

Mechanical harvesting

In this method numbers of mechanical devices are used for harvesting the produce on commercial scale

Citrus

Mechanical harvesting machines can be broadly classified as contact machines and mass-removal machines. The contact machines consists of

(1). The positioning mechanism and (2). The picking hand or arm. The mass-removal machines operate by applying external force, shaking the limb or tree trunk mechanically by holding it or applying force in the form of a jet of water or air to vibrate limbs, foliage, and twigs. In mass-removal machines, fruit drops onto padded catch frames or is allowed to drop on plowed ground. Fruit is collected in pallet bins or open trucks and transported. In general, mass-removal type mechanical harvesting is suitable for fruit destined for processing, while contact machines are useful for harvesting fruit destined for fresh consumption. The contact machines are based on the principle of selective picking and may use mechanical fingers, which are flexible and imitate human fingers. The distribution of fruit in the canopy has to be considered in designing a robot. The cultivars with maximum fruits in the outer periphery are most suitable since electronic detection and selection is easier. In citrus, Satsumas and Clementines are the most suitable for this purpose, as 80 percent of the fruit is available 70 and 30 cm from the periphery, respectively in these cultivars. Fruits of Washington Navel and Salustiana oranges are borne 140 and 100 cm inside the periphery, respectively, some promising results have been obtained in developing prototypes of mechanical arms, vision systems, fruit detectors, and end effectors. Fruit peduncles in 85 percent of fruit have been less than 5 mm and 98 percent of fruits presented intact calices. The injuries to fruit have been negligible to none. The system is very useful for fruit destined for the fresh fruit market.

The use of spectral reflectance and chrominance information to enhance digital color images to control a robotic manipulator for harvesting is possible. The spectral information is useful to differentiate the fruit image from background leaves, tree limbs, soil, and sky. The ability to harvest citrus fruits automatically by means of image processing (vision system). The field conditions pose difficulties in fruit recognition by automatic mechanical systems or robots for selective harvesting of fresh fruit. The important task for the robot is to recognize fruit against varying backgrounds (green leaves, blue sky, brown branches, and black soil) that have different colors under different light conditions. Fruits are also clustered most of the time. On the large commercial plantations of Florida and Brazil, where fruit is mostly utilized for processing, mechanization is beneficial as the manual harvesting is becoming uneconomical and laborers are not available when needed. Efficient mechanical harvesting is a key factor in economical fruit production for industrial processing. Mechanical harvesting by a conventional trunk shaker works well in young and uniform orchards, where shaker parameters are preadjusted to the uniform trees. In an old or non-uniform orchard, most shakers cannot be operated properly unless the shaker properties are adjusted to the individual tree during the harvesting operation.

The Florida Department of Citrus has been working with inventors and manufacturers to develop technologies that reduce harvesting costs for processing oranges and increase worker productivity. Mechanical harvesting systems are in various stages of development and fruit-abscission compounds are being evaluated.

Trunk shake-catch systems are being commercially used to some extent to mechanically harvest Florida oranges for processing. Tree-size management practices did not affect the fruit-removal performance or harvesting efficiencies of the shakers. Fruits left on the trees by the shakers and those missing the catch frames must be gleaned by hand harvesters. The cost of gleaning reduces or may eliminate the profit for the mechanical harvesting operation.

Abscission chemicals to reduce the detachment force of oranges are being tried to increase the removal efficiency of the shakers. Shaker removal efficiencies increase by 10–15 percent when orange detachment force is reduced 50–80 percent.

Asparagus

Asparagus are presently harvested by hand with labour costs at 71% of production costs and 44% of selling costs. Asparagus is a difficult crop to harvest since each spear matures at a different speed making it difficult to achieve a uniform harvest. A prototype asparagus harvesting machine - using a light-beam sensor to identify the taller spears - is expected to be available for commercial use.

Maine's blueberry

Mechanization of Maine's blueberry industry has reduced the number of migrant workers required from 5,000 in 2005 to 1,500 in 2015 even though production has increased from 50-60 million pounds per year in 2005 to 90 million pounds in 2015.

Chili pepper

As of 2014, prototype chili pepper harvesters are being tested by New Mexico State University. The New Mexico green chilli crop is currently hand-picked entirely by field workers as chili pods tend to bruise easily. The first commercial application commenced in 2015. The equipment is expected to increase yield per acre and help to offset a sharp decline in acreage planted due to the lack of available labour and drought conditions.

Peach

There has been an ongoing transition to mechanical harvesting of cling peaches (mostly used in canning) where the cost of labor is 70 percent of a grower's direct costs. In 2016, 12 percent of the cling peach tonnage from Yuba County and Sutter County in California will be

mechanically harvested. Fresh peaches destined for direct consumer sales must still be hand-picked.

Grape

As of 2007, mechanized harvesting of raisins is at 45%; however the rate has slowed due to high raisin demand and prices making the conversion away from hand labour less urgent. A new strain of grape developed by the USDA that dries on the vine and is easily harvested mechanically is expected to reduce the demand for labour.

Strawberry

Strawberries are a high cost-high value crop with the economics supporting mechanisation. In 2005, picking and hauling costs were estimated at \$594 per ton or 51% of the total grower cost. However, the delicate nature of fruit make it an unlikely candidate for mechanisation in the near future. A strawberry harvester developed by Shibuya Seiki and unveiled in Japan in 2013 is able to pick a strawberry every eight seconds. The robot identifies which strawberries are ready to pick by using three separate cameras and then once identified as ready, a mechanised arm snips the fruit free and gently places it in a basket. The robot moves on rails between the rows of strawberries which are generally contained within elevated greenhouses. The machine costs 5 million yen. A new strawberry harvester made by Agrobot that will harvest strawberries on raised, hydroponic beds using 60 robotic arms is released in 2016.

Tomato

Mechanical harvesting of tomatoes started in 1965 and as of 2010, nearly all processing tomatoes are mechanically harvested. As of 2010, 95% of the US processed tomato crop is produced in California. Although fresh market tomatoes have substantial hand harvesting costs (in 2007, the costs of hand picking and hauling were \$86 per ton which is 19% of total

grower cost), packing and selling costs were more of a concern (at 44% of total grower cost) making it likely that cost saving efforts would be applied there.

According to a 1977 report by the California Agrarian Action Project, during the summer of 1976 in California, many harvest machines had been equipped with a photo-electric scanner that sorted out green tomatoes among the ripe red ones using infrared lights and colour sensors. It worked in lieu of 5,000 hand harvesters causing displacement of innumerable farm labors as well as wage cuts and shorter work periods. Migrant workers were hit the hardest. To withstand the rigor of the machines, new crop varieties were bred to match the automated pickers. UC Davis Professor G.C. Hanna propagated a thick-skinned tomato called VF-145. But even still, millions were damaged with impact cracks and university breeders produced a tougher and juiceless "square round" tomato. Small farms were of insufficient size to obtain financing to purchase the equipment and within 10 years, 85% of the state's 4,000 cannery tomato farmers were out of the business. This led to a concentrated tomato industry in California that "now packed 85% of the nation's tomato products". The monoculture fields fostered rapid pest growth, requiring the use of "more than four million pounds of pesticides each year" which greatly affected the health of the soil, the farm workers, and possibly the consumers.