

COST ANALYSIS FOR A CITRUS HARVESTING SYSTEM EMPLOYING
LIMB SHAKERS, RAKE-PICKUP MACHINE AND TRUCKS

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SUMMARY:

Citrus harvest of early and midseason varieties using abscission chemicals, limb shakers and pickup equipment was studied. Detailed records of all system performance parameters were combined in an economic evaluation to arrive at an effective cost for tree to cannery mechanical harvest.



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Florida produced over 6.5 million tons of oranges in the 1971-72 season

Slightly more than 89 percent of this total orange production was used by canning and concentrate plants (4). USDA's Florida orange production estimate as of February 1973 was in excess of 7.6 million tons. Total orange production is presently estimated to increase to 9.0 million tons (200 million boxes) by the 1979-80 season (5). The average total cost of picking and hauling oranges to the plant for the 1970-71 season was \$.779 per box (90 lbs of fruit) with 73 percent of this cost for labor; 50 percent was direct picker labor cost (8). For the 1971-72 season the

¹Mention of commercial products in this report is solely to provide specific information and does not constitute endorsement by any of the agencies involved in these harvest trials.

average total cost of picking and hauling Florida oranges increased to \$.8447 per box (9).

Work by Coppock (1) in 1958-59 indicated that the limb shaker could remove 50-80 percent of the fruit. In a review of engineering problems in citrus harvesting, Hedden (6) indicated that by 1962-63 the limb shaker with 6 inch stroke and operated at 600-800 cpm was capable of 65 to 90 percent removal on early and midseason oranges. Two limb shakers mounted on catching frames were used during the 1966-67 season by Coppock (2) to successfully harvest cannery fruit on a commercial basis from tall and/or high yielding early and midseason oranges. This system harvested 80 to 125 boxes per hour with removal above 90 percent in all tests. On arrival at the plant, splits were 1 to 3 percent, and 20 percent or more of the harvested oranges had retained stems. Cost of removal from the tree was estimated at \$.06 to \$.18 less than hand picking when abandoned fruit was valued at \$.60 per box. At \$2.00 per box for abandoned fruit, this system's best effort was barely a breakeven situation when compared to handpicking. A performance evaluation was carried out for several citrus harvesting systems in Florida during the 1968-69 season by Hedden and Sumner (7). All systems included the inertia-type shaker used as a means of removal in combination with (A) catch frame, (B) ground cloths for windrowing plus pickup machine (C) mechanical windrow rake plus pickup machine (D) ground cloths plus hand pickup. System (A) with catch frames required the least labor per tree while system (C) with rake and pickup machine showed the least direct harvesting cost. The information reported did not include cost for abandoned or damaged fruit, labor overhead or system overhead costs. A Machine for raking harvested fruit into a windrow for subsequent machine pickup was built and evaluated during 1969 and 1970 by USDA (10). Economics of the machine were favorable; but bruising,

especially during the windrow pickup operation was high. As a result, an improved machine was built which combined the raking-pickup operations, eliminating the necessity of windrowing the fruit (Fig. 1).

DESCRIPTION OF HARVESTING SYSTEM

Prior to the 1971-72 harvest season, personnel working on the cooperative citrus harvesting project at Lake Alfred, Florida, concluded that equipment of sufficient reliability and performance existed for an extensive harvesting test on early and midseason oranges. The primary objective for these tests was to develop a complete picture of the cost of citrus harvesting with a system composed of self propelled limb shakers (Fig.2), the USDA combination rake-pickup machine (Fig.1), and conventional hi-lift trucks for transport of fruit out of the grove. Secondary objectives for the harvesting operation included (A) determination of the interaction of abscission chemical use on overall harvest cost; (B) performance evaluation of the individual machine as part of the system; (C) determination of acceptability of the mechanically harvested citrus for cannery use.

The harvesting was performed in 3 different grove areas, each on a different date. Grove descriptions were as follows:

- Test 1 - 20 X 24 foot spacing, 18 to 20 foot high trees, hedged (Hamlin) both middles in one direction, hedged every other middle in the other direction, fairly level terrain, 3-foot high tree skirts. Harvested 12/13 - 12/15/71.
- Test 2 - 25 X 25 foot square spacing, 16 to 20 foot high trees, (Pineapple) hedged both middles in both directions, fairly level terrain 3-foot high tree skirts. Harvested 1/10 - 1/12/72.
- Test 3 - 25 X 25 foot diagonal spacing, 20 to 25 foot high trees, (Pineapple) foliage canopied over in the top, fairly level terrain. Harvested 2/15 - 2/18/72.

