Automatic Bulk Fruit Sampler for Florida Citrus

James G. Blair
MEMBER ASAE

IN Florida, at one time, all citrus fruit was bought and sold by the box. The only measurement that was made of quality was to determine whether the fruit would pass the minimum maturity standards (1)*. If the minimum requirements were met, the number of boxes of fruit were counted and this figure multiplied by the agreed upon box price to determine the value.

The internal quality of the fruit became most important as soon as the major portion of the crop was being utilized for concentrate orange juice. Regulations established the minimum quality standards for the finished product so the processor needed to know what quality fruit he was buying. The term "pounds-solids" was coined by the citrus industry to represent a fair evaluation of this quality. It is usually expressed as pounds-solids per box and is the product of juice yield and soluble solids. For example, the juice yield from a 90-lb box of oranges is 50 percent and the soluble solids is 10 percent. Therefore, the pounds-solids per box would be 90 x .50 x .10 or 4.5.

Obtaining satisfactory measurements of pounds-solids presented many problems. Disagreements as to what constituted a fair measurement went on among growers and processors for many years. In 1961 the Florida Citrus Commission held an industry-wide meeting in their offices in Lakeland, Florida, to discuss the problems surrounding the measurement of pounds-solids. As a result of this meeting, a project was instituted the primary function of which was the development of improved methods and equipment for selecting samples, extraction of juice and measurement of degrees Brix (soluble solids).

The degree of success in determining the pounds-solids of a bulk load of fruit as delivered to a processing plant depends on several factors, one of which is obtaining a representative sample. A representative sample is one that fulfills the desired degree of reliability based on acceptable pounds-solids variations. Therefore, to a large degree, the solving of the problem resolved itself into one of statistics combined with good sound engineering design.

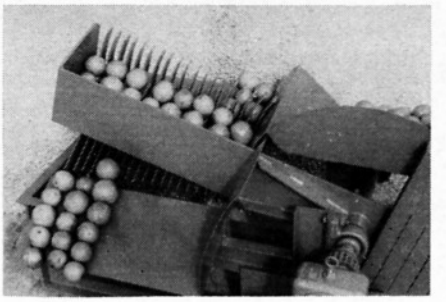

FIG. 1 Primary sample catcher.

The variables that affect the results fall into three general categories, namely, fruit, trucks and unloading systems. While a bulk load of fruit arriving at a processing plant for unloading may contain mixed varieties and maturities as well as other variables, the one of primary concern in obtaining a sample is the individual fruit sizes (2). Processing plants sometimes grade out undesirable fruit before the sample is taken, but, in any event the challenge still is to select a sample that will be representative of all variables. Since fruit size has a significant effect on results and fruit can be separated and counted, all evaluations were based on the samples being representative when the distribution of sizes was statistically correct.

The variability between trucks is mainly capacity, this ranges from 100 to 600 boxes with the majority being between 300 and 500-box capacity. There are about 50 processing plants in Florida, many with different fruit unloading systems. These change from year to year as improvements are incorporated, the objective being to unload faster with a minimum of labor and fruit damage.

EXPERIMENTAL PROCEDURE AND RESULTS

A typical fruit-receiving system was constructed at the Citrus Experiment Station at Lake Alfred, Fla., to measure the effect of some of the variables and to test sampling devices of all sizes, types and descriptions. The unloading and fruit-storage equipment was similar to that used commercially, except that it was of much smaller capacity. The bin held 150 boxes and was equipped with soft baffles to reduce damage from recirculating fruit. The vertical elevator had an open V-type flight 48 in. long and 10 in. wide mounted on 15 in. centers. The roller conveyors used for grading were standard 52-in. wide by 10-ft long, and the belt conveyors were 14 in. wide of varying lengths. The fruit was handled in the same manner as at most processing plants, except some special features were necessary for the purpose of experimentation:

1 The fruit elevator and all conveyors had variable-speed drives to facilitate the changing of unloading rates.

2 Provisions were made for the easy installation of experimental samplers as they became available.

3 Equipment was arranged so that the fruit could be recirculated.

Fruit for testing was unloaded from a bulk truck and conveyed to the storage bin from which it could be conveyed to the packing house, another truck or back to the bin. Samples were selected each time the fruit was moved from one place to another. All fruit in every lot was rerun at least three times including its trip to the packinghouse where it was sized and counted. The fruit was separated into individual sizes by means of a standard belt and roller sizer. A microswitch on each of the sizer bins activated an electric counter to show the number of fruit of that particular size. A simple calculation provided the percentage of each individual fruit size in the "lot." The samples obtained were sized, counted and percentages calculated in like manner.

Two different sampling devices were compared, type A being the experimental unit and type G a device that represented the best of those used at commercial processing plants. The experimental sample catcher consisted of a timed, rotating, fork-type pickup arm (Fig. 1) that passed completely through the flow of fruit taking an unbiased cross section. A matching-gridded, transfer plate was installed in the conveyor system so that the arm could pass through the free-flowing fruit. The fruit picked up by this arm was delivered to a singulator unit (Fig. 2) which arranged the fruit in single file for counting. The number of fruit selected for the final sample was regulated by a predetermined setting on the control unit (Fig. 3). The conventional or

Paper No. 68-303 was presented at the Annual Meeting of the American Society of Agricultural Engineers at Logan, Utah, June 1968, on a program arranged by the Electric Power and Processing Division.

The author—JAMES G. BLAIR—is associate mechanical engineer, Florida Citrus Commission.

Author's Note: The paper is approved as journal series paper No. 2978 of the Florida Agricultural Experiment Stations and reports cooperative research by the Florida Citrus Commission and the Citrus Experiment Station, Lake Alfred, Florida, 33850.

* Numbers in parentheses refer to the appended references.

This article is reprinted from the TRANSACTIONS of the ASAE (Vol. 12, No. 2, pp. 264, 265 and 269, 1969)
Published by the American Society of Agricultural Engineers, St. Joseph, Michigan