

Citrus Maturity and Packinghouse Procedures

VIII. Harvesting--Methods of Handling

Physical handling of citrus fruit on their way to the consumer's table begins with harvesting, the removal of fruit from the tree and its transportation to the packinghouse, cannery or gift house. Many different methods of handling have been devised. Some of them, like field boxes have been replaced by pallet boxes as the principal container for fresh fruit. Certain others, such as bulk handling, have been abandoned largely because of picker problems.

A. Harvesting

Citrus fruit in Florida are harvested on the basis of firm sales orders as a general rule. Packinghouse personnel will inspect each grove and block in the latter part of the growing season to estimate the crop and take samples to determine the stage and progress of maturity and color development, the range in fruit size and overall grade, and estimated packout (Table 19). This information is then utilized in determining when the grove or block can be picked and how many picking crews and equipment, trucks, etc., will be needed for the task.

Removal of citrus fruit from the tree has traditionally been, and will continue to be in the foreseeable future, a hand operation. Crews of 20 to 30 men equipped with picking bags, ladders and gloves (the last often pulled off and thrown away as the day warms up) pick individual fruit with a combination pull and twist which leaves the calyx (button) on the fruiting stem when done properly (and the abscission layer is well enough formed). Only those varieties liable to plug (tear the rind around the calyx) like tangerines, 'Pineapple' oranges, satsumas and lemons (and limes) will be clipped with short blunt-nosed shears, since it is so much slower than pulling. In fact, no fruit will be clipped if they can possibly be pulled.

Fruit for the gift trade are generally spot-picked on the basis of size, color, blemishes and edibility. A good many packinghouses formerly

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spot-picked fruit for size, color or maturity at certain periods, usually early in the season and some still do, but most trees are now clean-picked, because of general unavailability of labor. Clean picking, where all of the fruit except the most obvious off-bloom ones are removed in a single harvest, is standard practice for fruit going to a cannery.

Rates of hand picking vary according to the variety, crop load on the trees, size of trees, etc., but experienced pickers will harvest 8 to 10 field-box equivalents (roughly one pallet box) of oranges per hour, 10 to 15 boxes of grapefruit and 3 to 6 boxes of tangerines (clipped) under good conditions. Fruit much above about 20 feet (6 m.) from the ground will not ordinarily be touched by pickers. Rates will be lower in trees with scattered fruit, seedlings or when trees are spot-picked, each of these situations necessitating a substantial premium in the price per box paid for harvesting.

Pickers are paid on a piece rate basis by the box either on volume or weight. The unit for volume was formerly the field box (2.23 bu.), now the pallet box (10 field-box equivalents). Standard per box weights are 90 lb (40.8 kg) for oranges, 'Temple', and tangelos, 85 lb (38.6 kg) for grapefruit and 95 lb (43.1 kg) for tangerines. Payment on weight picked is the better method, as fruit vary considerably in mass during the season

Shortages (and general deterioration in quality) of picking labor in recent years has had 2 main effects: The per box piece rate has risen to \$1.00 or more for oranges, as compared to \$0.25 to \$0.30 in the late 1960's, with that for other varieties being inflated proportionately. Research to develop mechanical means of harvesting was begun in Florida shortly after World War II and has been accelerated greatly in the last decade. Many different types of pullers, shakers, blowers, revolving screws, etc., have been devised as possible methods of removing fruit from trees without the use of hand labor. Problems encountered have included removal of fruit without excessive tree damage, efficiency of fruit removal (% removal and speed), cost of the machines, and fruit damage. Attempts to perfect machines have been hampered from the outset by the

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peculiarities of citrus: To wit, the fact the trees are evergreen, set fruit over season of several weeks (when they do not produce more than one bloom), do not form a well-defined abscission layer (meaning the fruit may hang on the tree for months), and develop their fruit over a period of anywhere from 8 or 9 up to 12 or 15 months, certain varieties like 'Valencia' orange having 2 crops on the trees at the same time.

The earlier devices involved a combination of fruit removal and collection into a trailer or bulk truck. Most of the later machines separated the 2 functions, with one piece of equipment (or part of one) being used to remove the fruit and another to rake them up on the ground and load them into a carrier. A program to isolate a suitable abscission agents proceeded concurrently with the engineering studies, as it became apparent quite early in the course of the mechanized harvesting research that some treatment had to be devised which would loosen the fruit sufficiently for the puller, shaker, blower, etc., to achieve a practicable level of removal. Hundreds of compounds were screened in the search for any which would loosen mature fruit but not the leaves or small fruit, be easy to apply and non-toxic, soluble in a common solvent (preferably water), give a relatively quick response, and not be too expensive. The best abscission compound found thus far, cycloheximide, was made legal for use on citrus in 1977. Mechanized harvesting has become possible for early and midseason oranges, using cycloheximide, but not for 'Valencias' until an abscission compound selective for mature fruit only can be found. Cycloheximide sprayed on trees shortly before harvest does an excellent job of loosening the fruit but also disfigures them so badly with small pits they can not be used for fresh shipment. Mechanized harvesting will be utilized primarily for cannery fruit in the foreseeable future.

Shortages and a deterioration in quality of picking labor in recent years has led to a greatly increased amount of injury to hand-harvested fruit. This continues to be a cause of great concern to packinghouse and gift house operators as they cope with fruit damaged with bruises, cuts, abrasions, etc., and contaminated with sour rot spores and the like from

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dropping them on the ground. Amelioration of picking conditions and continual education in careful handling are major problems facing fresh fruit handlers now and in the future.

B. Methods of Handling

The 2-compartment field box was designed to contain sufficient fruit to fill a packed standard 1-3/5 bu. box. It holds 2.23 bu. (4800 cu.in. = 0.7867 cu.m.) and weighs 100 to 110 lb (45.5-50.0 kg) when filled. The box itself is heavy, clumsy to handle ("too big for a man, too small for a mule"), expensive (\$6-\$7), costly to maintain (ca \$2 a year) and requires more labor than any other container. It was the "work horse" of citrus packinghouses for many many years and is still used in a small way in low-volume houses, particularly for tangerines. Three types of carriers were used for hauling field boxes, narrow-boxed trucks ("goats") of 30-60 box capacity for short hauls to a packinghouse or to a nearby roadside for reloading onto 2-ton trucks holding 100 to 150 boxes or flatbed semi-trailers holding 250 to 400 boxes for hauls up to 150 miles.

Shortages of labor during and following World War II impelled packinghouses in California and Arizona to seek means of improving efficiency of fruit handling over the relatively short distances, usually not more than 10-15 miles, from their groves. A standard citrus field box was never developed in those states. Various types of rectangular, square and cylindrical bins were adopted by individual packinghouses until the 1950's when pallet boxes came into general use following the lead of deciduous fruit houses in the Pacific Northwest.

The trend away from field boxes was slower to develop in Florida because labor was still relatively plentiful in the first decade after the war. The first radical change to more efficient handling methods occurred in the early to mid-1950's when Haines City C.G.A., Chase and Co.'s Windermere house, and Indian River Exchange Packers in Vero Beach installed bulk handling systems. These involved pooling lots of fruit coming to the packinghouse and were not suited for handling either grapefruit or tangerines. At least one cooperative, Roper Bros. in Winter Garden, devised

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large metal bins, which were filled from the top and unloaded through a hinged door on the side, so that individual growers' fruit could be handled separately. Tractor baskets constructed of expanded metal were developed for handling cannery fruit, although some packinghouses used them for short, direct hauls. Studies on the feasibility of pallet boxes began in the early 1960's, by which time over 200,000 of them were used for apples and pears in Washington state alone. Cecil Chapman, packinghouse foreman at Haines City C.G.A., modified a hydraulic-lift type garbage truck to haul citrus from small or odd blocks where it was not economic to use their regular bulk system. At least 5 different systems thus were utilized among Florida packinghouses by the end of the 1960's. (See Grierson, 1962, and Bowman et al., 1971 for details.) Only one of these, pallet boxes, has continued to expand, because of its versatility, and now (1978) predominates throughout the industry. The others have fallen by the wayside for one reason or another, a major factor in the bulk handling types being picker problems. Brief details of these symptoms are given below:

I. Pallet boxes:

These are wooden (also plywood or plastic) boxes with solid sides (early versions were slotted), slotted bottom (ca. 10% open area) and runners (1 on each side and the center) underneath. Inner surface of boards are smooth and edges of slots beveled to reduce fruit injury. Overall recommended height is 32 inches (81 cm), the maximum which a picker can raise a full bag and empty it with minimum fruit damage, and width is a maximum 47 inches (119 cm.). Corners and top are reinforced to withstand boxes being picked up with clamps, as by a Lightning Loader. Pallet boxes are intended as a legal measure when used as a basis for paying pickers or volume sale of fruit, hence most are designed to hold 10 Florida field-box equivalents, with headspace of at least 2 inches (5 cm.) above the fruit recommended. Boxes are marked clearly inside at a level corresponding to 43,500 cu. inches (0.713 cu. m.) for 10 field box equivalents. Estimated life is about 6 years, although they are easily repaired and may well last longer depending upon usage (Wardowski and Grierson, 1978).

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Cost is about \$35.00 knocked down, considerably less than for an equivalent number of field boxes.

Pallet boxes can be used for large or small operations, including gift houses, and for all types of fruit including lemons and limes. They are handled in the grove with fork lift prongs or clamps on a tractor or Lightning Loader. Filled boxes are stacked 2 high onto a flatbed semi-trailer at a roadside, or, in the case of a system used by Lake Wales Citrus Growers Association, 4 or 5 high in a long row so that a "straddle carrier" (modified lumber hauler) can transport them 10-15 miles to the packinghouses. Boxes are unloaded at the packinghouse with a fork lift truck.

The remaining systems of handling fresh fruit are no longer used in Florida but are included because of potential value in citrus growing areas in other countries.

2. Two-wheel trailers (pure bulk systems):

There are 2 main versions, typifying short-haul and long-haul applications.

a. Short-haul (Chase and Co., Windermere; now closed): Trailers with wooden slats and 20-box capacity are hauled into the grove in long strings behind a grove tractor. Two pickers are assigned to each trailer, their earnings being pooled. Strings of 4 to 5 loaded trailers are hauled a maximum distance of 5 to 6 miles (crossing only one paved road). They are unloaded on a ramp outside the packinghouse, after which the fruit is presized, washed (with Dowicide A-hexamine in the water), graded (cannery fruit and culls taken out), sized and run by sizes into 100- to 150-box capacity bulk bins for degreening or temporary storage.

b. Long-haul (Haines City Citrus Growers Association; no longer using this system): Trailers with expanded metal sides and 25-box capacity are transported to the grove on a special carrier. Filled trailers are hauled singly to a nearby roadside where fruits are loaded via an elevator into a bulk semi-trailer for the haul (up to 50 to 75

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miles) to the packinghouse. The semi-trailer is unloaded from the side on a special ramp, after which fruits are presized, pregraded (rots and splits taken out) and conveyed to bulk bins for degreening or temporary storage.

3. Chapman loader (Haines City C.G.A.; no longer used): A special self-loading truck of 60 to 80-box capacity was designed for hauling fruit from blocks too small to warrant harvesting into 2-wheel trailers. The loader has a long basket across the back into which 6 pickers empty their bags. Periodically, the basket is swung over the top of the loader and emptied into the cargo space which has baffles to prevent bruising. The basket is low enough for pickers to empty their bags easily but is held off the ground so that sand and other trash falls out. Rates of picking are considerably higher (up to 25%) than into 2-wheel trailers and the loaders have been very successful, despite the fact pickers must pool their wages.

4. Tractor baskets (10-box capacity): These are utilized mainly for cannery fruit. Baskets are filled by individual pickers. A tractor with hydraulic lifts on the front and rear or a Lightning Loader is used for handling baskets in the grove and dumping fruits from them into a bulk semitrailer for transporting. Fruits acquire indentations from the expanded metal so baskets are seldom used for fresh fruit handling.

5. Bins: Several types of bins, including stackable shallow rectangular metal boxes, pressed fiber cylindrical drums, etc., are used in California and Arizona. The shallow boxes in stacks of 4 to 6 are hauled by a straddle-type lumber carrier while drums are handled with a chain hoist mounted on a flatbed truck. Hauls for these and other types are very short, usually less than 10 to 15 miles.

Sherkin (1977) evaluated some of these systems in Florida and others in California and Israel. This paper should be read as it contains a great deal of interesting information.

Bulk trailers, goats, Lightning Loaders and semi-trailers in various combinations with metal or plastic tractor baskets, tubs, etc., are

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utilized for handling cannery fruit harvested by hand. An increased proportion of the fruit going to a cannery is picked mechanically, in which case fruit will usually be swept into windrows then conveyed via combination pickup-loaders into a side-dump bulk trailer or Lightning Loader. The latter may go directly from the grove to a nearby cannery but are usually emptied into a bulk semi-trailer at a nearby roadside and then hauled to the cannery.

Studies of relative costs of handling systems for fresh fruit have shown field boxes is the most expensive and 2-wheel trailers hauled direct from grove to packinghouse the least expensive. The Haines City version of 2-wheel trailers and Chapman loader are a little more expensive than the direct-haul 2-wheel trailer system. Pallet boxes are intermediate in costs but offer great flexibility in both harvesting and packinghouse operations being adaptable to all sizes of houses and types of management. Direct savings of 6 to 20¢ per box were noted many years ago for bulk vs. field box handling (Phillips and Grierson, 1958) and roughly the same savings should apply to pallet box handling.

Table 19. Grove sampling and crop estimation.

A. Grove Sampling1. Purposes

- a. Determine stage and progress of maturity and development of color in relation to legal requirements.
- b. Determine range in fruit size and overall grade as an estimate of crop volume and % packout.

2. Sampling

- a. Samples must be representative of part of tree, whole tree, block or grove being checked.
- b. Variation of fruit (oranges) on a tree: Study by Sites and Reitz showing trends in °Brix, Brix:acid ratio, juice content, and rind color as affected by height above ground, compass direction and exposure to light; summarized on p. 18 of Cir. 315 (also read original articles in ASHS 54, 55, and 56).
- c. Variations of °Brix (total soluble solids) within a fruit: Study by Sinclair and Bartholomew showing trends in polar and circumferential directions (Original article in Hilgardia, 1944).
- d. Variation of fruit (grapefruit) within a packed box: Study by U.S. Dept. Agr. (Harding, Soule, Long, et al.) showing trends in juice content, °Brix, Brix:acid ratio, etc., of 'Duncan' and 'Marsh' grapefruit sampled from packing bins.

B. Crop Estimation1. Purposes

- a. Individual packinghouses, fruit buyers or contract harvesters: Number of boxes (1-3/5 bu. or 90 lb. for oranges, 85 lb. for grapefruit, 95 lb. for tangerines), distribution of sizes and % U.S. No. 1 fruit used as basis for allocation of harvesting crews, price of fruit (to buyers) and destination of fruit as to packinghouse or cannery.
- b. State, Federal and private agencies (e.g., Florida Citrus Mutual): Monthly surveys of sample groves to ascertain statewide crop size and condition by U.S. Dept. Agr., Growers Administrative Committee, Fla. Dept. Agr. & Consumer Serv., and Florida Citrus Mutual. State and federal surveys important factor in fruit marketing and price structure.

Table 19. (cont.)

2. Methods

- a. Total count: All fruit on tree sized and counted; accurate but slow and usually done only where yield records of individual trees in experimental plots are obtained.
- b. Frame count: Square frame (2 ft. by 2 ft. = 60 x 60 cm) held against tree at several designated positions (usually cardinal points) and visible fruit counted (may also be sized); count increased by factor to allow for inside fruit (% varies widely hence a major source of error in frame-count estimates).
- c. Photographic count: Pictures taken at designated positions; fruit counting done electronically.
- d. Visual estimate: Experienced men can estimate the total crop of a tree, block or grove within about 5%; based on mental image of box volume and fruit sizes; standard method for packinghouses, fruit buyers, and contract harvesters.

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