

# Mechanical harvester for lemons and grapefruit aims at portion of crop bound for processing

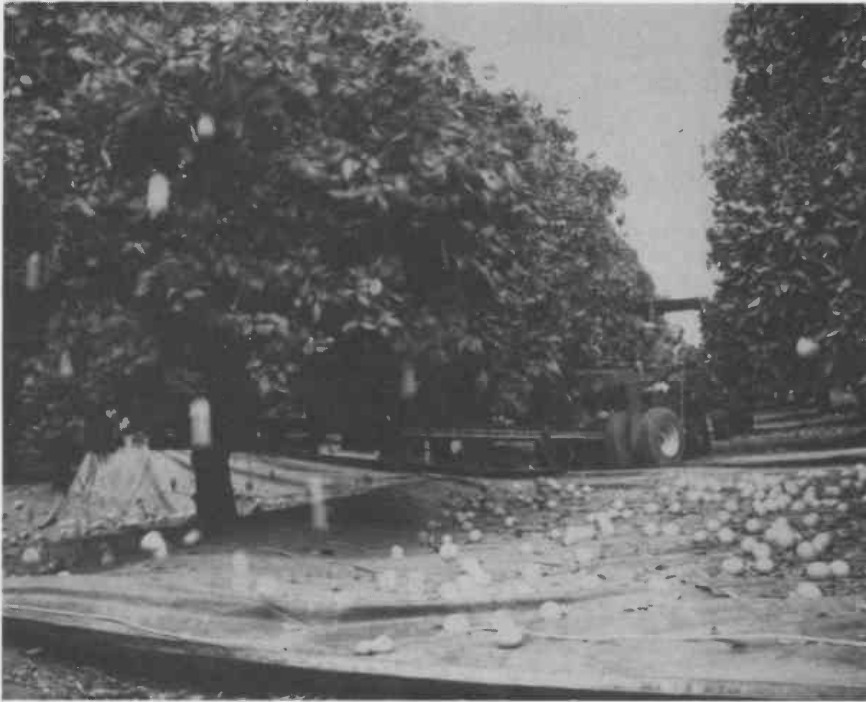
By Guy Webster

Grapefruits rain down onto the tarp spread under the tree while the longnecked machine hooked to the trunk shakes the tree about five times per second.

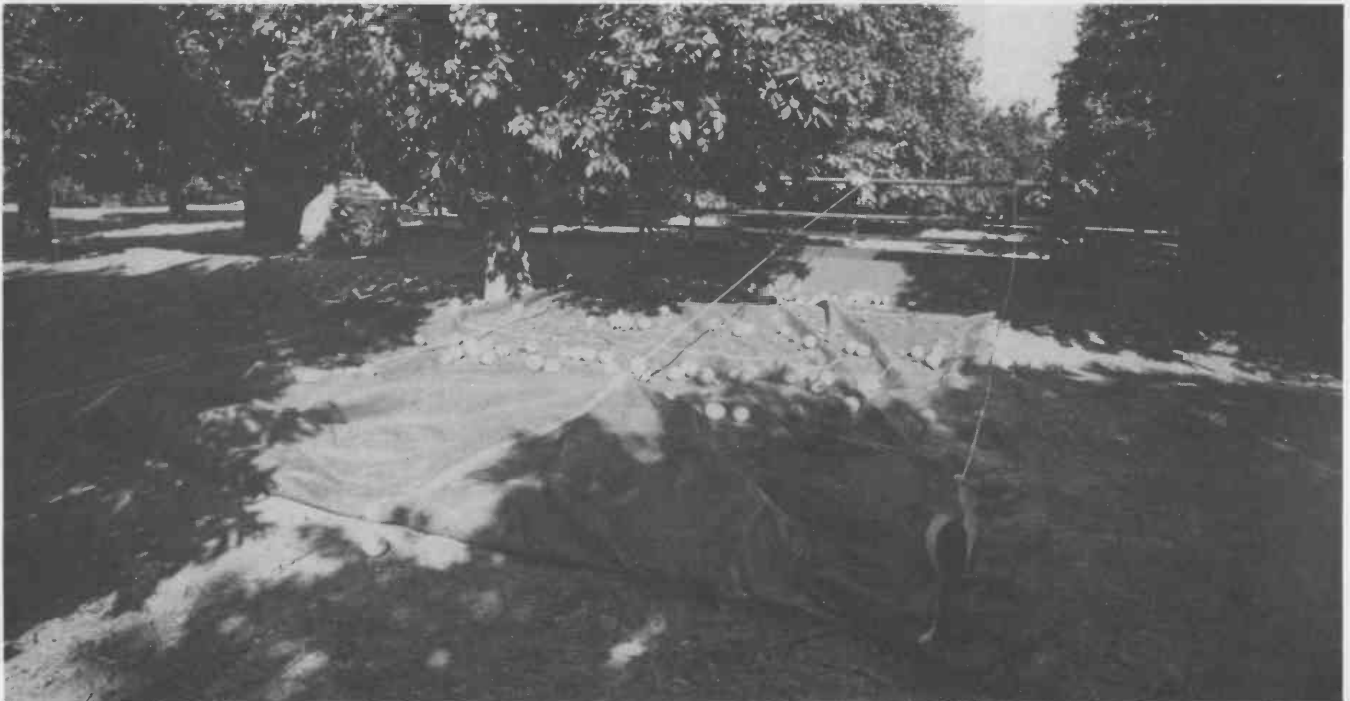
This tree is in a section of 48-year-old Marsh grapefruits at the University of Arizona citrus farm in South Tempe.

In 10 or 15 seconds, more than 90 percent of the fruit lies on the tarp. Before the minute is up, another machine pulls in the tarp like a fishing net and dumps the grapefruit onto a conveyer belt. The belt rolls them over a grid, where most twigs and leaves are sieved out, and into a wooden box, ready to go to the packing house or processing plant.

UA agricultural engineer Dr. Joe P. Gentry has been refining this experimental machine since 1976. Originally, he was aiming at the processed lemon crop. Fifty to sixty



Mechanical harvester shakes the trunk of a grapefruit tree hard enough to dislodge more than 90 percent of the fruit. Tree at right was shaken first, onto the same collection tarp.



Ropes winding around a rotating shaft pull in the collection tarp in the second step of the mechanical grapefruit harvest. Shaking has increased subsequent-year yields, compared to hand-harvested trees nearby.

percent of Arizona's lemon crop is sold for processing instead of fresh fruit. Hand-picking of the lemons costs more per box than the fruit are worth on the processing market. Most years, the amount of citrus sold as fresh fruit is limited by market conditions, not by the availability of high quality fruit.

Using the harvester on grapefruit is a spinoff from the work with lemons. About half of the state's grapefruit crop also goes into by-products, mainly juice and soda pop. Gentry has used the machine successfully on sour oranges, too. They are used in marmalade, but commercial production in Arizona is limited to one grower's 40-acre orchard. The state has about 20,000 bearing acres of lemons and 10,000 of grapefruit.

The machine is not expected to replace hand picking of fresh-market lemons and grapefruits, or of sweet oranges.

Economic and social considerations share the stage with engineering in the development of mechanized harvesting.

Citrus industry leaders familiar with Gentry's machine said it could add needed flexibility to help growers react to marketing and weather conditions. But public research into such labor-saving mechanization of agriculture has its critics, including, recently, Secretary of Agriculture Bob Bergland. However, Dr. L. W. "Pete" Dewhirst, director of the UA Agricultural Experiment Station, said that the citrus-harvester research fits the needs of the state for maintaining high productivity.

A spokesman for the United Farm Workers said that the union objects, not to mechanization research itself, but to the lack of accompanying research into ways of assisting people who lose jobs due to mechanization.

### Technology

Some technological hurdles remain before the mechanical harvester can affect the economics of the Arizona citrus industry. "If it were easy, somebody would have already done it," said Gentry during a drive from his office at UA's Mesa farm to the citrus farm near Interstate 10. He

and citrus farm coordinator A. Dean Bacon have mechanically harvested some of the fruit there three years.

The University of Arizona started working on mechanized citrus-harvesting when the University of California quit a similar project after 15 years of work. Gentry suggested two reasons the Arizona work is more likely to succeed:

"The desert lemon here is different than lemons in California and Florida. We have a two-month harvest here, and get all the fruit of one crop off the tree before the next bloom. In California and Florida, the harvest is six, seven and eight months long. You have two crops on the tree at the same time, and it's hard not to shake off the blossoms or small fruit when you're shaking off the mature fruit."

The same problem applies to most Arizona oranges. Gentry tried his machine on one Valencia orange tree and lost 90 percent of the new blossoms while shaking off the mature fruit.

The other advantage in the Arizona work is that it is aimed at fruit marketed for processing, not for fresh market. Earlier research that tried to mechanically harvest

fresh-market quality fruit used a limb-shaker instead of a trunk-shaker. The trunk-shaker can be a less complicated, and less expensive, machine, said Gentry.

### Custom-made Trees

For now, his machine works better on grapefruit than on lemons. Lemons bruise more easily, and the shaker skins the bark on the lemon trunks unacceptably. Bark on grapefruit and sour orange trees tears off of the trunk less easily.

"We're looking at growing a lemon tree specifically for mechanical harvesting," said Gentry. This spring, he and colleagues grafted lemon onto a sour orange sapling about one yard above the ground. Most lemons are grown on sour orange rootstock, but the graft is usually closer to the ground. The higher graft will allow room for attaching the mechanical lemon harvester to a sour orange trunk.

"Another possibility we'll be looking at is a tree with sour orange roots, a grapefruit trunk and lemon branches," he said.

Even grapefruit trees require some modification for best use of the harvesting machinery. Branches below



UA citrus farm coordinator Dean Bacon (right) and agricultural engineer Dr. Joe Gentry operate the conveyer system that rolls grapefruit over a grid and into the shipping box.



**Gentry has worked on mechanical citrus harvesting in Arizona since 1976.**

30 to 36 inches are pruned from the trunk in order to clear a spot for attaching the shaker.

The shaking does not appear to have hurt the old grapefruit trees in the UA orchard. In fact, their average yield has increased from 110 pounds of fruit the first year they were mechanically harvested to 250 pounds the second year and 300 pounds this year. Yield did not increase on comparable trees that were hand-picked each year. Bacon and Gentry speculate that the shaking may be breaking off tiny, nematode-infested feeder roots, or may help by loosening the soil or knocking off dead or unhealthy branchwood.

#### **Harvest Aid**

The reason for shaking trees, though, is not to increase yields; it is to reduce harvesting costs. With the shaker and mechanical pick-up equipment, three workers can harvest 12 grapefruit trees per hour.

Gentry believes the mechanization can cut the cost of harvesting a 50-pound box of grapefruit by about a dime from the present hand-picking cost of about 40 cents. Picking lemons by hand costs more: \$1.30 to \$1.50 per 37-pound box. Mechanical harvesting may be able to knock that below 50 cents, but Gentry noted that this pricing is

rough since the system does not work yet for lemons.

His current preliminary estimate for cost of the equipment is \$20,000 for the shaker and \$10,000 for the machinery that picks up the fruit.

Mechanized harvesting blemishes some of the fruit. On the UA grapefruit trees, about one-fifth of the machine-harvested fruit were fresh-market quality, in contrast to about three-fifths of the fruit from comparable hand-picked trees. Earlier prototypes of the harvester blemished more of the fruit, and Gentry expects further refinements in the machine to reduce the damage even further. Most of the blemishes are scratches in the skin from rubbing against twigs.

The target of the mechanical harvesting research is fruit marketed for processing, anyway. Almost every year, the citrus industry produces more fresh-market quality fruit than it can sell as fresh fruit, and even some high-quality fruit goes into processing.

Growers familiar with Gentry's rig hope that he can get it to work satisfactorily on existing lemon trees.

"I think the number one effect would be to give the producers a flexibility in dealing with their crop," said Pete Martori, manager of Production Farm Management Company, which grows, harvests and packs 3,000 acres of citrus at Goldmar Incorporated's Arrowhead Ranch in Glendale.

The processing market for lemons has been good this year, but in other years, "hundreds of acres of fruit were left on the trees, because there just wasn't a market. We couldn't even get our picking costs out of it," Martori said.

"As far as completely switching over to mechanical harvesting, though, I don't foresee that coming about," he said. "We would probably hand-pick the blocks of lemons where we know our best quality is, then shake those that are not doing as well."

He said that growers are locked into escalating labor costs, and that his company has trouble finding enough workers to do the job.

## Cooperatives

In size, and in harvesting and packing its own fruit, Production Farm Management differs from most citrus growers in the state. Most are members of cooperatives that harvest, pack and market the crop.

The cooperatives could invest in mechanical harvesting equipment that might be too expensive for small growers individually. But deciding which orchards to shake and which to hand-pick may require some reorganization, according to UA agricultural economist Dr. Roger W. Fox. Shaking could lower the cooperative's cost for harvesting some fruit that would be sold for processing anyway, but it would also lower the proportion of the grower's fresh-market quality fruit, which affects his payment from the cooperative.

Lew Whitworth of Sun City believes the growers would be able to adapt easily to using the shaker on selected blocks of trees. He is a private consultant for several citrus growers, and a member of the Board of Directors of one cooperative, the Arizona Citrus Growers Association.

"Mechanical harvesting of citrus is something we've needed for years," said Whitworth, who has seen the UA harvesting machinery in action.

Besides picking the processing portion of the lemon and grapefruit crops in normal years, the harvester could also improve the ability to salvage fruit after a freeze. Frozen citrus will dry out and ruin if left on the tree, but it can still be used for processing if picked soon after the freeze.

## Labor Effect

Mechanization in any industry raises the issue of its effect on workers. Last December, USDA Secretary Bergland announced at a Fresno, California conference that federal research funds would no longer be spent on projects aimed at saving farm labor. He modified his position with several qualifications a few weeks later, but the mechanization issue drew much attention in the meantime.



**Boom of the shaker clamps hydraulically onto the citrus tree trunk. Two 125-pound weights, counterbalanced and offset about six inches, shake the boom in line with its length.**

Arizona Agricultural Experiment Station Director Dewhirst said that such a funding cut-off would have little or no effect in Arizona. The citrus-harvesting research is continuing with state funds.

"This will not put many people out of work," he said. "Citrus growers, especially in Maricopa County, have had difficulty even finding enough pickers to do the job in recent years, and oranges and fresh-market lemons and grapefruit will still be hand picked."

Research to make agriculture more efficient benefits everyone who buys food, not just the agricultural industry, Dewhirst continued. "Research has been the groundwork for providing Americans with a more abundant variety of food, for a lower portion of their income, than people anywhere else in the world.

"In mechanization research, we're looking at areas where hand labor is inadequate for continued or increased productivity."

Some farm labor representatives say mechanization research does not go far enough.

United Farm Workers spokesman Marc Grossman, discussing the citrus-harvester research, said, "We're not Luddites: we do not op-

pose mechanization, *per se* ... We are not against growers trying to mechanize in order to grow more food to feed more people. The land grant universities have done a good job on that half of the job, but the other half of the job is to use some of that wonderful technology to tackle the problems of people hurt by the effects of that research," including small family farmers as well as displaced farmworkers.

Grossman, who is assistant to UFW president Cesar Chavez at the union's Keene, California headquarters, charged, "The land grant universities have not lived up to that responsibility."

Dewhirst said, "Land grant universities have traditionally been concerned about job displacement created by mechanization, and will continue to be so. In fact, most mechanization research has resulted in more jobs, and higher-paying, less-seasonal jobs, while it also increases the productivity of the average worker. Higher productivity allows raising workers' wages without passing on higher costs to consumers. Workers, consumers and growers, all three, benefit from research that increases agricultural productivity."