

## AN INVESTIGATION OF THE MOBILE PICKER'S PLATFORM APPROACH TO PARTIAL MECHANIZATION OF CITRUS FRUIT PICKING<sup>1</sup>

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Picking citrus fruit by hand is an expensive operation and one which entails a large portion of the cost of production and harvesting (3) (5). It is becoming increasingly difficult to find suitable labor to perform this strenuous task (1). At present citrus picking is limited to people of sturdy physique, regardless of intelligence or dexterity. The job is shunned by anyone who can find almost any other job at the same money. Adequate mechanization would make the job less strenuous, thus opening up a new source of labor not now available.

Previous studies (4) (2) indicated that the pickers' productivity could be increased and the work made easier by using a mobile picker's platform which would position the picker in the tree under conditions similar to those found when picking from the ground. A study of the design requirements and expected performance of such a machine are presented in this paper.

### PROPOSED PICKER'S PLATFORM

An analysis of the design requirements of a proposed picker's platform for use under current grove conditions revealed that it would have to transport two pickers to and from the grove, position them individually in the tree with a minimum of lost time, collect and store the picked fruit in bulk containers and discharge these containers when full.

The mechanics of the machine requires that its use be limited to positioning the picker so he can pick the fruit above a point six feet up on the tree. The fruit below the six-foot level would be picked by a picker standing on the ground (Figure 1). Efforts to enable the picker on the platform to pick all the

fruit complicated the design of the machine beyond the practical point.

It was felt that the proposed machine should consist of a transport unit, two pickers' baskets<sup>3</sup> with independent positioning mechanisms and a fruit removal system. The transport unit should be built low to the ground with adequate under carriage to assure good floatation in sandy soils. Power should be ample for rapid mobility in these soils. Controls should be within reach of the pickers from their baskets.

The picker's basket should be constructed to provide adequate room for a man to move around freely and to provide a smooth exterior shape. Mechanical means should be provided to move the baskets horizontally, vertically or rotate them through 270 degrees. The horizontal and vertical movements should be accomplished with a retracting type mechanism such as a telescoping tube or pantograph linkage. This would enable operation in close groves. Controls should be either of the throttling or modulating type for smooth starts and stops.

A batch type fruit removal system should be used to assure positive removal. The fruit would be collected in a bin on the picker's basket and emptied onto a conveyor as the basket passes over it in the normal picking operation. The conveyor would in turn empty the fruit into bulk containers which, when full, would be automatically discharged from the machine.

In operation, the proposed machine would require a crew of two — one picker for each of the two picker's baskets. The fruit below the six-foot level would be picked by a separate crew picking from the ground. This crew would not necessarily be co-ordinated with the platform's operation. The procedure of operation is shown in the lower part of Figure 2. The machine would be spotted between four trees. The picker located on the front of the machine would pick one-quarter of each tree on each side while the picker on the rear would pick the equivalent of the trees

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<sup>3</sup>"Pickers' basket" refers to the individual platforms located on the transport unit.

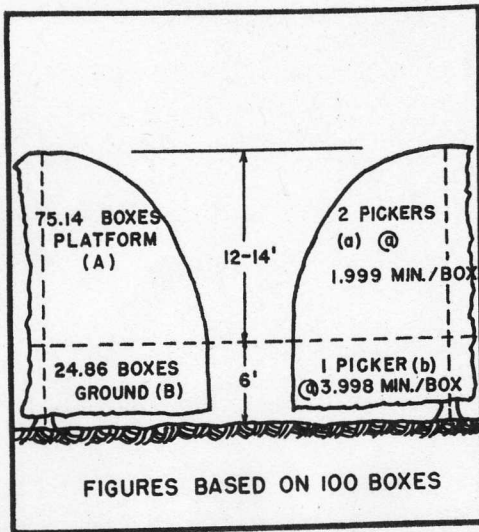


Fig. 1. Sketch of trees showing the area picked from the picker's platform and picked from the ground. Also, the adjusted time required per box and the quantity of fruit picked (based on 100 boxes) from each area are given.

to the rear. In the event one picker finished first, he would be free to swing over and help the other picker. This would offer flexibility to the system and tend to offset the variation in tree production and in the picker's work rate. When all the fruit has been picked the machine would be positioned between the next four trees by one of the pickers. The picked fruit would be collected on the picker's basket and emptied into an automatic fruit removal system as the basket passes over the transport unit. Fruit collected by this system would be stored in bulk containers such as bins or trailers which would be discharged when full from the machine. Suitable methods for moving the fruit from the grove to the packinghouse have been developed (6).

The machine should increase the picker's productivity by eliminating non-productive time, by reducing the necessary productive time per box, and by improving the picking crew organization. It should eliminate the need for ladders, a separate truck to haul pickers and equipment, and for "boxing" the grove.

INVESTIGATION

Factors affecting the design and performance of the proposed picker's platform are numerous and complex. The man is still necessary with all the physical and psychological

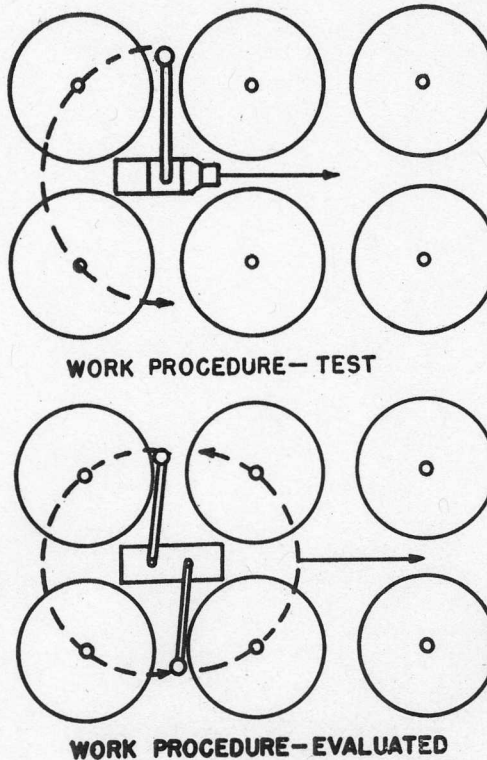


Fig. 2. Flow diagram of work procedure used in test and the work procedure for proposed picker's platform (evaluated).

factors that this entails. It is impractical to evaluate all these factors separately. An experimental mobile picker's platform was designed and built, so that many of these factors could be studied as a unit. The machine was not intended as a prototype of the proposed machine, but rather as a research tool.

*Experimental Picker's Platform.* - The experimental picker's platform shown in Figure 3 consists of a picker's basket attached to a boom-type positioning mechanism which enables the picker to move in and out vertically or rotate through 180 degrees. The positioning mechanism is mounted on a truck chassis. An 18 box, power-dumped bin is provided on the truck chassis for storing the picked fruit and for emptying this fruit into bulk containers or vehicles which can be moved to this roadside or to the processing plant. The picked fruit is first collected in a container on the picker's basket and emptied into the dump bin as the basket passes over the bin in the normal process of picking.

The vertical movement of the picker's basket is accomplished by a telescoping tower which moves the bottom of the basket from six feet to 21 feet above the ground. A double scissor or pantograph mechanism extends the picker's basket out from the tower 15 feet. The tower can rotate 180 degrees about its center, moving the picker's basket on a maximum radius of 15 feet. All movements including the dump bin are powered through a 1000 p.s.i., 18 g.p.m. hydraulic system.

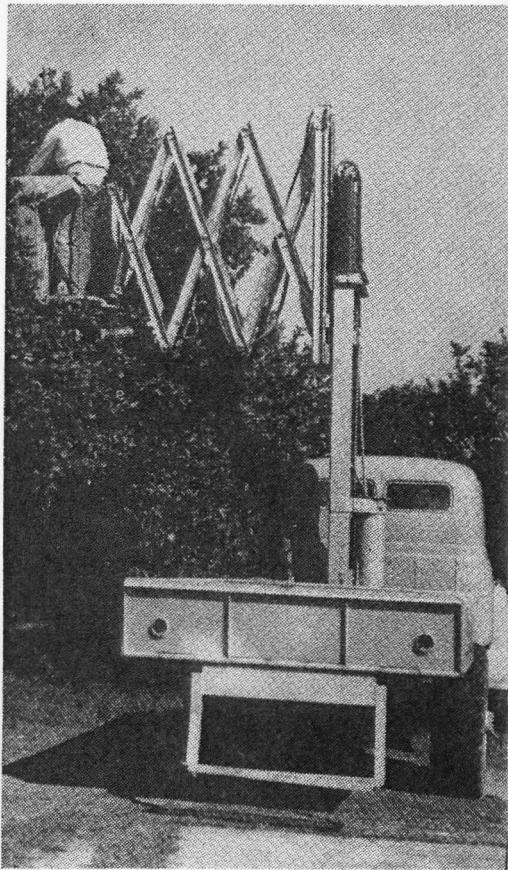


Fig. 3. Mobile picker's platform being used in test operation in orange grove. The arm extends upward to a height of 21 feet and outward 15 feet.

The control station is located in the picker's basket where the basket's movements can be controlled through solenoid-controlled pilot-operated valves. These valves are fitted with adjustable throttling chokes for smooth starting and stopping of the basket movements. For simplicity of operation, the control system is

designed to allow only one movement of the basket at one time.

In the tests conducted, the platform was operated by spotting it between four trees as shown at the top part of Figure 2. One-quarter of each tree above six feet located to the rear of the transport unit was picked. This was repeated as the machine moved forward between two tree rows. The one-quarter of each tree to the front of the unit was picked on the return trip. A separate man was used to move the machine to a new location.

*Field Test.*—Several field tests were made in oranges during the development of the experimental picker's platform. Only the test which was considered to reflect the performance of the platform at its present stage of development will be discussed.

The test was conducted in a 25 year old Valencia orange grove with trees ranging from 18 to 20 feet in height and yielding an average of 7.2 boxes per tree. Fruit size was relatively large averaging 167 fruit per box. On an average, 24.86 per cent of the fruit on the tree could be reached from the ground.

The same picker was used in all test operations. He was considered to be well-trained in picking fruit by the conventional method. After 56 hours of training on the picker's platform, he became proficient in its use.

In order to obtain the necessary data for evaluating the proposed picker's platform, work samples were taken of four picking operations; picking from the ground, picking from the picker's platform, picking on a ladder above 6 feet, and picking by the conventional method. These work elements were used to construct a work sample of the proposed picker's platform.

Two tree rows, five trees long (total of ten trees) and located adjacent to each other, were selected for the test area. All the fruit located on the tree below the six-foot level was picked from the ground. One-half of the remaining fruit was picked using the picker's platform. The remaining one-half was picked using the ladder and bag. All tests were conducted about the same time of day on consecutive days.

Each picking operation was divided into work elements and each element timed throughout the test area. The number of boxes for each of the four operations was recorded. No allowance was made for fatigue or un-

Table 1. Description of Activities and Time Required Per Box for Picking Oranges by the Four Methods Used in Test

Description of Activity	Conventional Method (Min.)	Ground <sup>1</sup> Below 6 Feet (Min.)	Ladder Above 6 Feet (Min.)	Picker's Platform Above 6 Feet (Min.)
Position Ladder	0.599		0.513	
Position Platform				0.327
Move to Position		0.170		
Climb Ladder	0.377		0.440	
Pick Fruit	3.890	2.734	3.931	3.423
Move Fruit to Box	0.336	0.347	0.323	
Move Fruit to Bin				0.212
Move Truck				0.070
Total Time Per Box	5.202	3.251	5.206	4.032

<sup>1</sup> Locations are shown in Figure 1

avoidable delay. A separate group of five trees located adjacent to the test area was picked by the conventional method. Work elements in this operation were timed and the picker's production recorded.

A description of the activities and their time requirements when picking by the four picking operations used in the tests are presented in Table 1. Work samples of the proposed picker's platform picking method were synthesized using two different crew organizations for picking fruit from the ground.

First, the time requirements for picking from the platform and for picking from the ground were adjusted to account for the additional truck moves needed in test operations. If the proposed platform is used in conjunction with a separate crew to pick the fruit below the six-foot level, then:

$$\text{Average time per box picker (min)} = \frac{3a}{1 + \frac{a}{b}} \quad \text{where:}$$

a = Time required per box per 2 pickers on platform (min), Figure  
 b = Time required per box per 1 picker on ground (min).

If the picker's platform is used without an additional crew to pick the ground fruit but with an extra man attached to the platform crew for this purpose, then:

$$\text{Average time per box per picker (min)} = \frac{Aa}{A + B} \quad \text{where:}$$

A = percent of boxes picked by platform above the six-foot level.  
 B = percent of boxes picked from the ground below the six-foot level.

The per picker picking rate (boxes per hour) for the two picking crew organizations was computed and compared graphically with

the conventional picking method in Figure 4. The productive times required per box for picking fruit from the ground, from the platform and from the ladder are listed in Table 1 and compared graphically in Figure 5.

*Performance of Experimental Picker's Platform.* - In operation, the machine did not present any serious mechanical problems. The picker was able to reach all the fruit above the six-foot level, including that inside the tree canopy. In some cases tree damage was noted, but it was not serious. It was quite obvious that the design of the picker's basket could have been improved by lowering the

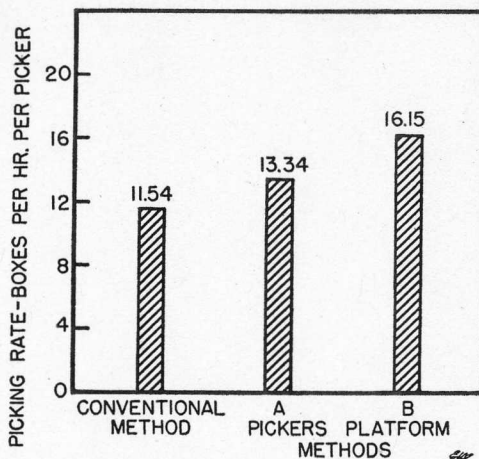


Fig. 4. Comparison of conventional and picker's platform methods as to picking rate. Picker's platform method (A) - Ground fruit picked by an additional crew member. Picker's method (B) - Ground fruit picked by separate crew.

collecting pan and by designing its exterior shape in a way that would make it easier to push through the tree canopy. The basket control system seemed to be the secret to the success of a machine of this type. A modulating system would have been most desirable; however, its expense seemed prohibitive. Foot control for the vertical movement would have been highly desirable. Picking the inside fruit required considerably more time than was expected. No doubt the over-all picking rate would have been higher if this fruit had been left on the tree.

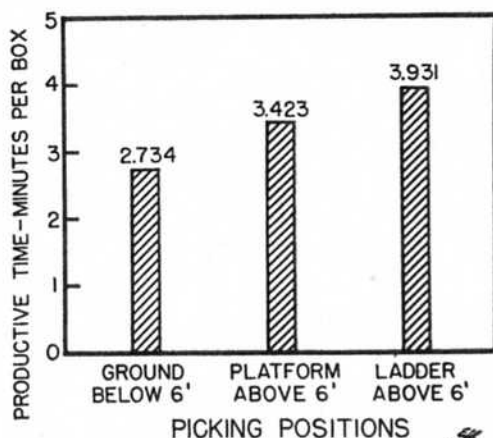


Fig. 5. Comparison of the productive time required per box when picking oranges from the three picking positions. Areas picked are shown in Figure 1.

#### CALCULATED PERFORMANCE OF PROPOSED PICKER'S PLATFORM

The performance of the proposed picker's platform was calculated on two methods of use: (A) The platform plus a separate picker on the crew to pick the ground fruit and (B) the platform plus a separate picking crew to pick the ground fruit. The Platform increased the picker's picking rate in both methods over the conventional picking method, Figure 4. The increase was 15.6 per cent for method (A) and 40 percent for method (B). The difference between the two methods is attributed to the lack of enough fruit that could be reached from the ground to keep the ground picker in method (A) busy one-hundred percent of the time. This is a variable factor and depends primarily on the grove conditions. The over-all increase in the picking rate of the picker on the platform is caused by eliminating part of the non-productive time

and by reducing the amount of productive time required per box, Figure 5. The latter cause is attributed to the picker being able to stand on a more stable platform. The ground picker required 30.5 percent less productive time per box than the ladder picker, while the platform picker required 12.9 percent less. This indicates that additional gains are possible in this area since the optimum platform productive time would be that which approaches the ground productive time.

#### DISCUSSION

Organization of the picking crew would be an important factor in the use of the proposed picker's platform. Arrangements would have to be made so that the pickers could finish their work areas at the same time. This would be especially so when using a separate crew member to pick the ground fruit, because the amount of fruit that can be reached from the ground is highly variable. The rotation of picker's basket and arm through 270 degrees would allow the work areas of the pickers to overlap, making it easier to coordinate their work.

The present method of paying the pickers on an individual "piece-rate" basis would have to be changed to a pool method. This would not be too difficult a problem to overcome since the crew would consist of only two pickers or possibly three as the case may be. A skilled operator would be needed to obtain optimum use of the machine which is an important factor because of the relatively large investment per operator.

No doubt, there would be many small economies to be gained which were not included in the performance calculations. Some of these are: mobility of equipment and crews, elimination of the need to "box" the grove, gains from competition between pickers caused by pooling the pickers' work, reduction of accidents thus lowering insurance costs and the psychological effect of the work being easier.

The unsuitable tree shape and structure is a great deterrent to the success of the picker's platform. Pruning or training the trees to grow in a narrow hedge would eliminate the need for all but one movement of the platform. This would obviously reduce the cost as well as make it possible to place more pickers on the platform.

The economics of the proposed picker's platform are difficult to predict because of the

wide variations in grove conditions and harvesting procedures. The tests indicated that a 40 percent increase in the pickers' picking rate could be expected in the orange grove described in this paper, provided the ground fruit was picked by a separate crew. The increase in terms of manpower eliminated per machine would be 1.01 man. In this grove the number of ground pickers needed to keep up with the platform pickers was 54 percent of one picker, thus giving the equivalent of 2.54 men per machine crew.

Assuming that an average picker receives approximately \$2000 per season, then the gross savings due to the platform would be about \$2000 if only the increase in picker's productivity is considered. The amount that the platform is used per season, the skill of the picker, and the grove conditions would greatly influence the gross savings. In order to apply these savings against the machine cost, pay rate per box would have to be adjusted so that the picker would still receive the same dollar return per day as when picking by the conventional method. This would be a difficult problem to solve.

The fatigue of the picker caused by the accelerated picking rate was not considered in this study. A prototype machine operated over an extended period would be needed before this factor could be evaluated.

#### SUMMARY

A study of the design requirements of a proposed picker's platform for use under cur-

rent grove conditions revealed that it would have to transport two pickers to and from the grove, place them individually in picking position with a minimum of lost time, collect and store the picked fruit in bulk containers and discharge these containers when full.

An experimental picker's platform was built for use in studying some of the factors affecting the performance of the proposed picker's platform.

Tests conducted in an orange grove showed that the proposed machine could be expected to increase the pickers' picking rate 40 percent over the conventional method. This increase in terms of man-power eliminated would be approximately one man per machine.

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## EFFECT OF DELAYED HANDLING AND OTHER FACTORS ON RIND BREAKDOWN AND DECAY IN ORANGES<sup>1</sup>

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Delay in handling of oranges from the time they are picked until packed can allow the development of rind breakdown about the stem end of the fruit, designated "stem-end rind breakdown," and can increase spoilage.

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Stem-end rind breakdown occurs in fruits of Hamlin, Parson Brown, Pineapple, and Valencia varieties of oranges, especially when held for two or more days and subjected to low relative humidities and high rates of air flow before being washed, waxed and packed. This condition is characterized by a collapse of the rind tissue in the stem-end portion of the orange and often extends several centimeters from the fruit button (Figure 1). In general, stem-end rind breakdown is not evident in oranges within two or three days after picking when held under adverse post har-