

Harvesting: From Manual to Mechanical¹

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Mechanical harvesting and many other improvements in harvesting of Florida citrus have their origins in the mid-1950s. During the 1950s and 1960s, a consistent labor supply for hand harvesting was becoming increasingly difficult to obtain and acreage along with yields of Florida citrus was steadily increasing. These concerns led to the development of a citrus mechanical harvesting program spearheaded by the Florida Department of Citrus, United States Department of Agriculture and the University of Florida. The program sought to develop harvesting systems to remove or aid in the removal of fruit from the trees, thereby reducing the number of hand harvestors needed. Industry interest in mechanical harvesting decreased in the 1980s when the devastating freezes of 1983, 1985 and 1989 decreased acreage and volume of fruit to be harvested.

More recently, while sufficient labor has been available to hand harvest the citrus crop, the cost for hand harvesting operations has steadily increased without regard to the delivered-in price that growers received for their fruit. In today's production system, it is easy to spend more for harvesting the crop than for all other production costs combined including

fertilizers, sprays, irrigation, and weed control. The cost squeeze (increasing harvesting costs and constant or decreasing price for fruit) results in small profit margins currently being experienced by growers, led the Florida Department of Citrus to resurrect the mechanical harvesting program. Dr. Galen Brown was hired as the program's administrator and the Citrus Harvesting Research Advisory Council was convened in 1995. In 2003, Robin Bryant replaced Dr. Brown as the program's administrator. The goal of this program is to develop harvesting systems that reduce harvesting costs. Harvesting is the last major area where growers can achieve cost reductions via mechanization. Commercially available systems can help growers maintain profitability in a global marketplace. Interestingly, citrus is one of the last major tree crops which still relies on hand harvesting. Most of the other major tree crops, even some which are intended for the fresh market, have adopted mechanization, thereby reducing labor requirements as well as total harvesting costs.

In the 1950s, initial mechanization programs resulted in the conversion of harvesting systems from the standard wooden 90-pound field box (Fig. 1) to

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larger metal containers for harvesting fruit which utilized a tractor-mounted system and 10-box metal bins (Fig. 2). These bins were transported to and dumped into high-lift trucks which could contain 60 to 100 boxes of fruit. Additional advancement led to the development of 'Lighting Loaders' which provided greater harvesting efficiencies. These trucks allowed loading of semitrailers which were located outside the grove, thus replacing the single axle trucks which had been previously used. Converting from the 100 to 180 box single axle trucks to utilization of semi-trailers significantly reduced transportation and unloading labor requirements at the processing plants.



Figure 1. Harvesting oranges with one-box field boxes that will be hand loaded into a truck.



Figure 2. Harvesting fruit with 10-box metal bins.

It was not until the 1970s that the metal bins were replaced by the currently used round polyethylene tubs. While this mechanization aided in the loading process, fruit was still harvested by hand from ladders by thousands of hand harvesters throughout the state.

Mechanical Harvesting Research and System Development

During the last 40 years, significant efforts have been devoted to improve productivity and mechanize the harvesting of the Florida citrus crop. Initial work focused on ways to improve the hand harvesting operation by providing harvesting aids to improve worker productivity. Through these studies, it was determined that the hand harvester spent at least 25% of their time in activities that were not directly related to fruit removal from the tree. Various harvesting aids were subsequently developed that provided marginal improvements in harvesting efficiencies but these harvesting aids and systems have experienced limited long-term successes.

Beginning in the 1960s, efforts were directed at developing mechanical harvesting systems that provided mass removal of the fruit from the tree. These initial systems either shook the entire tree near its base (trunk shakers) or would clamp to a single large limb (limb shakers) to remove fruit by shaking action. Systems were integrated with a catch system mounted to the shakers, which minimized dropping fruit on the ground and improved overall harvesting labor productivity. When shake and catch systems are employed, you actually have a unit on each side of the tree, one with a trunk shaker and one with a system to collect the fruit, separate trash (leaves and stems) from the fruit, store the fruit, and then convey the fruit into a truck to be transported to a semi-trailer at the edge of the grove. With a catch frame, trunk or limb shaker could improve hand harvest labor productivity from 8 to 10 boxes per hour to slightly more than 30 boxes per hour. Other harvesting systems utilized air speed (wind) or pressurized water as the fruit removal force. Once the fruit was on the ground, rakes and windrow machines gathered and collected fruit, removed leaves and trash and transported the fruit from the field to roadside trailers. Once the fruit was loaded on semitrailers, it was then transported via conventional methods to the processing plant.

Researchers developing these early systems quickly realized that if products or materials were developed that loosen the fruit from the tree, improvements in harvesting rates could be achieved.

These fruit loosening agents were termed abscission materials. Work has continued on the development of these abscission materials with significant effort in developing or securing compounds that can be registered for use in commercial citrus.

The removal of Valencia oranges has posed additional concerns to the development of systems or a combination of systems to aid in the removal of the mature fruit while not significantly removing the young, developing crop. With the development of appropriate abscission chemicals, selective fruit removal could be enhanced.

Mechanical Harvesting Systems of the 1990s and Present

From these early beginnings, modern mechanical harvesters have emerged. The units which are currently being utilized in the industry are of two basic types, the trunk (Figs. 3 and 4) or canopy shake (Figs. 5 and 6) systems. Various types of these harvesting systems will also operate with a catch frame system which is incorporated to catch the fruit and load it into a truck for transportation to a semitrailer at the edge of the grove. The majority of the mechanical harvesting systems utilized today are shake-catch systems, although some shakers (such as shown in Fig. 5), shake fruit to the ground to be picked up by hand labor. Mechanical shake-catch systems without hand gleaning are about 90-95% efficient whereas manual harvesting is close to 100% efficient in removal of all fruit from the tree and allowing it to be delivered to the fruit trailers for transport to the processing plant.



Figure 3. Coe-Collier trunk shaker.



Figure 4. Coe-Collier trunk shaker and receiver.



Figure 5. OXBO tractor drawn canopy shaker.



Figure 6. OXBO self-propelled shake and catch harvester.