Yield and Labor Time for Mechanical and Hand Harvested Cider Apples

Cider apples (used for fermented, hard cider) are hand harvested in the U.S. whereas in Europe they are mechanically harvested to reduce production costs. European mechanical harvest shakes trees to knock fruit to the ground and sweeps fruit up from the orchard floor. These shake-and-sweep harvest systems have been developed for free-standing cider apple orchards where average tree density is 283 trees/acre, and orchards tend to be located in regions with poor soil where dwarfing rootstock do not perform well.

In the U.S., cider apples are planted on dwarfing rootstocks with closer spacing (726 to 1452 trees/acre), higher yield and more precocity than the older orchards. Shallow-rooted rootstocks, relatively small trunk diameter, and narrow row spacing limit the use of the European harvest system. Additionally, while groundfalls can be used in hard cider production, fruit should be segregated in the harvest and processing lines for mixed operations. It is important to note that fermentation has been shown to be an effective microbial kill step, reducing patulin levels significantly below the FDA guideline limit of 50 $\mu g \cdot L^{-1}$.

To address the need for mechanical harvest for U.S. cider apple production, researchers at Washington State University Mount Vernon Northwestern Washington Research and Extension Center (WSU NWREC) carried out a proof-of-concept study to evaluate the suitability of an over-the-row shake-and-catch small fruit harvester to harvest 'Brown Snout' cider apples (Fig. 1). In this research trial in 2014 and 2015, the small fruit harvester (Littau OR0012) retrieved 81% of the yield as compared to hand harvest when all machine picked fruit were taken into account (Table 1). The orchard density and tree height in this study were low, thus yield was 1.4 to 2.8-times lower than for a typical orchard system. Fruit that fell to the ground during mechanical harvest could be prevented by adding netting to the front and back of the machine. Increased drum-brush pressure and rotation speed could increase the number of fruit knocked off the tree. Further, an application of a hormone such as ethephon could provide more uniform fruit maturity and reduce the number of fruit left on trees. For hand harvest, 4-5 unskilled agricultural workers picked the cider apples while for mechanical harvest 3 people were picking, and labor time was reduced 23% with mechanical harvest (Table 2).

Figure 1. Harvesting 'Brown Snout' cider apples with an over-the-row shake-and-catch mechanical harvester at WSU Mount Vernon NWREC (left); rotating drums knock fruit off trees (center); fruit fall onto a catch plate within the harvester (right).

Table 1. Yield (lb/acre) of 'Brown Snout' cider apples picked by hand and by machine in a proof-of-concept study at WSU Mount Vernon NWREC in 2014 and 2015 (Alexander et al., 2016).

Harvest method		Total Yield (lb/acre)	Efficiency (%)[1]
Hand		11,760	
Machine	Fruit harvested by machine	8,699	74
	Above plus fruit fallen from the machine	9,530	81
	Above plus fruit that left on trees	11,392	97

[1] Calculated by dividing the total yield (lb/acre) for machine harvest by the hand harvest yield.

For the mechanical harvester used in this study a maximum of 3 people are needed for the operation regardless of orchard size. Thus labor savings could be greater for larger orchards.

Table 2. Mean labor time (hrs/acre) for 'Brown Snout' cider apple harvest.

Hand	Machine
8.77	6.76

While the size, shape, and yield of trees in this experiment do not represent a commercial production system, information gained from this proof-of-concept study provide a preliminary comparison of the two harvest methods in terms of fruit yield and labor hours for harvest. Based on these results, over-the-row shake-and-catch harvesters appear to be a viable option for cider apples, and a larger over-the-row harvester designed for trees such as olive should be tested.

Publications:

Alexander, T., J. King, E. Scheenstra, and C.A. Miles. 2016. Yield, fruit damage, yield loss and juice quality characteristics of machine and hand harvested 'Brown Snout' specialty cider apple stored at ambient conditions in northwest Washington. HortTechnology 26(5): *in press*.

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