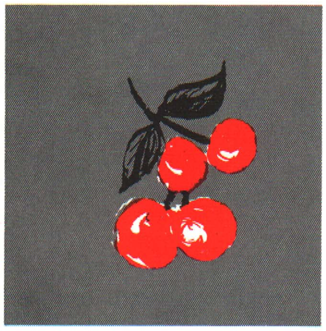
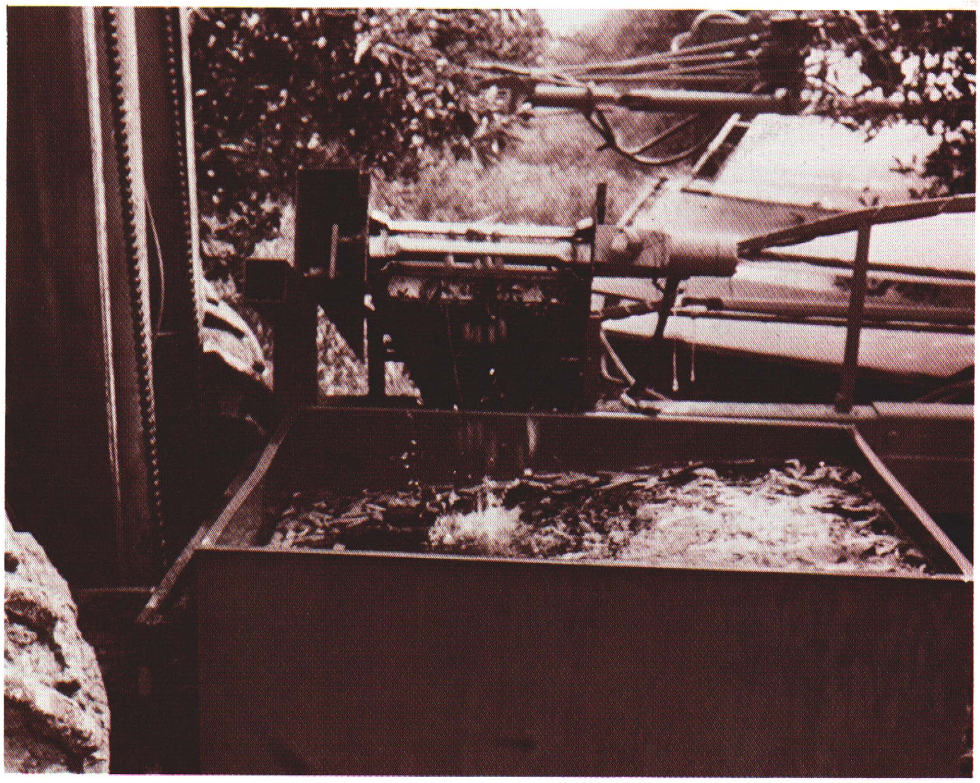


Mechanized Harvest Systems

FOR RED TART CHERRIES



MICHIGAN's tart cherry industry has felt the impact of mechanized harvest. Without this development, growers would be hard-pressed to locate sufficient labor to harvest a crop which ranges from 90 to 380 million pounds annually.

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Mechanical harvest helps reduce harvest costs, permits easier handling of harvested fruit through the use of water-filled pallet tanks, and reduces seasonal labor problems.

In 1968, an estimated 140 million pounds of fruit, or 70% of the Michigan crop, was mechanically harvested. This compares with 12 million pounds (3%) harvested mechanically in 1964. In 1970, over 600 harvesting machines will be in operation in Michigan.

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The Mechanized Harvesting System

The primary objectives of the mechanized harvesting system are:

- to harvest the crop in a given period of time at optimum maturity for processing
- to maintain fruit quality with least possible damage
- to acquire adequate harvest capacity at a reasonable cost

A complete harvesting system includes:

— the harvesting machine

— one or two tractor fork lifts to handle water-filled pallet tanks

— a cooling pad or station with an adequate water supply

— an adequate number of pallet tanks

— transportation equipment to move filled pallet tanks from the cooling pad to the processing or receiving station

Types of Harvesting Equipment

Mechanical harvesting systems utilize reciprocating limb or trunk shakers with various types of catching devices. Early models consisted of portable, elevated catching frames with inclined catching surfaces to collect and direct falling fruit into lugs. These evolved into self-propelled or tractor-drawn units that conveyed fruit directly into water-filled pallet tanks. Although these units had higher capacity and lower labor requirements, they also involved more investment and required more highly skilled operators.

About 75% of the machines in Michigan are of the inclined catching frame design (Fig. 1). Most are self-propelled and utilize a conveyor to move harvested fruit away from the catching frames. Another type of elevated unit utilizes lightweight, hand-carried frames to direct fruit into shallow boxes under the tree. Other machines, based on the roll-out design consist of a rubberized catching fabric which is unrolled from the machine and placed around the trunk of the tree (Fig. 2). After a tree is shaken, the fabric is rolled back into the machine with the fruit dropping onto a conveyor.

Proper Operation and Care

Optimum performance throughout a two to four week harvest period requires an adequate preventive maintenance program. This means that you must (1) understand and adhere to manufacturer's recommendations, (2) recognize the characteristics of the equipment, and (3) regularly inspect and maintain the engine(s), hydraulic system, shaker mechanism(s), catching frame, catching material and the chassis.

Lubricate equipment shortly after harvest to prevent rust and corrosion during storage. Be sure all lubrication points receive additional fresh lubricant before re-using. Several weeks prior to harvest, remove the unit(s) from storage and make sure all components are in good working order. Make repairs as required at this time. Take time before harvest begins to train operators in handling and caring for the equipment. Point out components and areas where problems may arise.

Maximum engine life and machine performance depend on proper care. Time and money can be saved with a regular maintenance check of engine and machine components, as specified in the operator's manual.

Most problems with hydraulic equipment are due to either system contamination or loss of fluid. For maximum performance, the hydraulic system filter and fluid should be changed regularly. To avoid contamination during service, observe the following practices:

1) *Clean* the exterior surfaces of all parts prior to removing any of these parts. This includes the filler caps, filter housing, drain plug and all surrounding areas.
2) Use *clean* containers to transfer the hydraulic fluid from the storage container to the reservoir.
3) Use a *clean*, high-quality oil as specified by the manufacturer and have adequate fluid storage facilities.
4) Securely replace all components removed after *cleaning* and service.

Hydraulic fluid leaks may allow dirt or air to enter the system. Oil and other lubricants should not be allowed to come in contact with products for human consumption. A small quantity of oil-contaminated fruit at the processing plant, can cause rejection of large quantities of fruit (Fig. 3).

Leakage is often caused by loose fittings. Make regular inspections to correct leakage. Be sure to use the proper part when replacing fittings or hoses. This is especially true with hydraulic fittings, which are available in several different thread types or flare angles. Use of the manufacturer's specified replacement will eliminate confusion. Replace hoses when the metallic reinforcing sheath is visible and becoming worn. Once this protective layer is broken, hose failure is almost certain. Hot oil erupting from the hose under high pressure can cause personal injury and time lost to clean the machine, catching fabric and conveyor.

During harvest, equipment should be thoroughly cleaned with a high-pressure water hose and mild detergent at least daily, and again before storage (Fig. 4). A few hours spent in this way can save several days of preparing equipment for harvest the next season. This will reduce the possibility of machine failure and increase the value and performance of the equipment in later years. If parts need replacement, order and install them as soon as possible after harvest.

Lack of proper maintenance can be costly. Failure at harvest time may mean paying (1) wages ($10-$20/hr in total) to non-productive labor held up by a failure, (2) for repair parts needed to correct improper maintenance ($.15-$150+), (3) for a qualified serviceman ($5-$10/hr) and, (4) for additional losses resulting from decreases in crop value. Crop value losses might be due to lower quality, lower yield or lower selling price per unit. Regardless of the chance of a large dollar loss, preventive maintenance usually more than pays for itself.

Fruit Quality

All operators should understand the various factors which affect fruit quality. These are discussed in Extension Bulletin E-659, "Cooling Stations and Handling Practices for Quality Production of Red Tart Cherries." Mechanical equipment requires additional knowledge and new techniques to assure acceptable quality for processing. Although all of the factors which affect fruit quality interact together, research has shown the individual effects of each.

Harvest and post-harvest bruising of fruit was once a problem in mechanical harvesting. However, with improvements in harvesting equipment and handling and cooling practices, quality of machine-harvested fruit can be as good, or better than, that of hand-harvested cherries.

Research over the past few years has shown that three basic factors affect the preservation of fruit quality.

— design of the machine,

— ability and attitude of the operator(s), and,

— post-harvest handling, cooling and processing techniques.

Machine Design

Research and experience indicate that harvest bruise is most effectively minimized with an elevated catching frame with a self-clearing, inclined surface (Fig. 1). However, post-harvesting handling and cooling practices may affect fruit quality as much as, or more than, variations in machine design.

Operational Techniques*

Table 1 shows how the operator's skill can affect the degree of bruising and fruit quality as indicated by the undesirable scald at processing time.

Table 1. Influence of the operator on fruit quality.

Operator	% Bruise at Harvest	% Scald at Processing
A	8	1
B	16	4
C	21	29
D	24	32
E	32	55

Common operational practices resulting in excessive loss of fruit quality include:

— overloading the catching frame or conveyor

— shaking too much fruit, too quickly

— shaking too long resulting in severe whipping of the fruit still attached and in excessive amounts of trash being dropped with the fruit

— harvesting tree loads from two or three trees into the conveyor before emptying the conveyor

— excessive and severe handling of lugs when fruit is harvested with hand-carried frames

— working too quickly and carelessly

Working too quickly and carelessly usually causes mechanical breakdown and time lost for repair. Besides the resulting inefficiency, fruit quality will suffer. Speed of the harvesting operation should not exceed the ability of the operator(s).

Careless operators can also damage trees. With limb shakers, the shaker claw must be positioned at a near-perpendicular angle to the limb, or the claw will tend to slide and strip-off the bark. (Fig. 5). Such bark damage leads to disease, reduced yields and even death of the tree.

The faster the harvesting operation, the less time available to detect minor mechanical or hydraulic problems. Minor problems, if not corrected, will cause major difficulties. Oil leaks should be repaired as soon as they are detected. As previously mentioned, oil contamination may result in rejection of entire pallet tanks of fruit. Even without oil leakage, the machine should be cleaned at least once in every 5 to 10 hours of operation due to normal contamination of the catching fabric and conveyors from juice, dirt, and trash.

*See also Extension Bulletin E-654, *Tart Cherries*, A. E. Mitchell and J. H. Levin, Cooperative Extension Service, Michigan State University.

Figure 6 shows harvest bruise data collected for a roll-out type machine. A flatter curve would be expected for elevated frame designs. Severe harvest bruising, coupled with inadequate cooling practices, will result in weight or volume losses to the grower before fruit is delivered for processing. Amount of bruise is directly related to the rate at which fruit is removed from the tree. (Figs. 7, 8, 9). Bruise is the primary cause of scald, a discoloration of the bruise at processing time. This localized discoloration cannot be removed and consequently affects the ultimate grade of the processed product (Fig. 10).

Amount of harvest bruise directly affects pitted yield. Figure 11 shows that as amount of bruising is increased, pitted yield decreases.

Pitted yield is a term used to indicate reductions in product weight from normal processing operations. It refers to weight losses in pit removal, and pitting losses resulting from poor fruit texture. Pitting losses usually average about 14 to 16 percent. Excessive harvest and post-harvest bruising may further increase processing losses by as much as 12 percent.

Economics of Mechanical Harvesting Systems

Labor cost for hand harvesting varies with tree size, terrain, tree yield and available labor. Normally, hand labor costs between 4 and 8¢ per pound. Costs of housing, equipment, benefits, etc., add to the total hand harvesting cost.

Cost of mechanical harvest varies from about 1 to 5¢ per pound, depending on machine costs of owning and operating, machine use per year, and harvesting rates and tree yields. At harvesting rates of 20 to 25 trees per hour, with yields of 75 pounds per tree, and an estimated machine use of 200 hours per year, total mechanical harvesting costs will range from 1.4 to 2¢ per pound. At slower rates of 10 to 15 trees per hour, with reduced yields of 40 pounds per tree and estimated machine usage of only 100 hours per year, the estimated cost for harvest may range from 9 to 10¢ per pound. The above analysis assumes a three-year machine life and is based on ownership costs per $1,000 of total machine purchase price as follows:

Hours of use per year	Ownership cost per hour of use per $1,000 of purchase price
100	$3.72
150	2.48
200	1.86
300	1.24

These figures are based on depreciation, interest, taxes, storage, insurance and repair costs equaling about 40 percent of the purchase price per year. Harvesting cost per pound may be estimated by determining approximate ownership cost per hour at the level of use at which you will be working. Use your own figures in the following equations to figure your harvesting cost per pound.

For example, from the above figures, at 150 hours of use per year, ownership cost is $2.48/hr/$1,000 of purchase price:

$$\$2.48/\text{hr.} \times \frac{12{,}000 \text{ purchase price}}{1{,}000} = \$29.80 \text{ per hour ownership cost}$$

$$\$29.80/\text{hr. ownership cost} + \$7/\text{hr. labor cost} + \$1.25/\text{hr. fuel cost} = \$38.05 \text{ total harvesting cost/hr.}$$

$$\$38.05/\text{hr.} \div (20 \text{ trees/hr.} \times 80 \text{ lbs/tree}) = 2.4¢/\text{lb.}$$

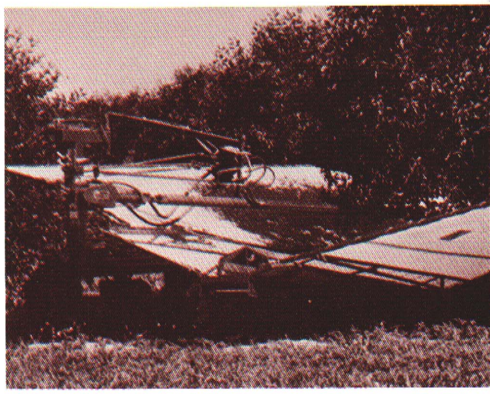
This analysis makes no allowance for on-farm fruit transportation costs or cooling pad amortization costs which are estimated to be about 1.5¢ per pound.

Summary

Mechanical cherry harvesting systems allow growers to harvest and handle fruit both conveniently and economically. Rapid developments in harvesting systems require growers and operators to maintain the technical knowledge and skill necessary to keep the system operating properly. This includes a basic understanding of the mechanical components in the system and their proper maintenance. Much of this information can be found in the equipment operator's manual which all owners and operators should be familiar with.

Mechanical harvesting systems can do an excellent job of harvesting high quality fruit. Used properly, they can provide growers dependability and reduce harvesting cost. But, all personnel must recognize and follow recommended practices to achieve optimum machine performance and preserve on-the-tree fruit quality.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U. S. Department of Agriculture. George S. McIntyre, Director, Cooperative Extension Service, Michigan State University, E. Lansing, Mich. 1P—7.5M—5:70—HA



▲ Fig. 3—An oil film on the surface of conveying water in a standard orchard tank, caused by fluid leakage. ▶ Fig. 4—Using a pressure sprayer to clean a harvester.

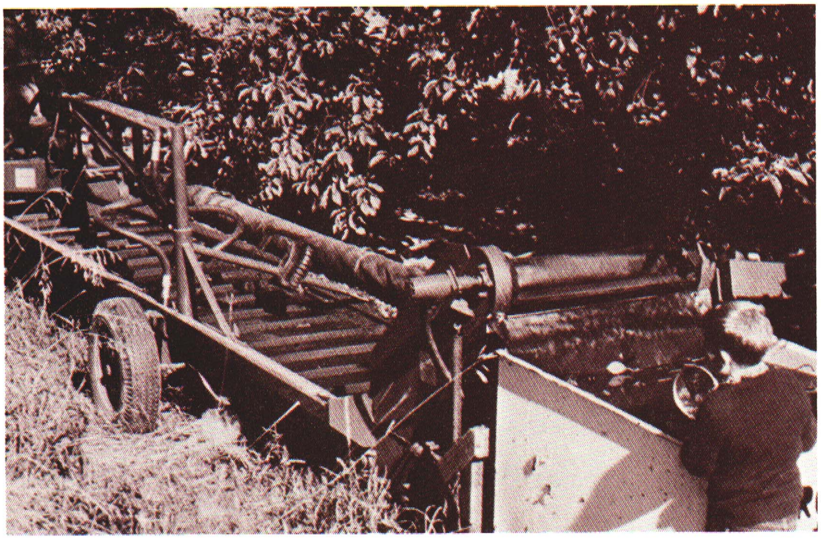


Fig. 2—A roll-out type machine in position for harvest.

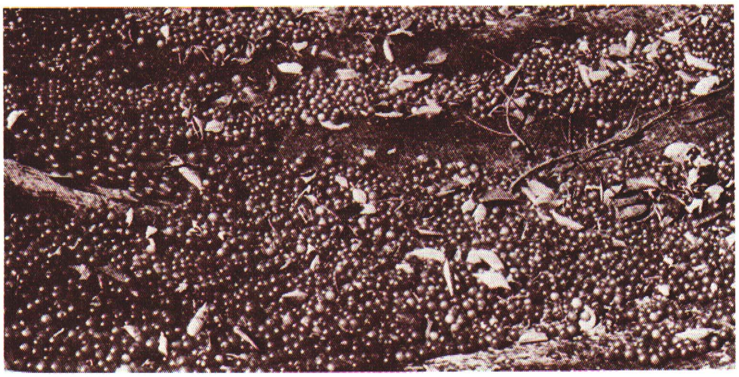


Fig. 8—An overloaded catching fabric from a heavily loaded tree caused by harvesting too rapidly.

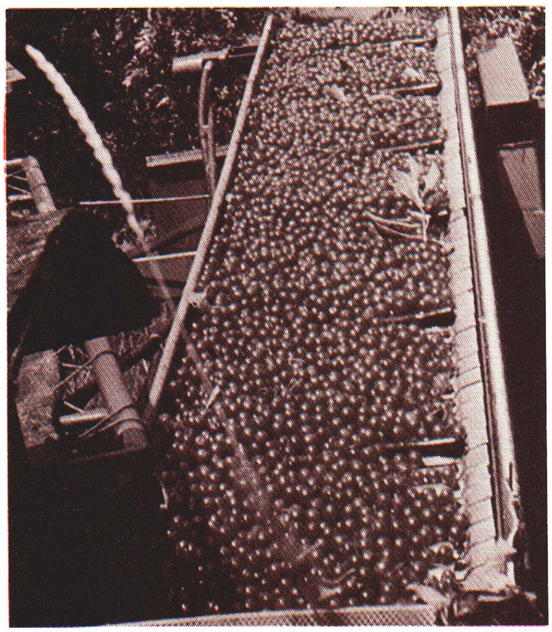
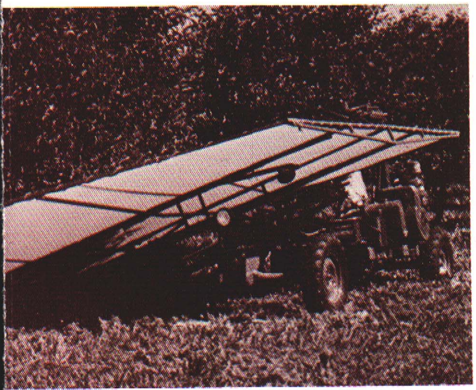


Fig. 7—An overloaded conveyor caused by an excessive harvesting rate. Overloading increases fruit damage, such as bruising and eventual scald.

◀ Fig. 9—Severe rehandling of dry fruit after harvest will affect pitted yield.



◀ Fig. 1—A self-propelled, elevated-frame harvester with limb-shaker and catching frames in position.

Fig. 5—Injury caused by improper operation of the shaker boom.

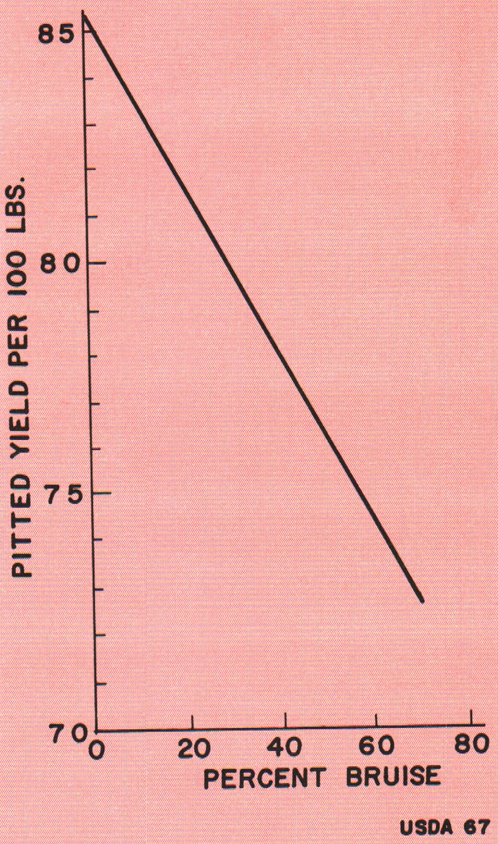


Fig. 11—Effect of excess bruise on pitted yield.

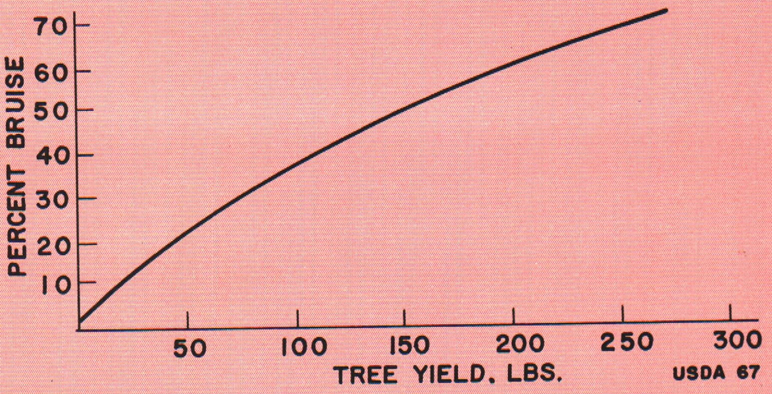


Fig. 6—Harvest bruise expected from increased tree yields (roll-out machine).

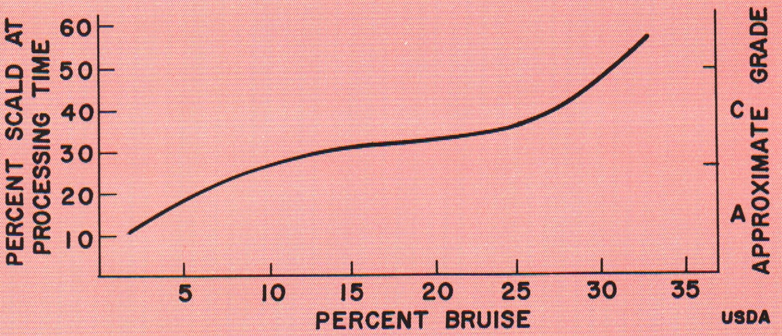


Fig. 10—Effect of bruise on scald.