Mechanized Fruit Harvesting
Past achievements, Current Status and Future Prospects

Yoav Sarig, Prof. Emeritus
The Institute of Agric. Eng.
P.O. Box 6, Bet Dagan, Israel
Presentation layout

- Introduction – background & statement of the problem
- Objectives
- The scope of mechanical harvesting
  a) Labor aids
  b) Labor saving machines
  c) Robotic fruit harvesting
- Site-Specific solutions
- Conclusions
Objectives

- To briefly describe the currently available technologies – advantages & drawbacks and suggest that no single solution is applicable
- To propose a course of action, which should be taken by industry – both growers & equipment manufacturers, in order to maintain the viability and competitiveness of the fruit industry
This presentation doesn’t purport to report on new technological breakthroughs. Rather, it attempts to provide a different thinking on the complex process of fruit harvesting, contributing, hopefully, to its optimization.
Statement of the problem
Fruit growers in the developed countries are facing two significant problems that could determine the future of their business:

• Lack of adequate labor supply
• Competitiveness in the global market

Can’t we solve these problems?
Back in the 70`s there was a commercial on the U.S TV: “They can send a man to the moon, how come they can’t make a good coffee?”
Paraphrasing on this commercial:

The developed countries have advanced technologies in many areas, but fruits, for the most part, are still being picked by hands, worldwide.

Why is it that no mechanical solution is yet available for harvesting fresh fruit?
The reason is simple:

Rather than make investments in new technologies, farmers, worldwide, mostly focused on lobbying governments for easier access to inexpensive labor – and succeeded!
The cheap labor that mass immigration provided in countries such as the U.S., Germany, France, Israel, Spain and others, has blocked any incentive to develop mechanical systems to replace manual labor.

The end result is that at present these countries are in a disadvantage position in the face of global competition.
Ironic, but sad:

The cheap, mainly illegal labor immigrants are becoming unprofitable with the competition from even cheaper labor in less developed countries!
The conclusions:

- Farmers in developed countries can’t ignore any more technological improvements and the need for investments.
- Competing on low labor costs is infeasible.
- To stay in business means reducing costs – the only viable way to do that is through mechanization.
While mechanization is recognized as the major vehicle for reducing the cost and the only mean to stay competitive, it is important to note that in addition:

- Mechanization reduces the farmer’s drudgery and improves his ability to perform operations in a timely matter
- Reduces the risks associated with need for large amounts of seasonal labor for short periods of time
- Lessens the social problems which accompany excessive influx of low-wage workers
- Has the ability to potentially reduce human contact with food (food safety)
In spite of the complexity of the problem there are, nevertheless quite some cases of success that are already in commercial use
Past Achievements
Few examples of a successful mechanical harvesting
Unfortunately, after 60 years of R&D, the harvesting of 25 fruit crops still has not been mechanized.
However, apple, pear, apricot, peach, mango, avocado, litchi, kiwi, olives, sweet cherries - few examples of fruit crops which are still being hand picked!
Admittedly, not all harvesting situations are amenable (yet) to mechanization

But, unfortunately, even those solutions which are available are only partially employed, and in many cases their use is not justified economically!
Moreover!

- Many of the growers (regardless of the country) are not well informed of what is being done to mechanize fruit harvesting outside their perimeter – both domestically and internationally!

- There is not enough awareness with regard to the need to adapt the orchard characteristics – size, shape, tree spacing, in a comprehensive system approach to optimize the harvesting
Ever since Eve has reached out to pick the apple in Eden, attempts are being made to develop better methods for harvesting fruit.
There are basically three modes of harvest mechanization:

- **Labor-aids**
- **Labor saving machines**
- **Robotics & Automation**
Labor-Aids

Labor-aids are aimed at reducing the drudgery of farm labor by reducing the effort and endurance required for the fruit-picking operation.
The ladder-the basic picking-aid
A 4 workers articulated picking-aid
Advantages:

Picking-aids increase the supply of labor, reduce seasonal demands, stabilize the labor force and increase the potential of pool of laborers by improving working conditions.
Disadvantages:

- None of the picking-aids makes the harvesting competitive with standard methods and thus, their use is not justified economically!

- As long as picking is done manually, the potential for increasing productivity is limited
Labor-saving machines

Main characteristics:
their ability to remove fruits in multiples (mass harvesting)
Mass-harvesting of grapefruit (Israel)
Mass-harvesting system for olives for oil (Italy)
An experimental harvester for jojoba (Israel)
Shake & Catch System for Harvesting Oranges (U.S.)

Fruit Harvesters International trunk shaker/deflector unit
Mechanical harvester for wine-grapes (France)
A shake & catch system for harvesting appricot & cling peaches (the U.S.)
Major advantages:

- This class of equipment offers a significant increase in harvest labor productivity – with some crops a 100 fold increase in productivity has been recorded!

- Thus, these machines have the potential to meet the objective of reducing total harvesting costs
Disadvantages

- The major deterrent to the introduction of labor-saving machines is the excessive mechanical damage incurred during mechanical harvest.

- Thus, although productivity can be increased significantly, the commercial implementation of labor-saving machines is limited to fruit which are destined for processing (such as olives), or are not prone to mechanical damage (nut crops).
Robotic Fruit Harvesting

A Fruit Picker

vision sensor

hydraulic

high pressure air

trolley

computer image

ripe fruit
Robotic fruit harvesting aims to automate the fruit picking process by using a system that emulate the human picker for decision making and picking. Conceptually, it should provide the same, or better quality, at a much faster rate.
Robotic harvesting
Examples of Engineering Concepts
Robotic harvesting should provide, in principle, the only solution for substituting manual labor for picking perishable fruit destined for the fresh market.

- Unfortunately, although remarkable and encouraging results have been already obtained (with apple & citrus), robotic harvesting is yet not feasible and can’t be considered as a competitive solution.
The current status of harvest mechanization worldwide
Labor-aids

- Are widely used in Italy, where typically many small manufacturers build their own version of a high-lifting platform.
- Are used in Australia mostly imported designs.
- Are quite common in Israel (of local design), but used mostly on tall trees (avocado, dates).
- Are used, to some extent in the U.S. Spain, France and other fruit-producing countries in Europe.
- Special design of labor-aids have been developed and used in the Netherlands.
Labor-saving machines

- Are currently used for harvesting all nut crops,
  - Mechanical harvesting of wine grapes (U.S., France, Italy, Spain, Australia, South Africa & Israel)

- Mechanical harvesting of coffee (Brazil)

- Mechanical harvesting of olives for oil (Italy, Spain, Israel, Argentina, U.S.)

- Mechanical harvesting of prunes, citrus fruit peaces & tart cherries destined for processing (U.S.)
Robotic harvesting systems

- None is being used commercially at present
- In the past – work in the U.S., France, Spain, Italy, Hungary, Israel & Japan
- Present R&D work continues in Japan.
- Work has also commenced in Holland and Australia & a renewed work in the U.S.
In spite of the tremendous R&D work in more than 60 years of research, a commercial use of harvest machinery has been only partially implemented and is not viable yet, for fresh fruit crops.

Is it really a no-win situation?
WE STATE CATEGORICALLY THAT MAINTAINING COMPETITIVENESS IS FEASIBLE!

However, to reach this goal is not easy, especially with fruit destined for fresh consumption, which presents a major challenge.
What direction should the industry take?
Because of the complexity of the harvesting operation, the diversity of the fruit crops and growing conditions, a system approach should be adopted.

- Within this approach we propose that all available solutions should be evaluated on the basis of “site-specific solutions” to yield the optimal solution for a given harvesting situation.
A few examples to illustrate the concept of “Site-specific Solutions”
A picking-aid system for picking peaches in a semi-dwarf orchard
A continuous moving picking-aid
Mechanical harvesting of peaches in a meadow orchard
Mechanical harvesting of olives for oil
A mechanize harvesting system for citrus destined for processing (in Florida)
Harvesting dates (in Israel)
Mass-harvesting of dates
In addition we propose:

- Changing orchard characteristics—size, shape, tree spacing and varietals changes to make it amenable to mechanical harvesting
- Introducing mechanical solutions to reduce mechanical damage and sorting systems to sort out damaged fruit
- Developing economical viable robotic harvesting systems, substituting manual labor for harvesting fresh-market fruit
The challenge is big! Will the industry rise to meet the challenge?
Thank you for your attention