

Over-the-row mechanical harvesting machine for dwarf and young citrus trees

By Reza Ehsani and Lav Khot

Since the mid-1950s a significant amount of effort has been directed to reducing the harvesting cost of citrus by developing mechanical harvesting machines that can effectively and economically remove fruit from trees. These diverse efforts resulted in development of various fruit removal and handling systems such as limb and trunk shakers, oscillating air and water shakers, and continuous canopy shakers. In spite of these efforts, less than 8 percent of Florida citrus is currently mechanically harvested, and continuous canopy shakers are the only machines that are being used.

Different factors have contributed to the slow adoption of this technology. Some of the factors are related to the machines themselves, such as high costs or their massive size, which

make them difficult to transport from one grove to another. Other factors are related to concerns some growers have about the adverse effects of machines on trees, such as structural damage and yield reduction of next year's crop, especially during harvest of late-season varieties.

These issues also originate from the fact that scientists and engineers historically have been trying to design and develop harvesting machines for citrus that fit existing trees and grove design. To accommodate the size of the trees that exist in the citrus groves today, engineers developed very large-sized harvesting machines. However, due to their size and weight, these machines required a significant amount of power and expensive hydraulic components that made them very expensive and complicated. Also, citrus trees,

unlike nut trees, have specific characteristics that quickly dampen the vibrational force. Therefore, to remove citrus fruit, the machine needs to put a significant amount of force on the canopy that could result in structural damage or extra stress on the trees, especially on trees that are already stressed from drought or disease.

Examination of the successful mechanized harvesting systems for other crops confirms that for a successful mechanized system to work, a systematic methodology should be followed in which the machines, cultural practices and cultivars are designed together. The olive industry is a good example of how a systematic approach to mechanization could result in widespread adoption of mechanical harvesting. New high-density olive orchards designed for mechanical harvesting have worked very well for olive growers and resulted in significant reduction in harvesting costs and improvement in fruit removal.

For citrus production, the spread of exotic diseases has caused some growers and researchers to critically evaluate traditional grove management approaches. High-density planting is an alternative concept for citrus groves that affords many economic and production advantages. During the April International Symposium on Mechanical Harvesting at the Citrus Research and Education Center in Lake Alfred, the high-density planting approach for citrus was presented with the opportunities it may offer. High-density citrus groves with dwarf trees offer benefits in terms of reduced harvesting costs, easy adaption of the trees to machines, increased labor efficiency, better disease management, early entry of trees into production, early return on investment and a potential for increased yields. When coupled with the advanced citrus production system (ACPS), which applies and manages irrigation and nutrients to tree root systems (mimicking an open hydroponics system), high-density groves can be a reality in Florida.

The ACPS concept was explained in the August 2009 issue of *Citrus Industry* magazine by Arnold Schumann, Kelly Morgan, Bill Castle and Jim Syvertsen. If ACPS and high-density groves with dwarf trees become widely accepted, they can provide an opportunity for utilizing small over-the-row harvesting machines similar to



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Figure 1 (right). An Oxbo over-the-row olive harvester is being tested for harvesting young citrus trees.



Figure 2 (below). A BEI over-the-row blueberry harvester is being tested for harvesting young citrus trees.



the ones used for harvesting blueberries and olives. The small-sized trees have a fruit-bearing zone near primary and secondary scaffold branches that increases vibration transmissibility to the fruit-stem junction. Therefore, from a theoretical point of view, a smaller fruit-removal system using smaller harvesting forces can remove the fruit easier and more effectively. A smaller machine would be easier to transport and need less labor to operate, resulting in lower operational costs.

In 2011, a commercially available olive harvester (Figure 1) and a blueberry harvester (Figure 2) were tested for harvesting small, young citrus trees in South Florida. Our preliminary tests indicated that existing over-the-row harvesting equipment can be adapted to harvest small citrus trees. In field trials, an Oxbo olive harvester and a BEI blueberry harvester removed 95 percent of the fruit from small citrus trees. To work more effectively for citrus, both systems will need some modification to improve fruit removal, the fruit conveyance system, and the entrance tunnel size. However, the results were encouraging and demonstrate the potential of these machines for Florida citrus.

Adaptation of small, existing over-the-row harvesters to Florida citrus offers opportunities for manufacturers

of harvesting machines because they can develop machines with parts that are interchangeable for other crops, and allow manufacturers to produce lower-cost machines with higher market demand. Imagine small, easily maneuvered machines advancing over the row without much damage to the tree or to irrigation systems. In addition, the use of an abscission compound in combination with over-the-row harvesters could provide additional fruit removal and economic benefits.

In conclusion, the challenges of dealing with exotic diseases and the continuously growing costs of citrus production and harvesting provides an opportunity for growers to consider alternative grove designs and production systems such as high-density plantings within the ACPS framework. New grove designs could provide an opportunity for employing smaller, lower cost, over-the-row harvesters that could reduce harvesting costs and increase the profit margin of citrus production.

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WHAT'S SHAKIN'

At the recent International Symposium on Mechanical Harvesting and Handling Systems of Fruits and Nuts, Karen Lewis, a tree fruit regional specialist at Washington State University, made a presentation about vacuum assist machines being evaluated as harvest aids in fresh apple orchards. Fresh market apples currently are being picked by hand with picking speeds ranging from 0.5 to 1 fruit/second/picker. More importantly, up to 30 percent of total harvest time is spent repositioning each picker/climbing ladder, and then walking to empty picking bags into harvest bins. Vacuum assist machines can reduce that time.

Two companies, DBR and Oxbo International, are evaluating harvesting platforms with vacuum technology for citrus harvesting. Both companies have been able to deliver apples into dry bins without any significant fruit bruising. Harvesting efficiency gains, however, have been limited to a narrow range of available tree canopies, and more work is needed to increase the suitability of this technology for a wider range of orchard types and to increase picking speeds. Visit http://www.youtube.com/watch?v=b_C7otpeT0&feature=relmfu to look at the YouTube video of the DBR machine.

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